Bu Proje, Avrupa Birliği ve Türkiye Cumhuriyeti tarafından ortaklaşa finanse edilmektedir.

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Centrum výzkumu globální změny AV ČR, v.v.i.

Effectiveness evaluation, long-term monitoring studies
Selected case studies

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28/04/2021

T.C. ÇEVRE VE ŞEHİRCİLİK BAKANLIĞI

Çevre ve İklim Eylemi Sektör Operasyonel Programı

Kalıcı Organik Kirleticiler

UNDP

Bu Proje, Avrupa Birliği ve Türkiye Cumhuriyeti tarafından ortaklaşa finanse edilmektedir.

Target

Examples of long-term monitoring programmes.
Effectiveness evaluation of remediation and bioremediation.

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Groundwater monitoring

Objectives groundwater monitoring:

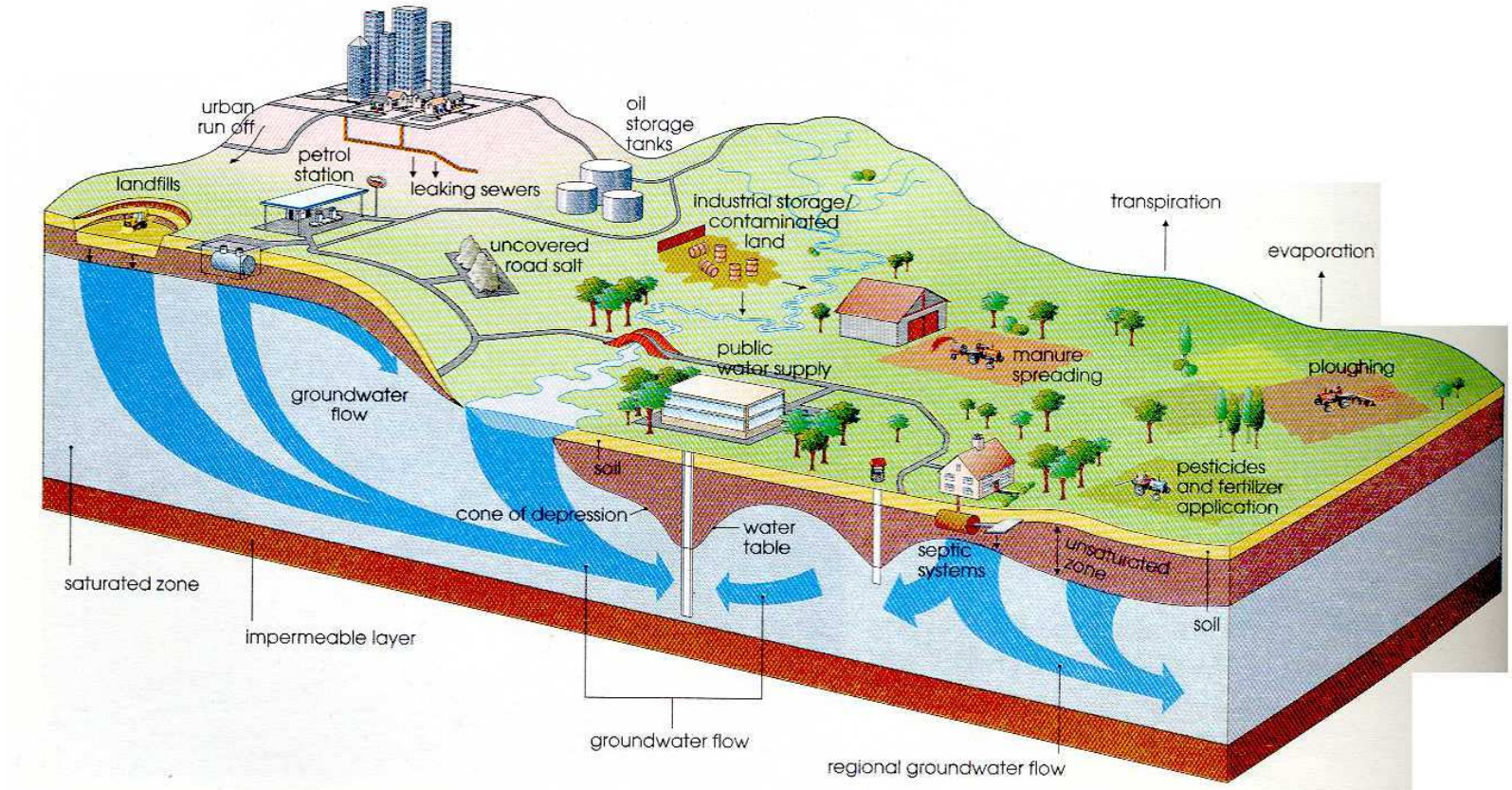
- To assess/understand general groundwater quality of the groundwater (ambient + operational monitoring)
- Finding major pollution sources (ambient/effluent monitoring)
- Compliance with regulations/ standards (effluent monitoring)
- Impact of an accidental pollution (early warning monitoring)

Groundwater pollution

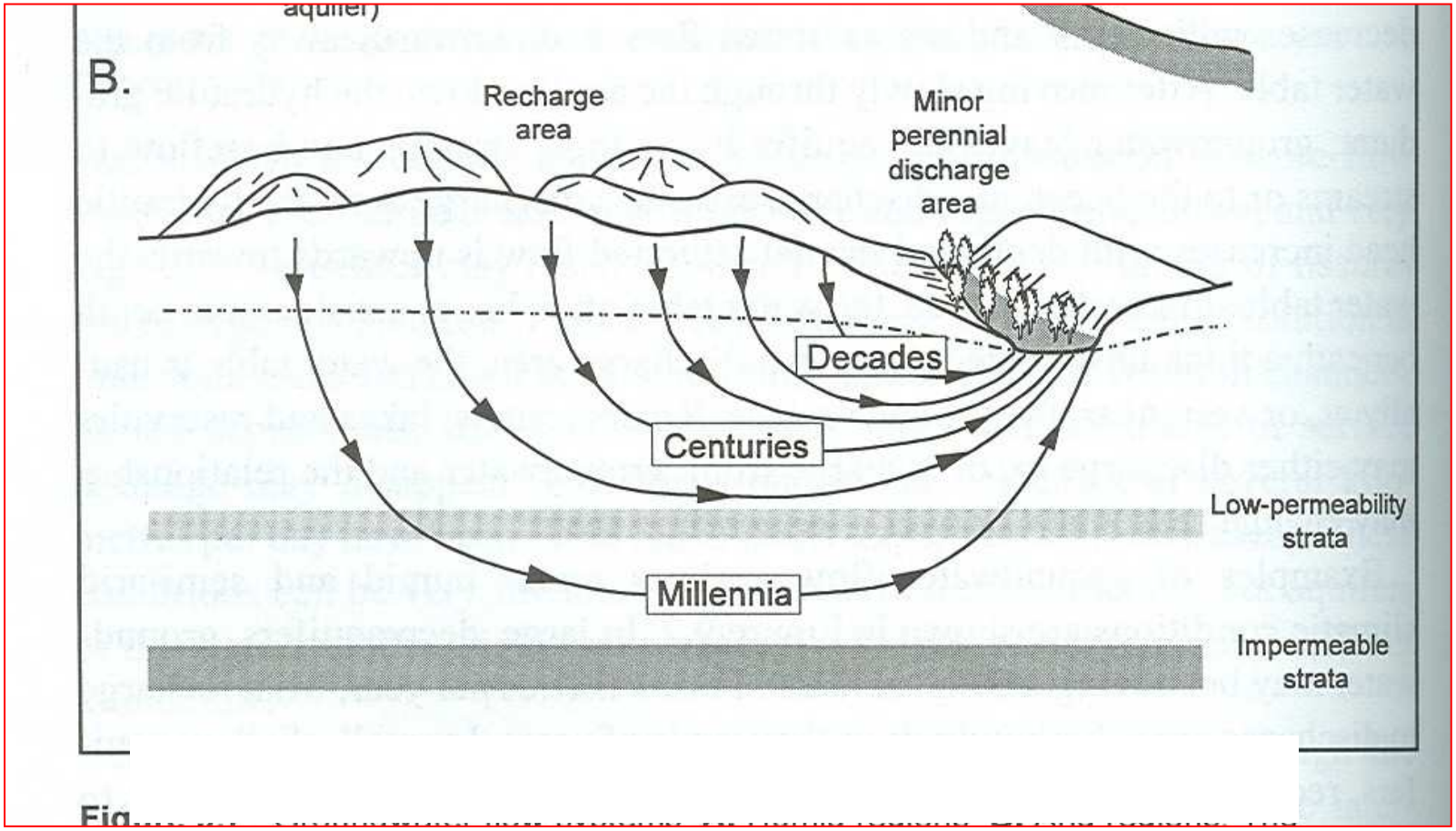
- Input of untreated domestic wastewater (BOD, Suspended solids, nutrients, bacteria and viruses, *etc.)*
- Industrial spills; mining (BOD, SS, micropollutants)
- Agriculture (NO_3^- , pesticides, Cl^- ....)
- Pit latrines and other on-site sanitation systems
- Waste dumps (domestic and hazardous wastes)

Treatment: slow, difficult and very expensive --> prevention!

Groundwater-surface water relationships



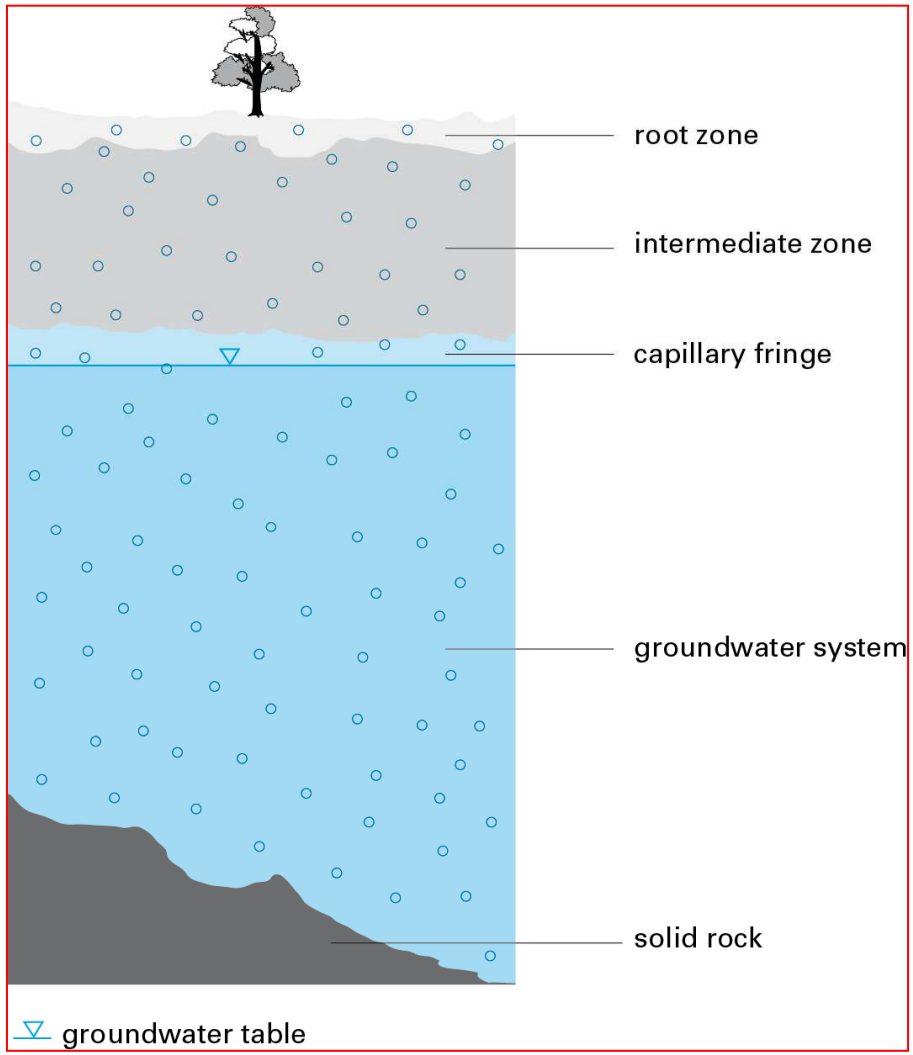
Groundwater flows



May take decades-millenia between recharge → discharge

In arid/semi arid zones often poor quality, *e.g.* high salinity

Unsaturated zone



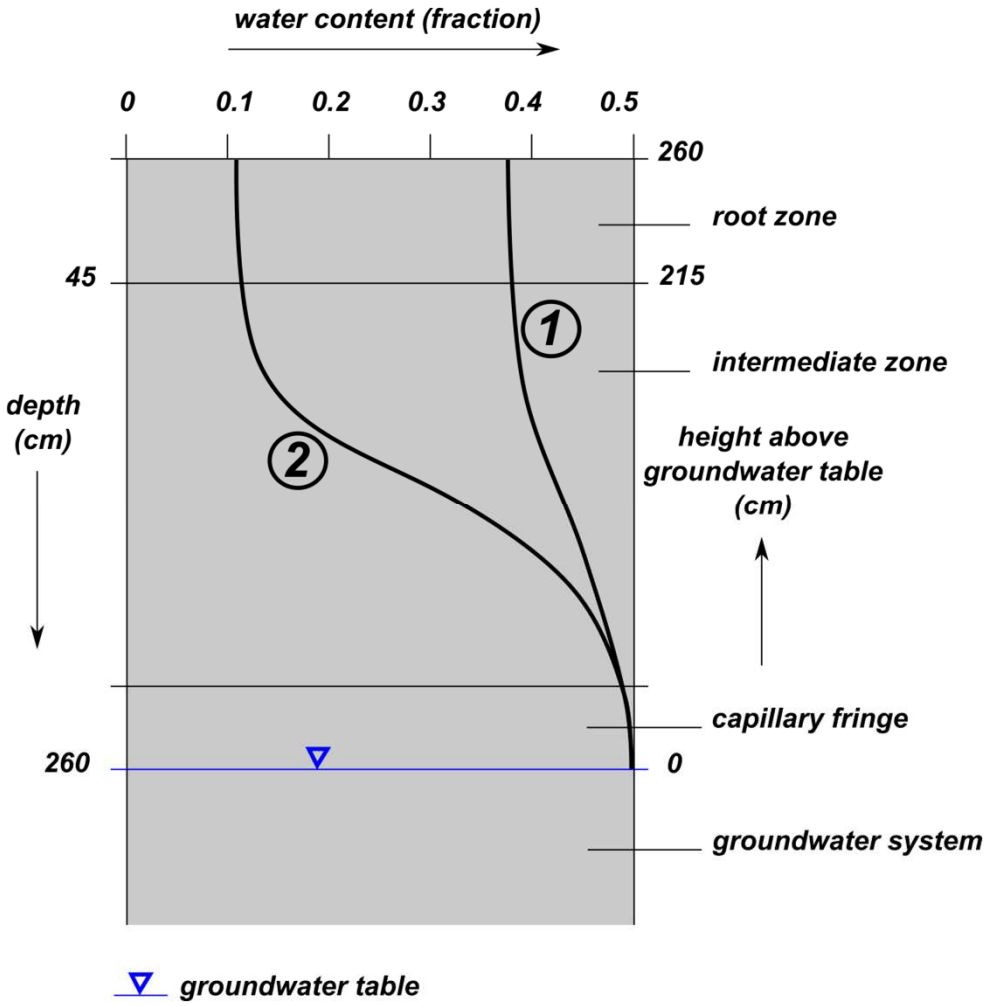
Contains network of plant roots; usually < 2m thick;

Absent in humid areas, but with large thickness in arid areas;

Zone directly above groundwater table; water pressure is less than atmospheric (tension). Thickness ranges from 1-50 cm, dependent on rock type.

Zone with (saturated) groundwater. Pressure at the groundwater table is atmospheric.

Process in the unsaturated zone



Water in unsaturated zone is prone to evapotranspiration and/or downward flow or 'groundwater recharge from precipitation'.

Assuming a precipitation event with groundwater recharge, then after the event stopped, downward flow will continue until field capacity is reached (curve 1). At field capacity, gravity forces acting on water equal surface tensions exterted by the pore structure, and downward flow terminates. Field capacity depends on type of soil. The one shown here is typical for silty loam.

During dry periods, when there is no downward flow, there may be upward flow or capillary flow. When wilting point is reached, roots are not able to extract sufficient moisture for plant survival. Curve 2 shows wilting point conditions for a silty loam.

The structure of rocks: porosity

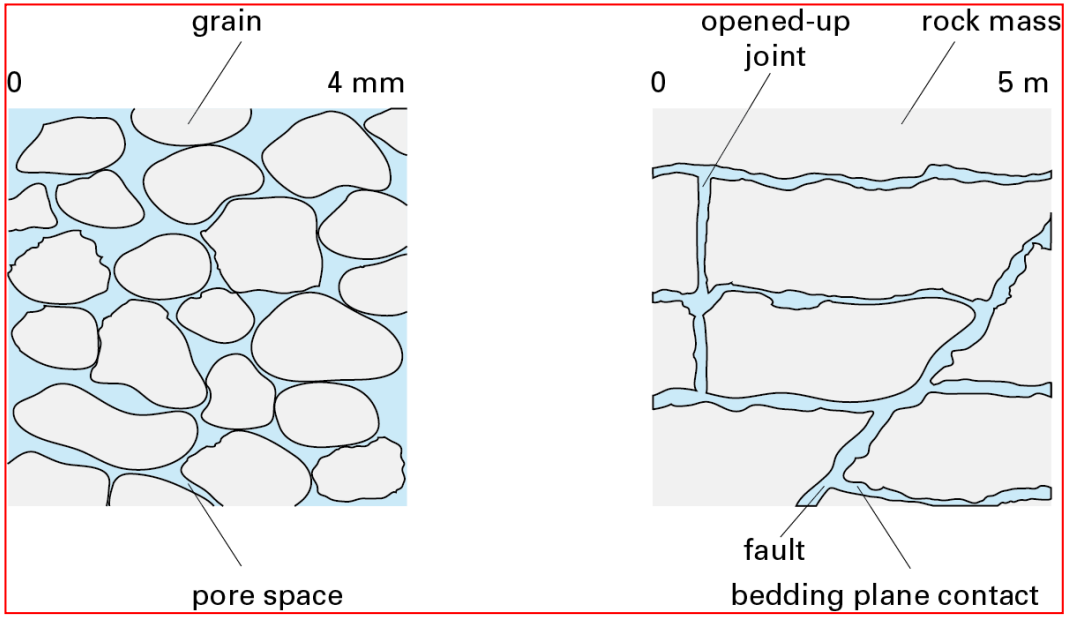
Porosity of rock is the ratio of the volume of open space in the rock and the total volume of rock (including the open space):

$$n = \frac{V_O}{V_T}$$

n rock porosity

V_O volume of the open space (m^3)

V_T total volume of the rock including open space (m^3)



In consolidated rocks, openings are primarily present at fractures, joints, bedding planes, and solution holes. This type of porosity is referred to as secondary porosity.

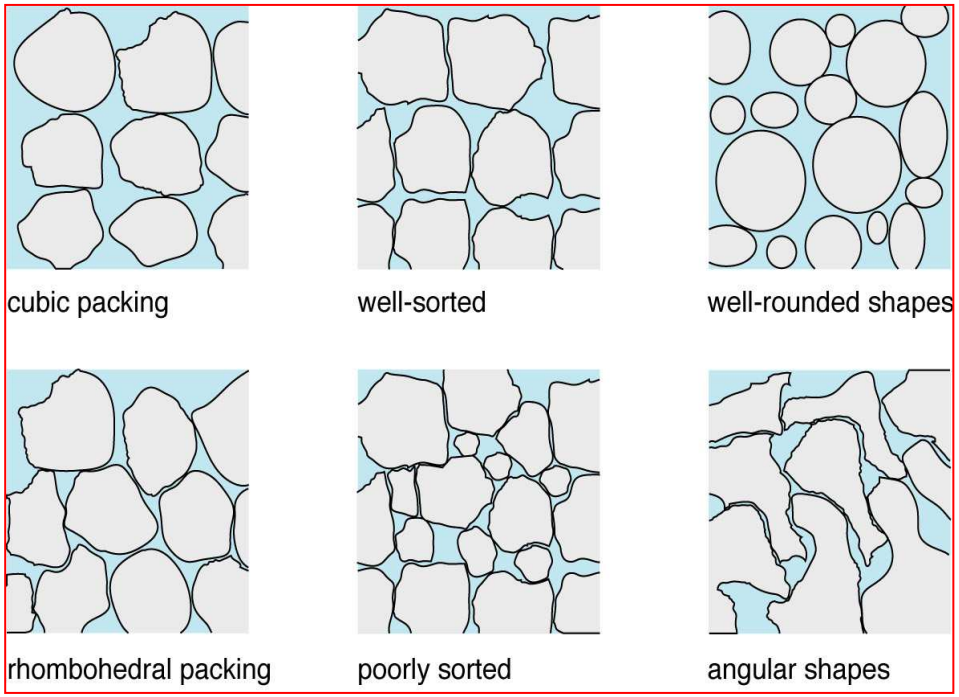
In unconsolidated rocks, openings or pores are present between individual grains. This type of porosity is referred to as primary porosity.

The structure of rocks: porosity

The structure of rocks: porosity

In unconsolidated rocks, (total) porosity ranges from 0.2-0.7.

Rock type	Range of porosities
Unconsolidated rock	
Gravel	0.2-0.4
Sand	0.2-0.5
Silt..→clay	0.3-0.5 0.3.. -0.7→>0.95



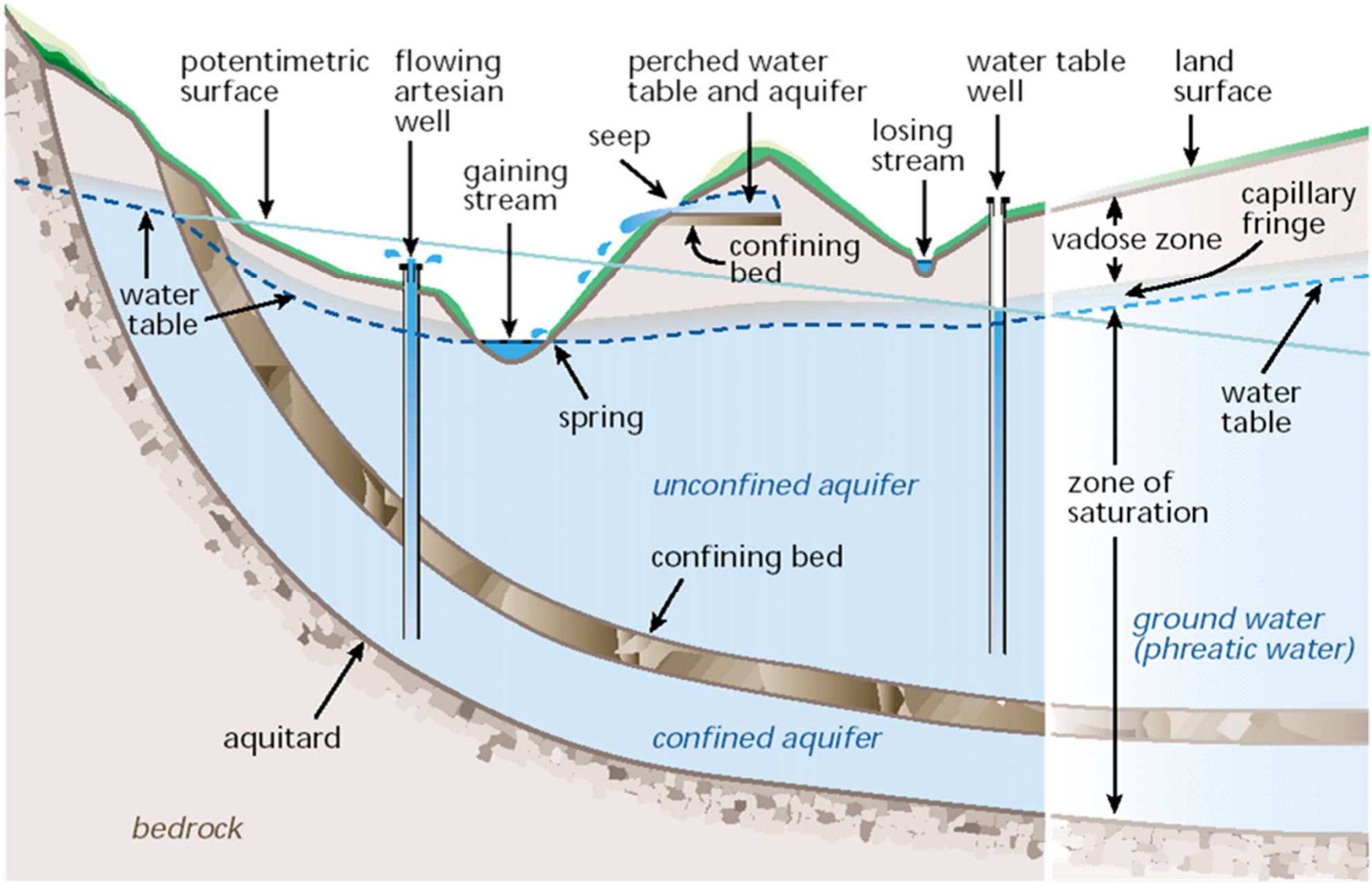
Porosity in this case relates to the packing, sorting, and shape of grains:

Porosity of sediment with cubic packing, well-sorted, well-rounded = ~ 0.48

Porosity of similar sediment, but rhombohedrally packed = ~ 0.26

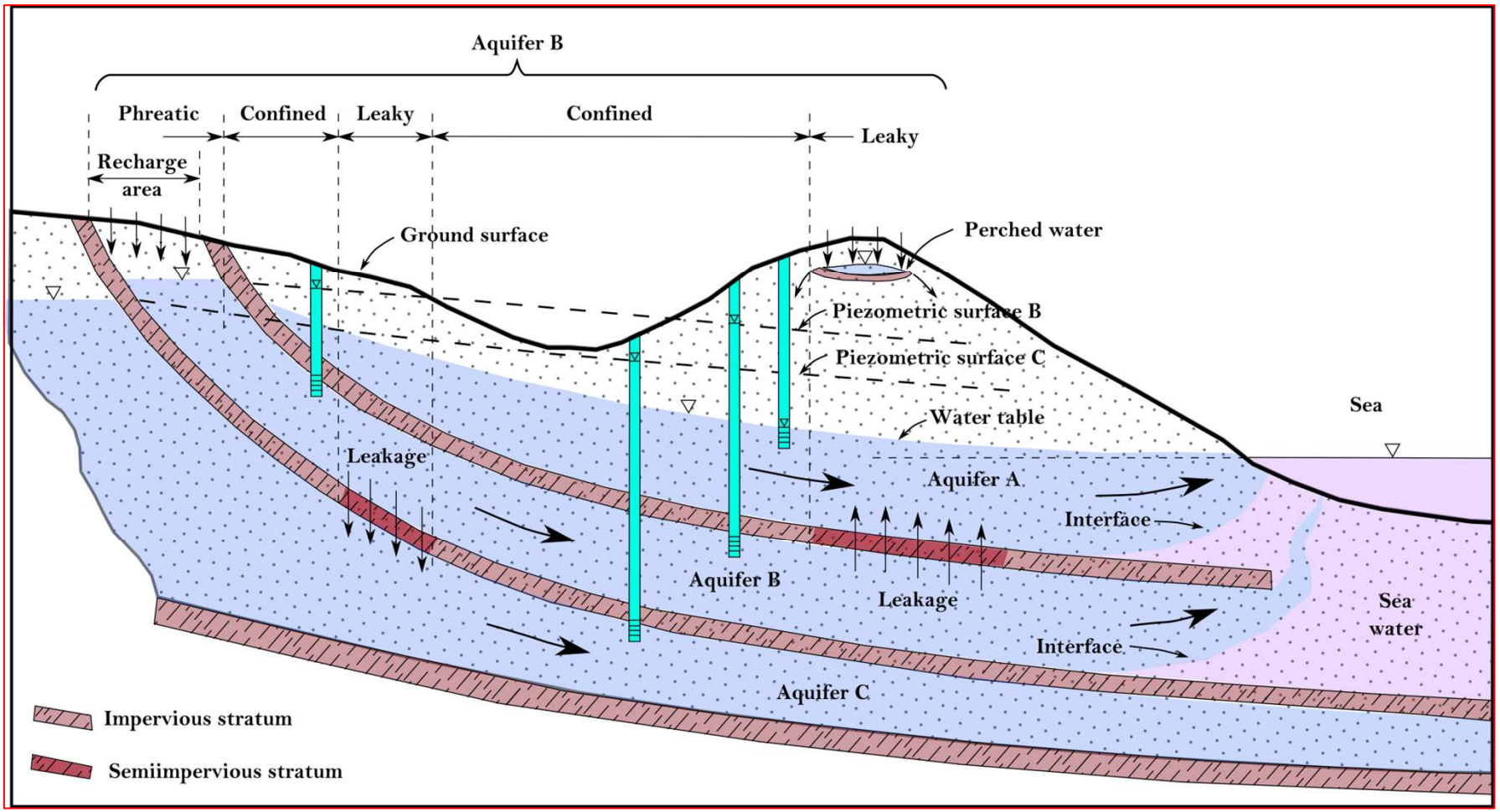
When sorting is poor, and grains are not rounded, porosity decreases further.

Groundwater Terminology

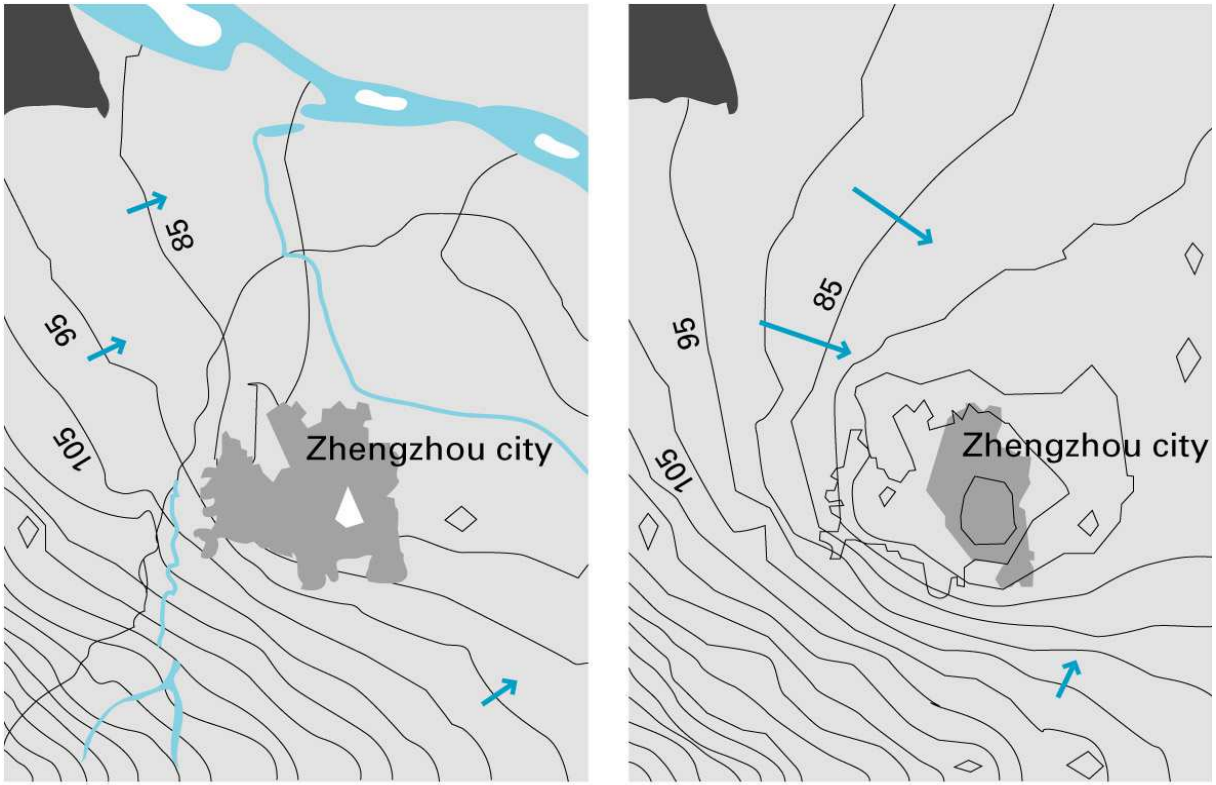


Classifying aquifers: a quite complicated example

From left to right, aquifer B is phreatic, confined, leaky, confined, and finally, leaky again. Please note that, when the piezometric surface is above ground surface, the aquifer is called 'artesian'.



Regional flow and groundwater head contour maps



105 groundwater head contour line

→ flow direction

For shallow aquifer: flow towards river.

For lower aquifer: flow towards the city. Here, a cone of depression is present, caused by excessive pumping below the city.

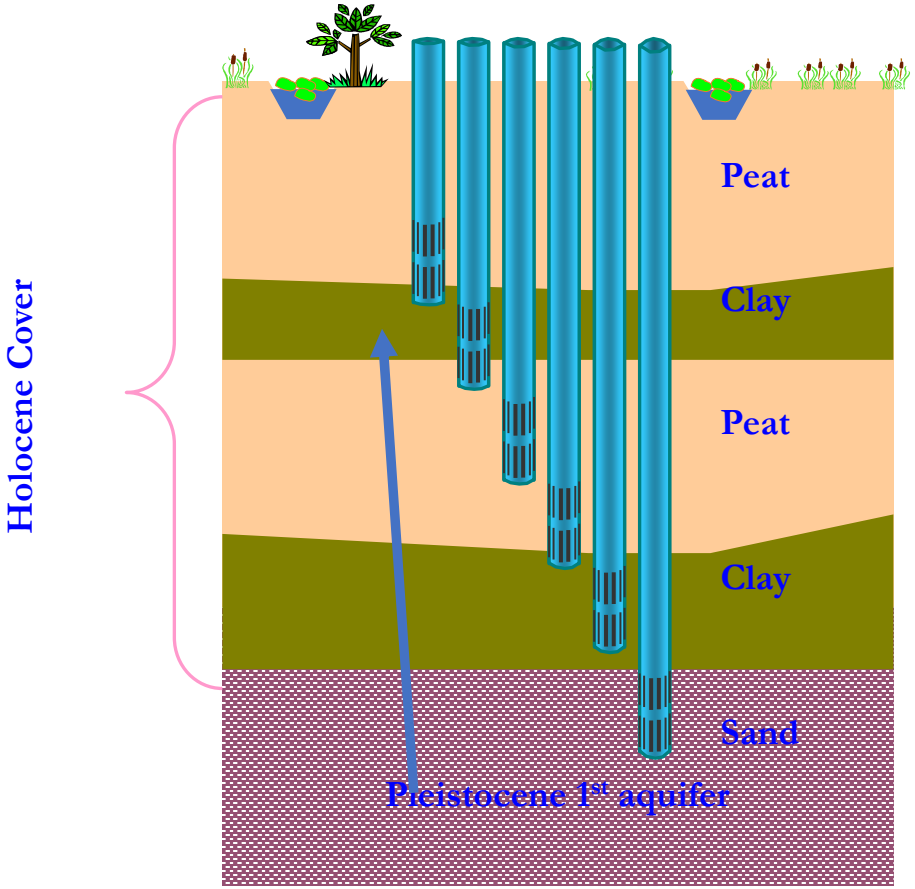
There is also flow from the upper to the lower aquifer through the aquitard.

Left figure: upper aquifer; right figure: lower aquifer (separating aquitard is not shown)

Groundwater sampling/ analysis

Piezometer nests

in Exfiltration area



Groundwater sampling/analysis

Sampling a 60 m deep groundwater well
in
Limburg, The Netherlands

Karst spring, Mount Hermon area, Syria

Dug well in Yemen highland

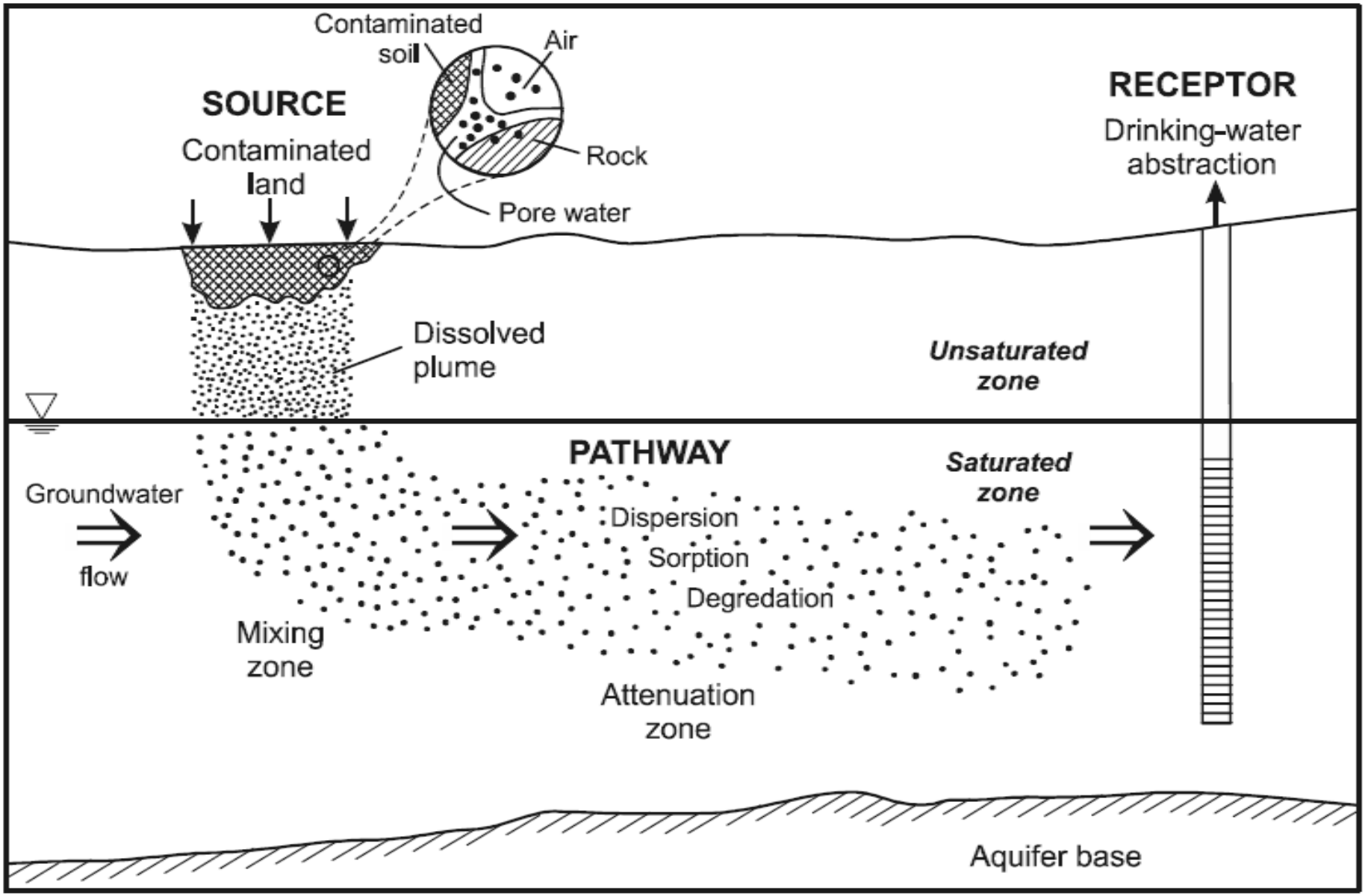
Hidden in the little hill, a public supply
drinking water well, Brixen, Italy

Groundwater seep (with very low
electrical conductivity!!)
South-Pare mountains, Tanzania

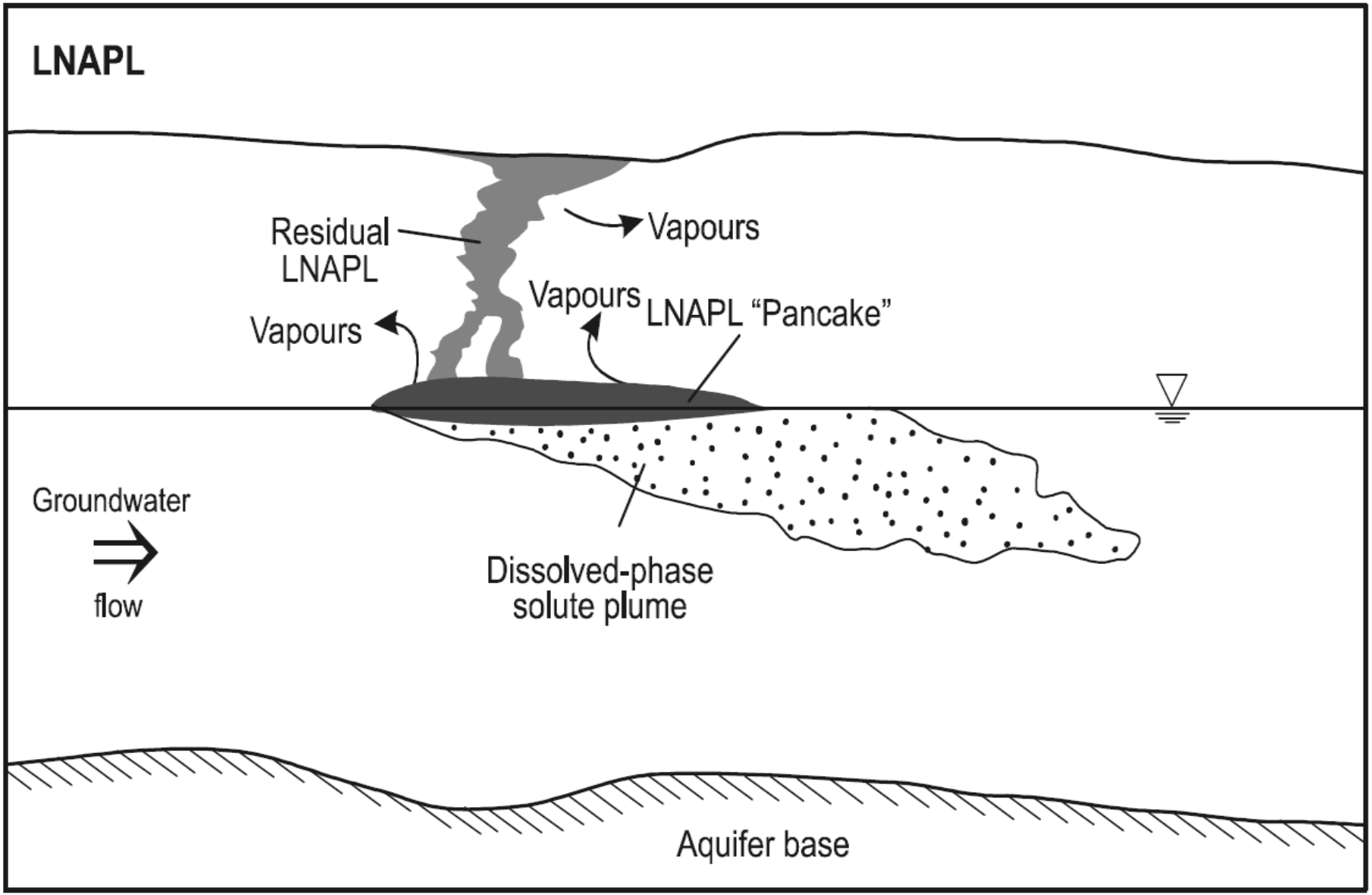
Artesian well, Strijbeekse beek,
The Netherlands

Groundwater sampling/analysis

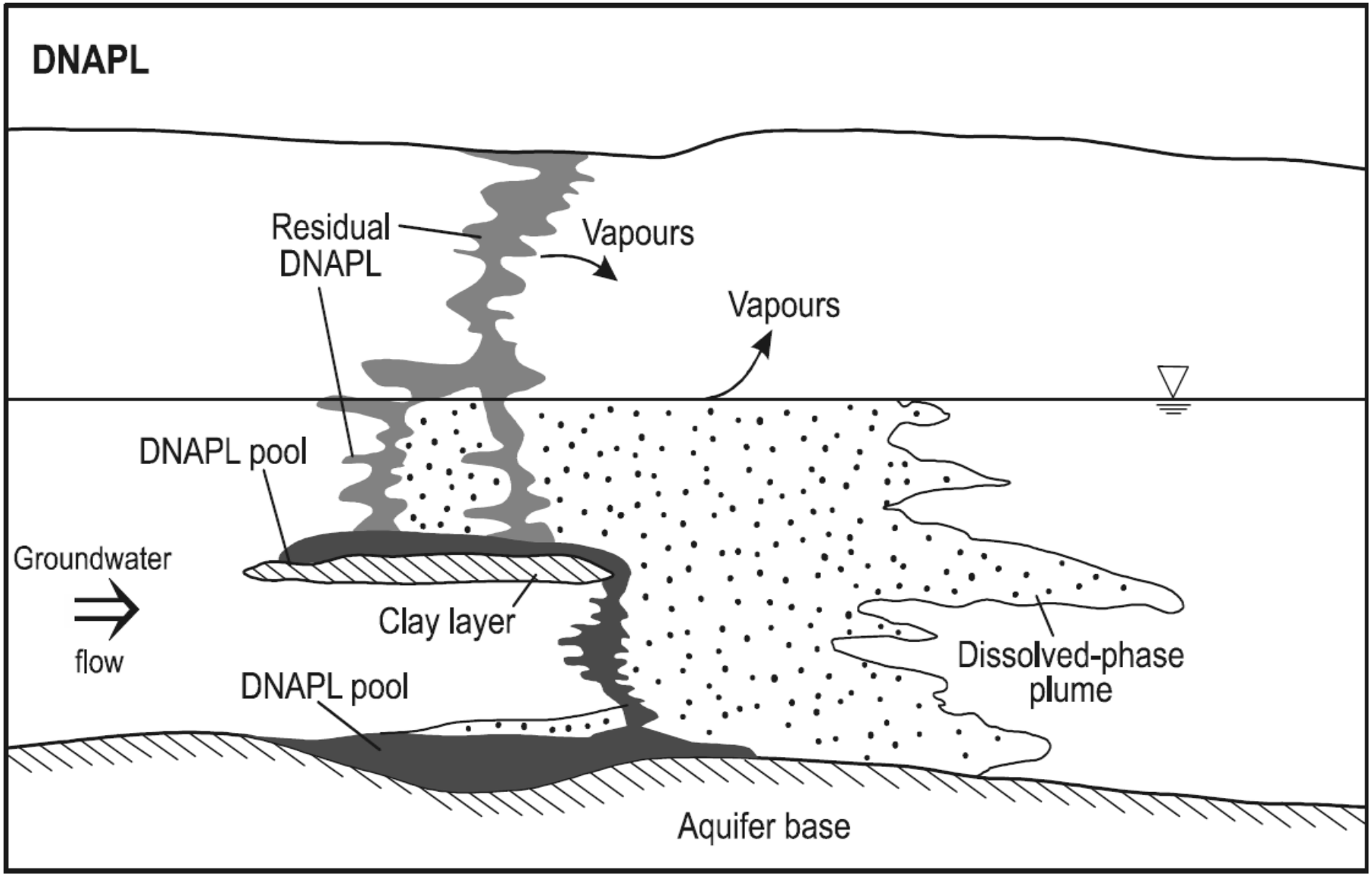
Classical contaminant conceptual model



LNAPL (light non-aqueous phase liquid; *e.g.* petrol, benzene)

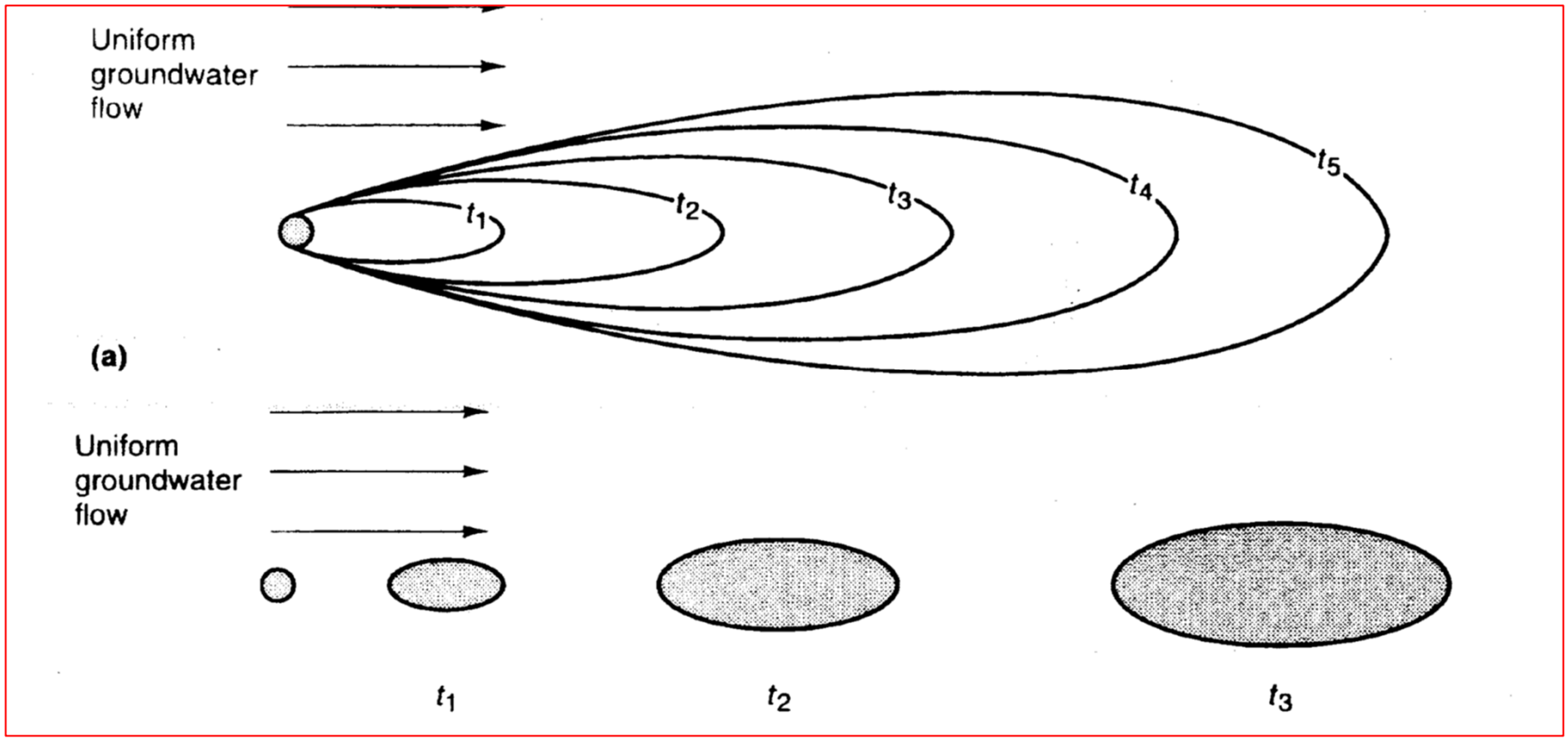


DNAPL (Dense non-aqueous phase liquid, e.g. heavy oils)



Fate of pollutants on groundwater

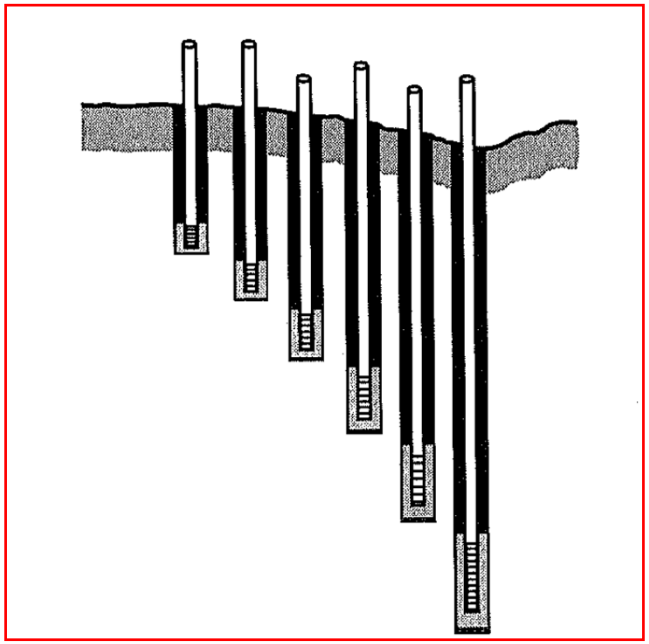
Groundwater flow cm's/day (much less in clay)



- Adsorption/precipitation (but for *e.g.* NO_3^- unhindered flows)
- Microbiological degradation (*e.g.* BOD; also die-off of bacteria)
- Complexation, redox reactions, *etc.* (*e.g.* $Fe^{2+} \rightarrow Fe^{3+} \rightarrow Fe(OH)_{3\downarrow}$)

Number, locations, frequency

- Number of stations much dependent on objectives; in The Netherlands: *ca.* 1 per 100 km^2 (near drinking water extractions)
- In many (large and/or less developed) countries: much lower density.
- Location of stations: After surveys. Look at groundwater flows and directions; geology, *etc.* Often special boreholes have to be constructed.



Piezometers installed in a drillhole

Number, locations, frequency

Sampling frequency: about 1-4 times per year; much more for:

- Specific research (see figure hereunder)
- Rapid groundwater flows; high permeability (sand)

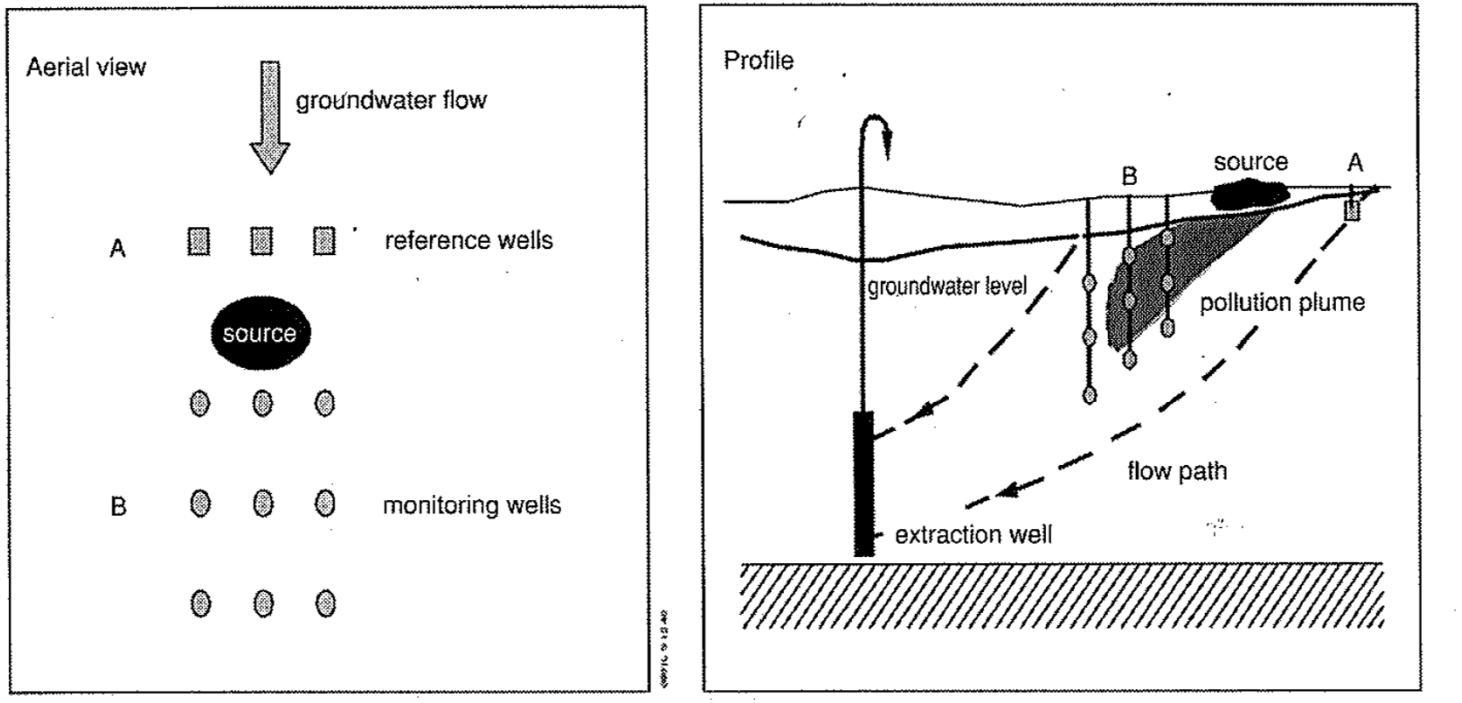


Figure 4: Aerial view (left) and profile (right) of the recommended lay out to monitor point pollution, using reference wells upstream (A) and monitoring wells downstream (B) of the potential source.

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Global monitoring of POPs

Need for regional monitoring programmes

UN ECE Convention on Long Range Transboundary Air Pollution – POPs Protocol - includes the measurements of several PTSs in the air

EMEP Activities

AMAP collects data on PTS levels in the Arctic region

Marine conventions in Europe (OSPAR, Helsinki, Barcelona and Bucharest Conventions) collect data from the marine environment

The Water Framework Directive demands a large amount of new data to be produced in EU

DG Environments initiative ”Health and Environment”

Regional monitoring of POPs

Existing monitoring programmes

- European Monitoring and Evaluation Programme (EMEP)
- The Arctic Monitoring and Assessment Programme (AMAP) and the Northern contaminants programme (NCP)
- Norwegian Arctic and Antarctic stations
- The Toxic Organic Micropollutants (TOMPS) air monitoring programme
- Monitoring (MONARPOP)
- Integrated Atmospheric Deposition Network (IADN)
- The National Air Pollution Surveillance (NAPS)
- Global Atmospheric Passive Sampling (GAPS) network
- MONitoring NETwork (MONET) of POPs in ambient air using the PUF passive samplers

Regional monitoring programmes

- UN-ECE LRTP POPs protocol includes measurements of several PTSs in air
- AMAP is collecting data on PTSs levels in the Arctic region
- Marine conventions in Europe (OSPAR, Helsinki, Barcelona and Bucharest Conventions) are collecting data from the marine environment
- The Water Framework Directive will demand a large number of new data to be produced in EU
- DG Environments initiative ”Health and Environment”

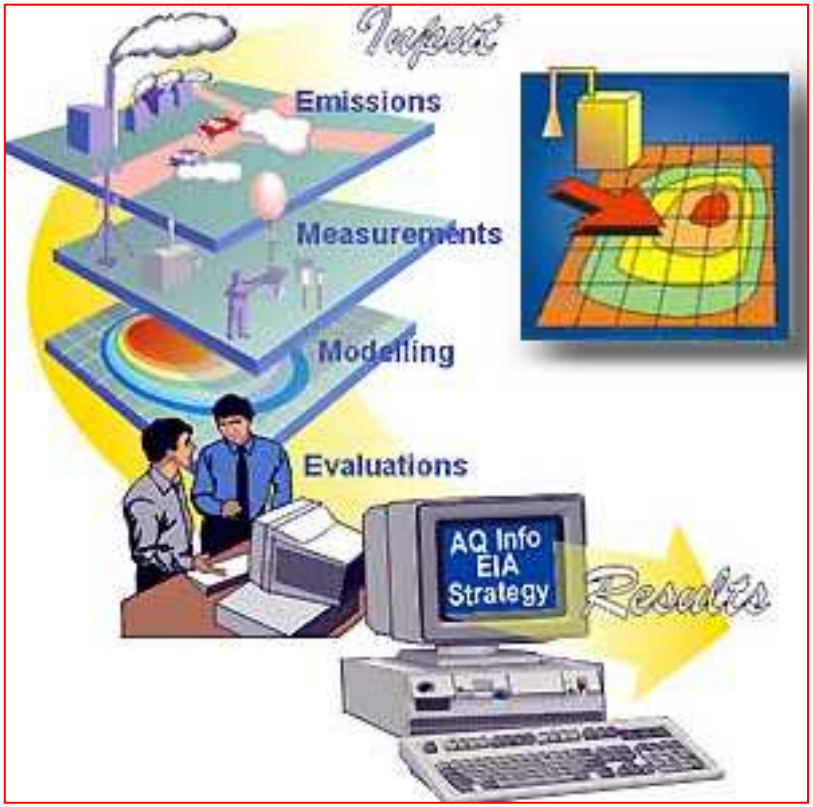
Regional approches

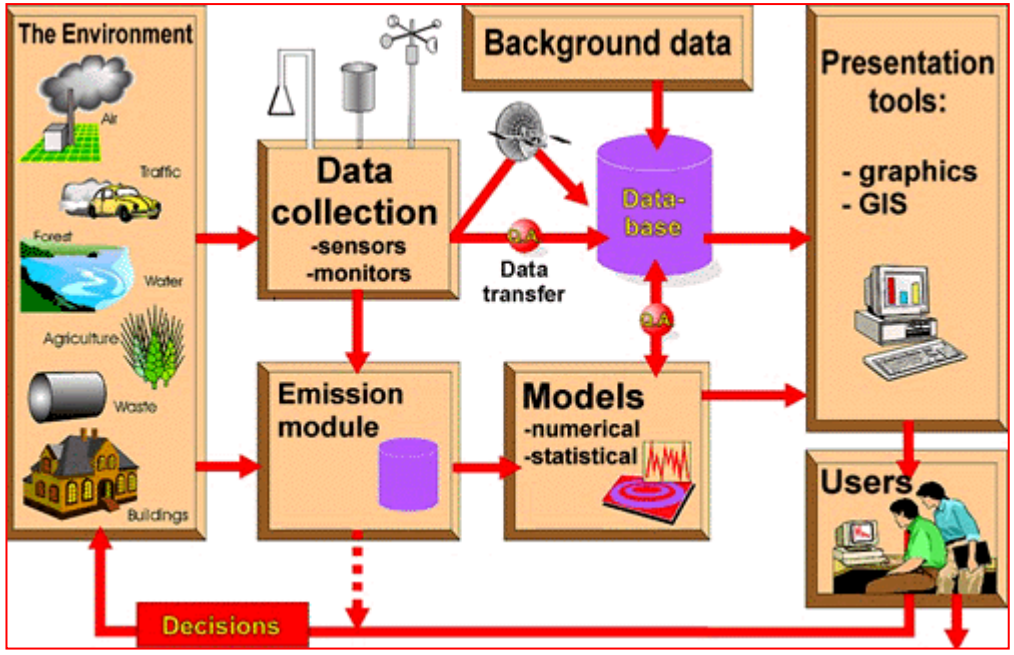
Regional:

- **UN ECE Convention on Long Range Transboundary Air Pollution – POPs Protocol**
- **EMEP Activities**

Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe

EMEP - Regional approches





Water Framework Directive

- Water Framework Directive (WFD) 2000/60/EC
- Environmental Quality Standards (EQS) Directive 2008/105/EC
- Directive 2013/39/EU amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy
- Directive 2009/90/EC on technical specifications for chemical analysis and monitoring of water status (QA/QC)

Water Framework Directive

- Protection of aquatic ecosystems
- No deterioration principle
- Water management based on river basin districts
- Environmental quality standards and emission controls
- „Phasing out" of priority hazardous substances
- Integration of other directives related to water issues
- Objective: To achieve good water status (ecological and chemical) by December 2015

Environmental Quality Standards (EQS) Directive 2008/105/EC and its update 2013/39/EU

- Sets out environmental quality standards (EQS) of certain pollutants and substances or groups of substances identified as priority on account of the substantial risk they pose to or via the aquatic environment
- AA-EQS - the average value or concentration of the substance concerned calculated over a one-year period. The purpose of this standard is to ensure the long-term quality of the aquatic environment;
- MAC-EQS the maximum allowable concentration of the substance measured specifically. The purpose of this second standard is to limit short-term pollution peaks.
- Member States must ensure compliance with these standards. They must also verify that the concentration of substances concerned does not increase significantly in sediments and/or the relevant biota.

Priority Substances according to 2008/105/EC

Priority Hazardous Substances

Anthracene
Brominated diphenylethers
Cadmium and its compounds
C10-C13-Chloroalkanes
Di(2-ethylhexyl)phthalate (DEHP)
Endosulfan
Hexachlorobenzene (HCB)
Hexachlorobutadiene (HCBD)
Hexachlorocyclohexane
Mercury and its compounds
Nonylphenols
Pentachlorobenzene
Polyaromatic Hydrocarbons (PAHs)
Tributyltin compounds
Trifluralin

Toxic, persistent, liable to bioaccumulate

Priority Substances

Alachlor
Atrazine
Benzene
Chlorfenvinphos
Chlorpyrifos (ethyl)
1,2-Dichloroethane
Dichloromethane
Diuron
Fluoranthene
Isoproturon
Lead and its compounds
Naphthalene
Nickel and its compounds
Octylphenols
Pentachlorophenol
Simazine
Trichlorobenzenes
Trichloromethane

Other specific pollutants

DDT / p,p‘-DDT
Aldrin
Dieldrin
Endrin
Isodrin
Carbontetrachloride
Tetrachloroethylene
Trichloroethylene

New Priority Substances: 2013/39/EU

- 10 additional Priority Substances (PS)
- Pesticides and biocidal products
- Industrial chemicals (POPs)
- Pharmaceuticals (only included to Watchlist)
- Stricter EQS for some existing PS
- Biota standards for several substances

Water Framework Directive

All surface waters

- **Rivers, lakes, artificial waters**
- **Transitional waters** (partly saline)
- **Coastal waters** (up to one sea mile)

Types of Chemical Monitoring

- **Surveillance (12 samples per year)**
- **Operational**
- **Investigative**

Available water data

European environmental agency holds a database

http://www.eea.europa.eu/#tab-datamaps

And so does AMAP - http://www.amap.no/data - from the marine environment there is little water data as monitoring is mostly focused on biota

For OSPAR the data are accessible at ICES www.ices.dk - ICES seems to allow passive sampling data, but not much is uploaded yet.

Dome portal has all sediment data up to 2011 available ofline

http://ices.dk/marine-data/data-portals/Pages/DOME.aspx

In the UK http://data.gov.uk/ On request they also deliver data on specification http://data.gov.uk/odug

The Netherlands data accessible through http://live.waterbase.nl/waterbase_wns.cfm?taal=en, but can be delivered in database format through https://www.rijkswaterstaat.nl/formulieren/contactformulier_servicedesk_data.aspx

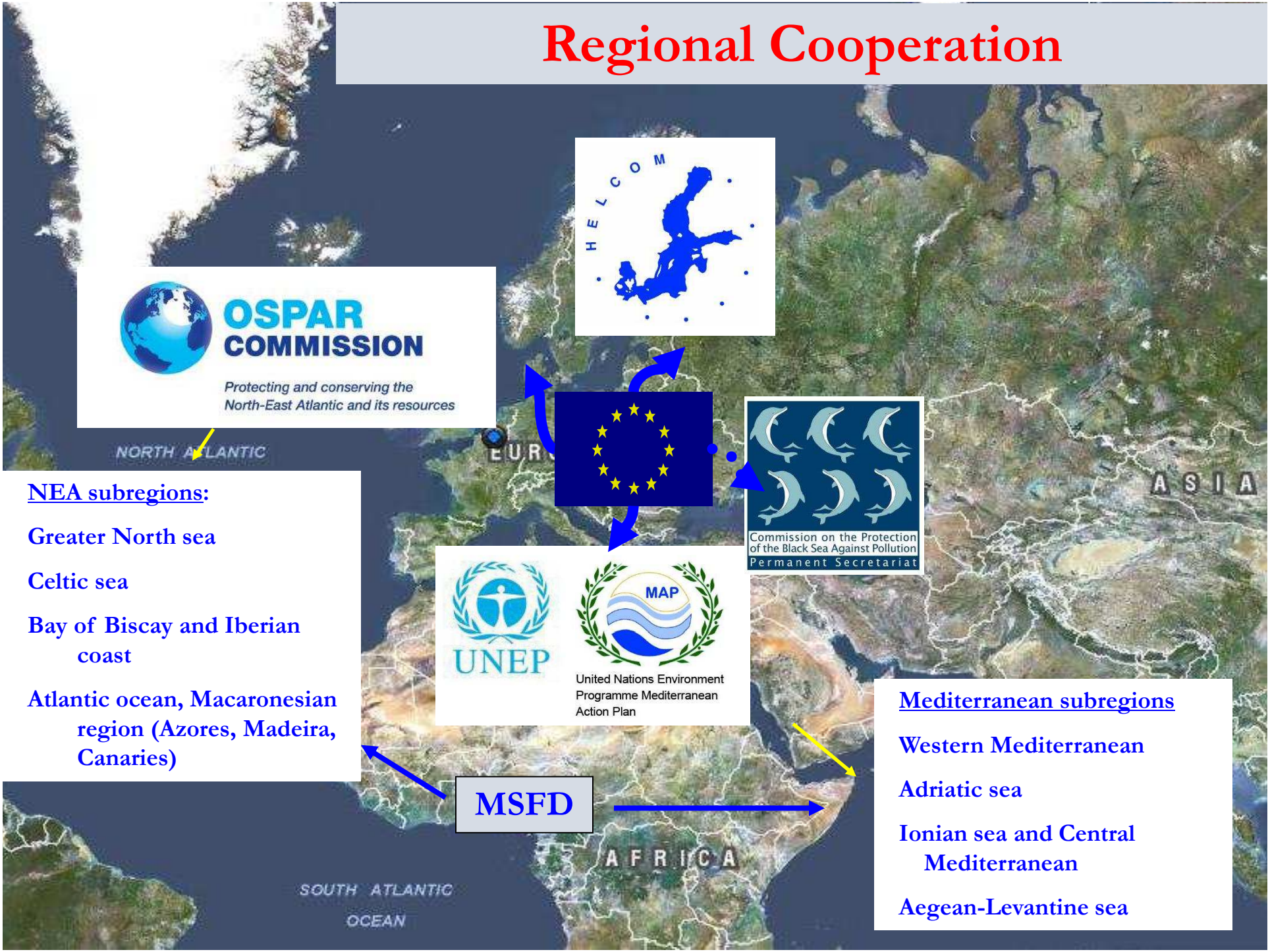
The Marine Strategy Framework Directive
EU's legal instrument for the protection of our seas

Overall objective: achieve or maintain Good Environmental Status (GES) of the EU's marine waters by 2020.

Adoption of an ecosystem-based and integrated approach to the management of all human activities which have an impact on the marine environment.

Regional approach to implementation, and establishment of European Marine Regions

Regional Cooperation



NEA subregions:

- Greater North sea
- Celtic sea
- Bay of Biscay and Iberian coast
- Atlantic ocean, Macaronesian region (Azores, Madeira, Canaries)

Mediterranean subregions

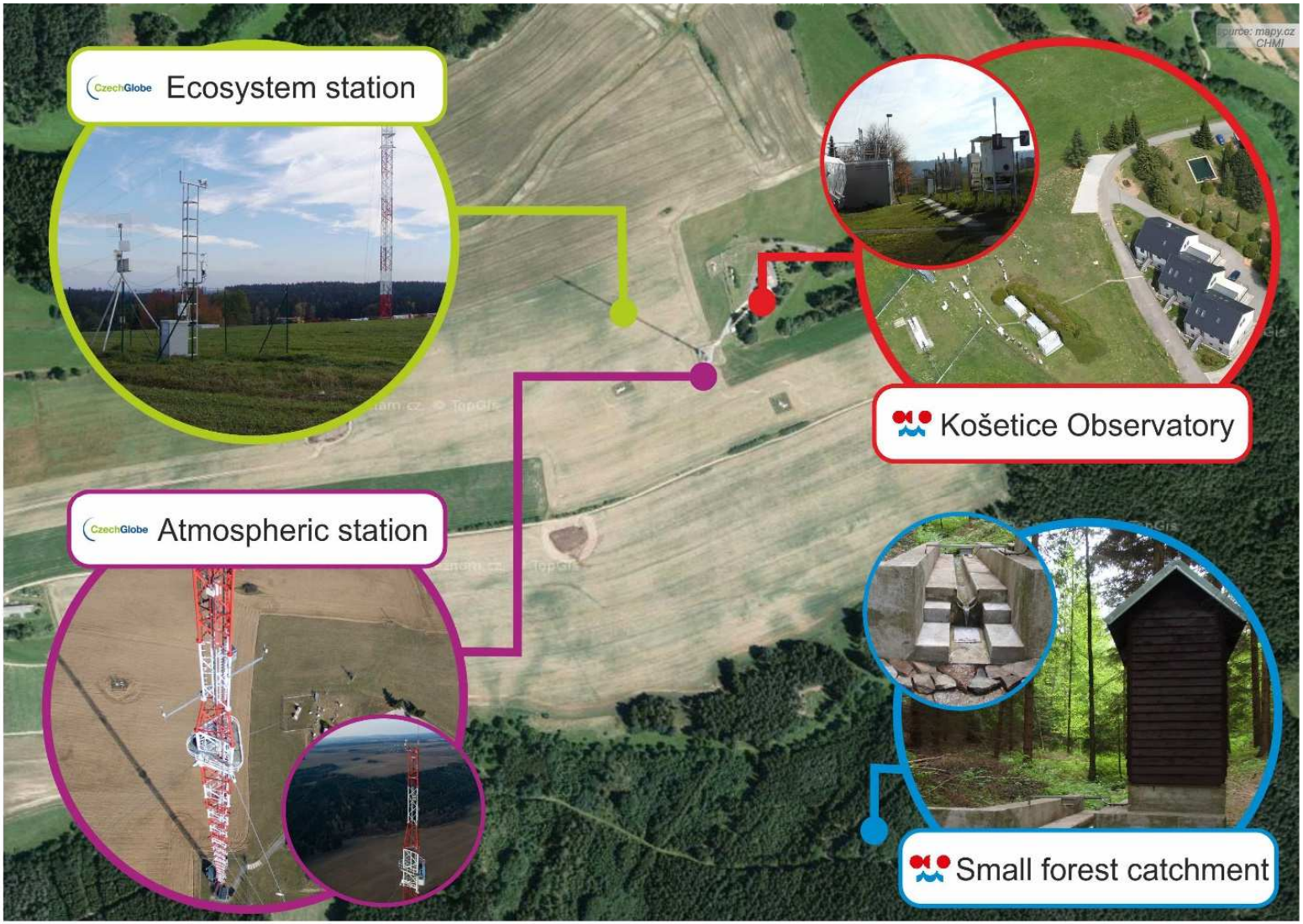
- Western Mediterranean
- Adriatic sea
- Ionian sea and Central Mediterranean
- Aegean-Levantine sea

Good Environmental Status (GES)

"The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive" (Art. 3(5)).

- Marine resources are used at a sustainable level, ensuring their continuity for future generations.
- Ecosystems are fully functioning and resilient to human-induced environmental change;
- Biodiversity is protected and biodiversity decline caused by human activities is prevented;
- Substances and energy introduced in the marine environment by human activities do not cause pollution effects.

National Atmospheric Observatory Košetice – the core part of ACTRIS-CZ



Atmospheric Station, CzechGlobe

Atmospheric Station, CzechGlobe

- **250 m tall atmospheric tower**
- **ground based technological containers**
- **technological container at 230 m**
- **air-conditioned cabinets at 8, 50, 125 m**
- **elevator (230 m)**

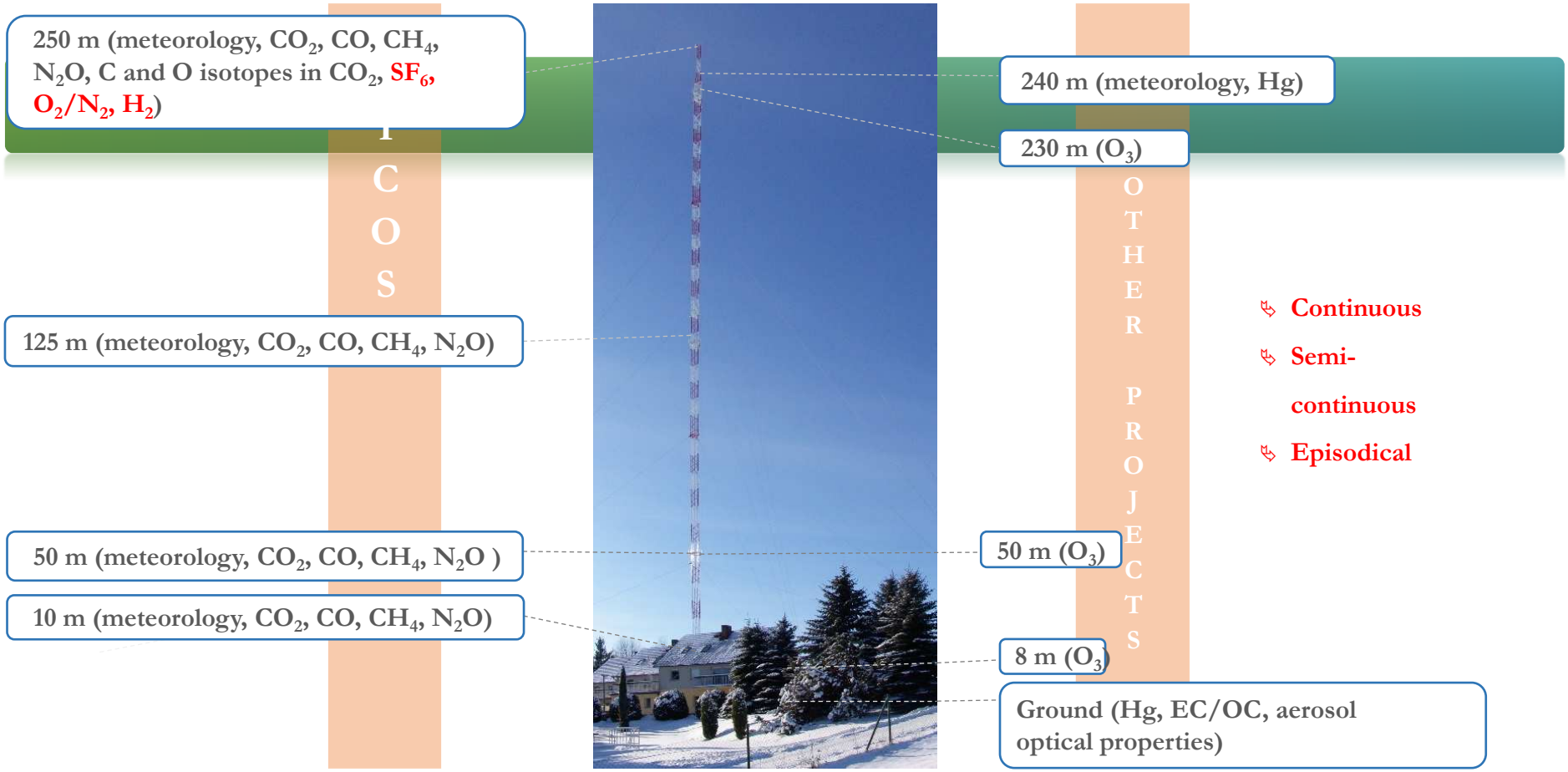
AS is focused on the investigation of the background temporal trends, vertical concentration gradient and long-range transport of GHGs and selected atmospheric pollutants.

This is complemented by the monitoring of basic meteorological characteristics.

Atmospheric station Křešín u Pacova

Exploiting the potential of high tower

Measurements



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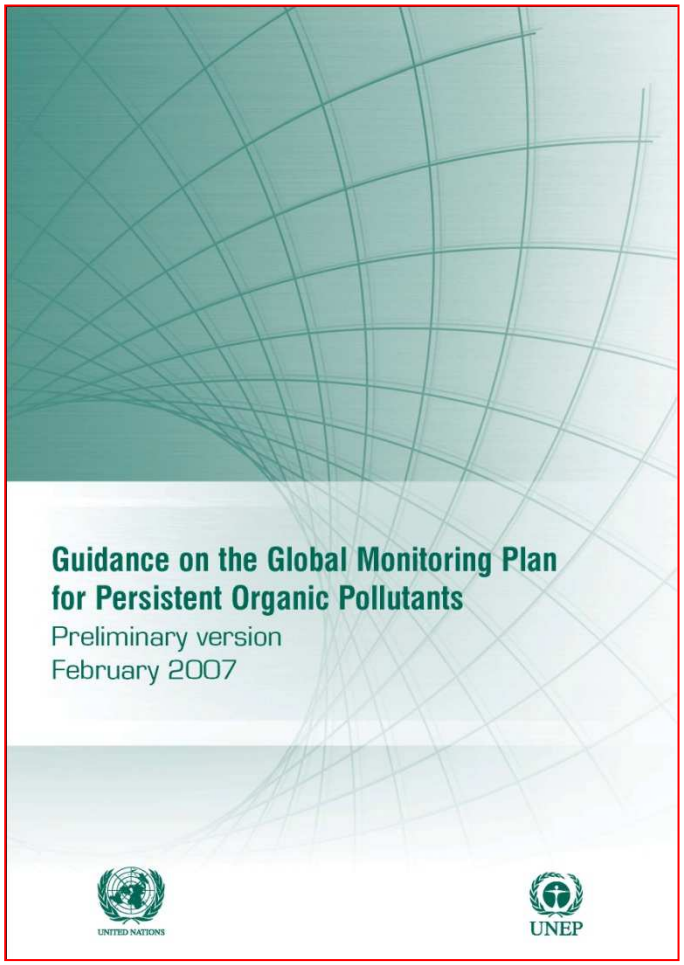
Stockholm Convention

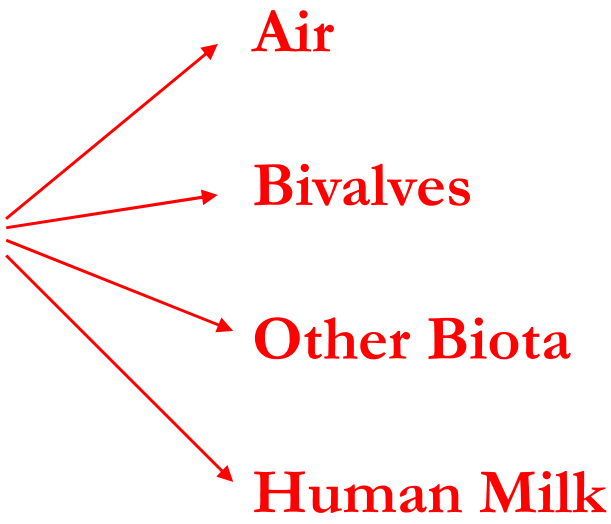
The objective of the Convention is to protect human health and the environment from POPs with the ultimate goal to eliminate them, where feasible.

An obvious way to evaluate the effectiveness of the Convention (pursuant to Art. 16) is to measure (to monitor) the concentration of the POPs listed in annexes A, B, and C of the Convention in relevant matrices.

Global Monitoring - Air



UNEP - Stockholm Convention on POPs
"Effectiveness Evaluation"



Air:

Passive air samplers to complement active air samplers.

- no pump; no electricity
- small and cheap
- simple

Recommendations for POPs to be monitored

Because it may not be necessary or even possible to analyse all individual congeners present in the POPs mixtures, such as PCBs, PCDDs, PCDFs, Toxaphene, the following substances, incl. some transformation products are recommended for monitoring analysis:

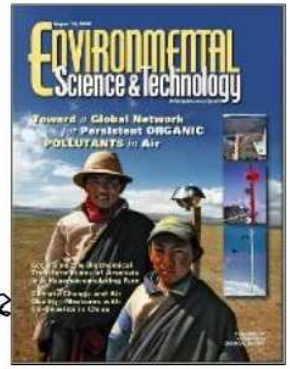
Chemical	Parent POPs (Transformation Products)
Aldrin	Aldrin
Chlordane	*cis*- & *trans*-chlordane (*cis*- & *trans*-nonachlor, oxychlordane)
DDT	4,4‘-DDT, 2,4‘-DDT (4,4‘-DDE, 2,4‘-DDE, 4,4‘-DDD, 2,4‘-DDD)
Dieldrin	Dieldrin
Endrin	Endrin
HCB	HCB
Heptachlor	Heptachlor (heptachlorepoxide)
Mirex	Mirex
PCBs	SPCBs: # 28, 52, 101, 105, 118, 138, 153, and 180 PCBs with TEFs: # 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189
PCDDs	2,3,7,8-substituted congeners
PCDFs	2,3,7,8-substituted congeners
Toxaphene	Congeners # 26, 50, 62

GAPS, Environment Canada

GAPS – Global Context

Global Atmospheric Passive Sampling Network

Pozo et al., ES&T, 2009



Shunthirasingham et al, JEM, 2010

2010 sampling sites
Modified: October 15, 2010

- ~55 sites since 2005
- Monitoring (reporting to GMP)
- Surveillance (new priority chemicals)

GAPS Network:
www.ec.gc.ca/rs-mn/default.asp?lang=En&n=22D58893-1

Canada

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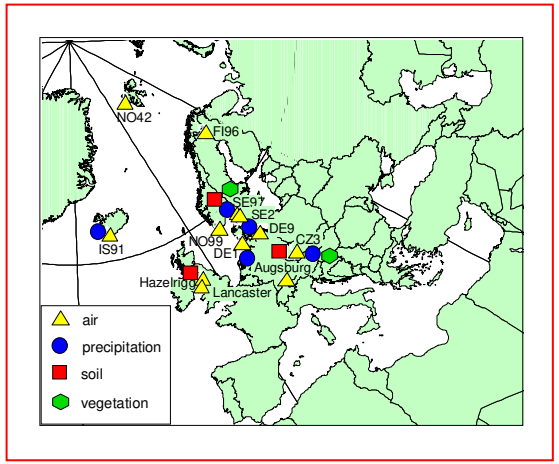
Superstation concept - Observatory Košetice, CR

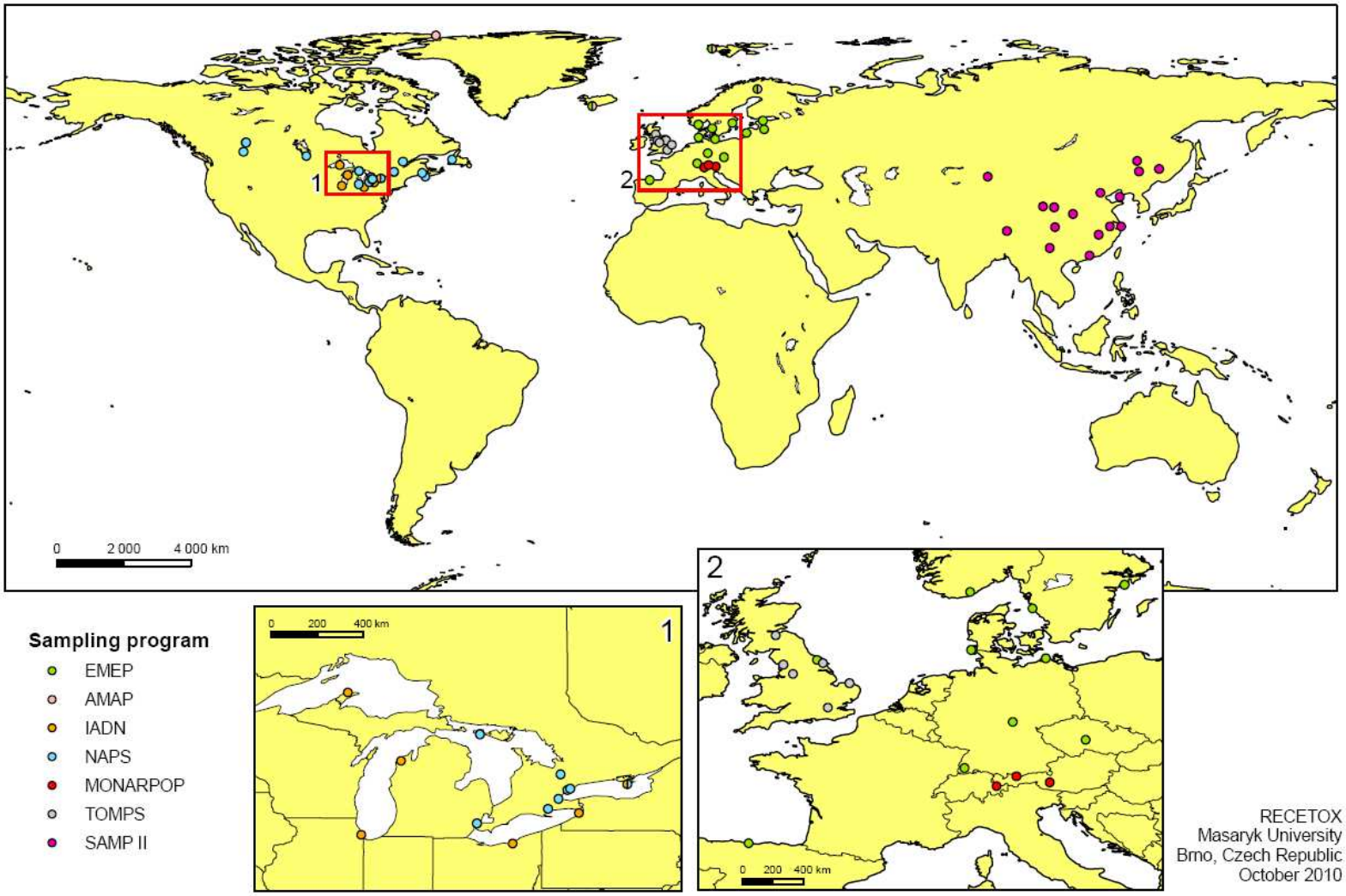
EMEP POPs Network



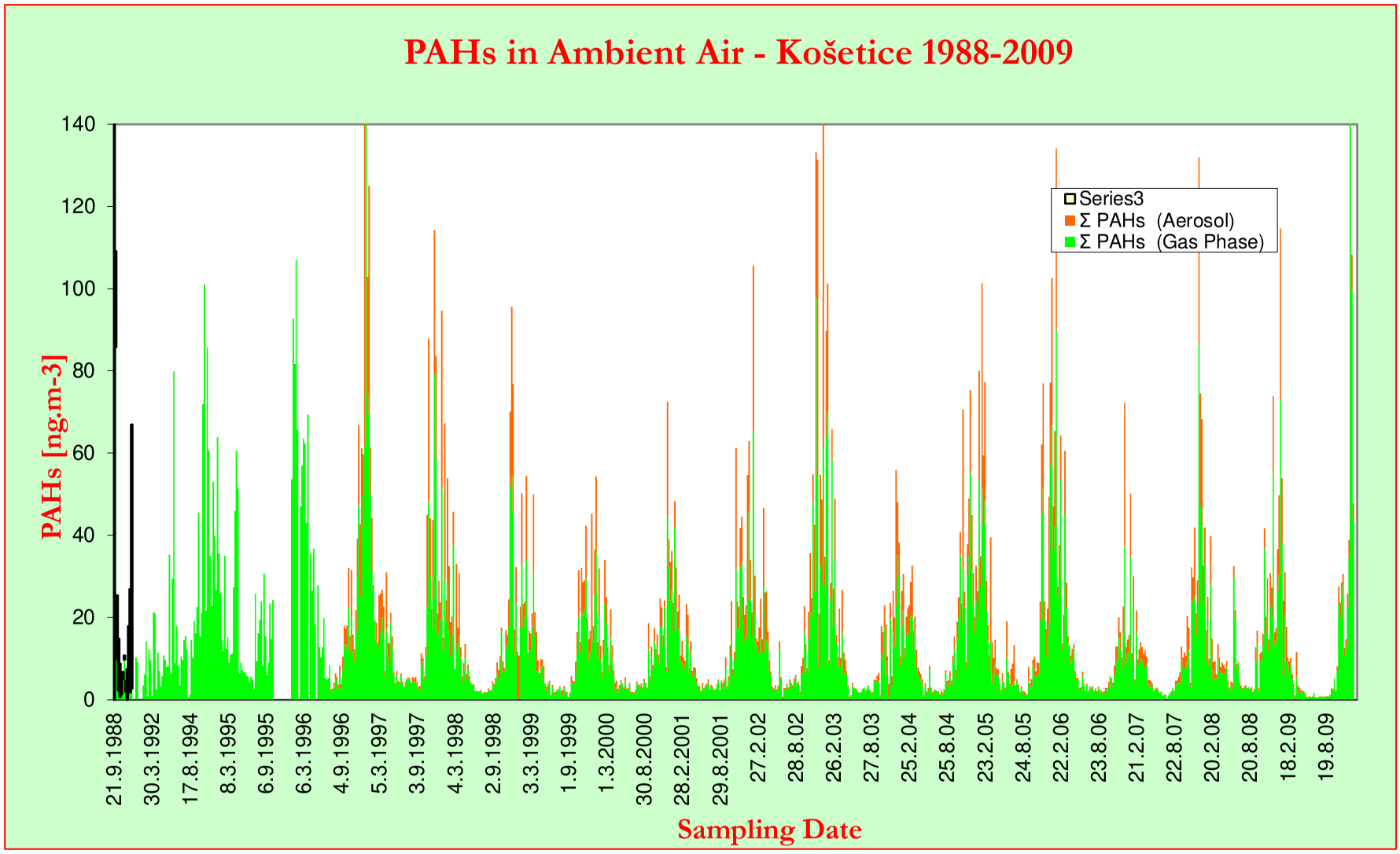
Integrated POPs monitoring - Observatory Košetice

Comparison of existing programmes (EMEP, GAPS, MONET) and approaches (active vs. passive)

POPs ambient air monitoring programmes until 2006

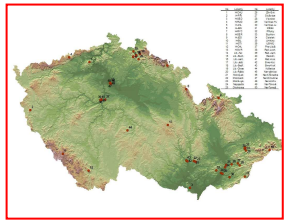


Σ 16 PAHs in air, observatory Košetice, seasonal variations, sampling every week, 1996 - 2009 [ng.m^{-3}]



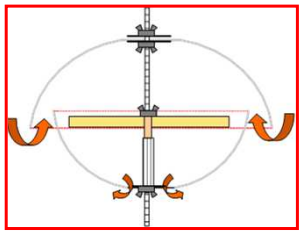
Global/national POPs monitoring - MONET

RECETOX Monitoring Network



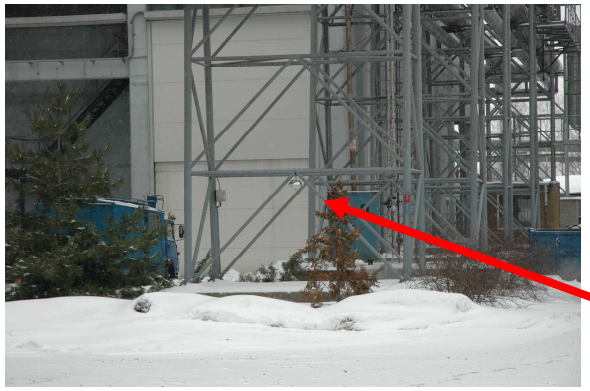
MONET = MOnitoring NETwork

MONET-CZ = Czech Republic	MONET-PIs = Pacific islands - Fiji
MONET-CEECs = 20 CEE countries + 2 CA countries	MONET-Africa = 17 African countries

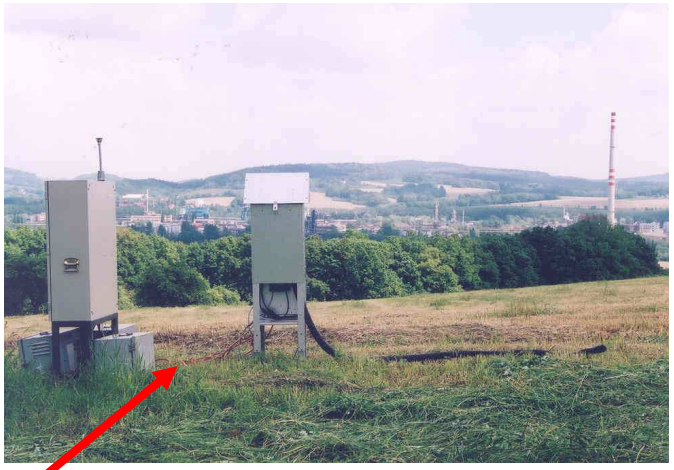


MONET-EUROPE – 55 sampling sites round whole Europe

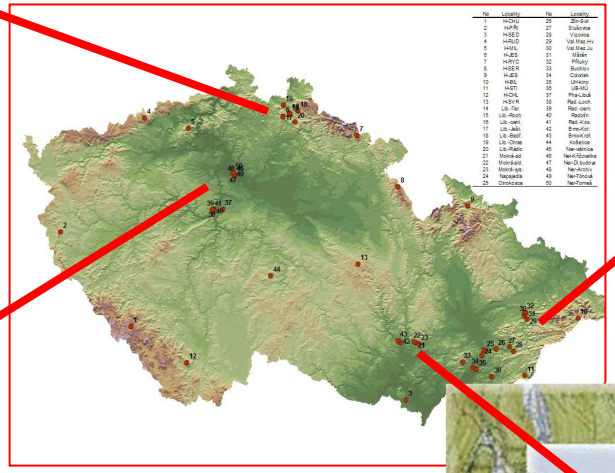
POPs Monitoring in ambient air – selected POPs sources



Municipal waste incinerator

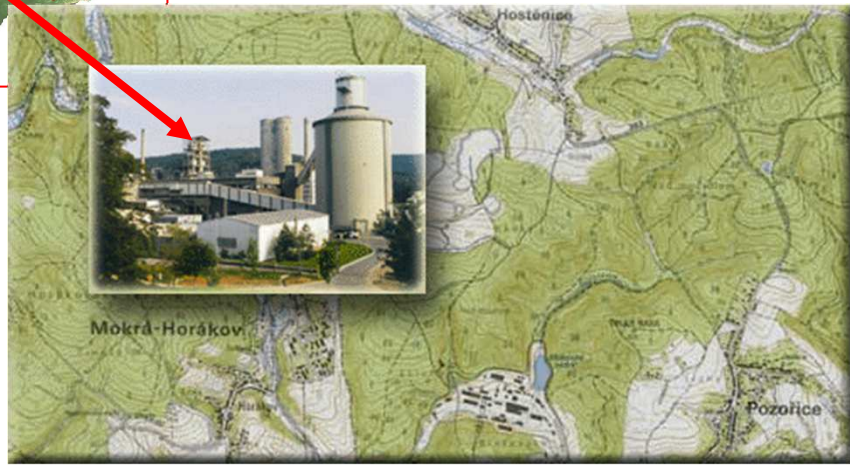


DEZA Valaššské Meziříčí

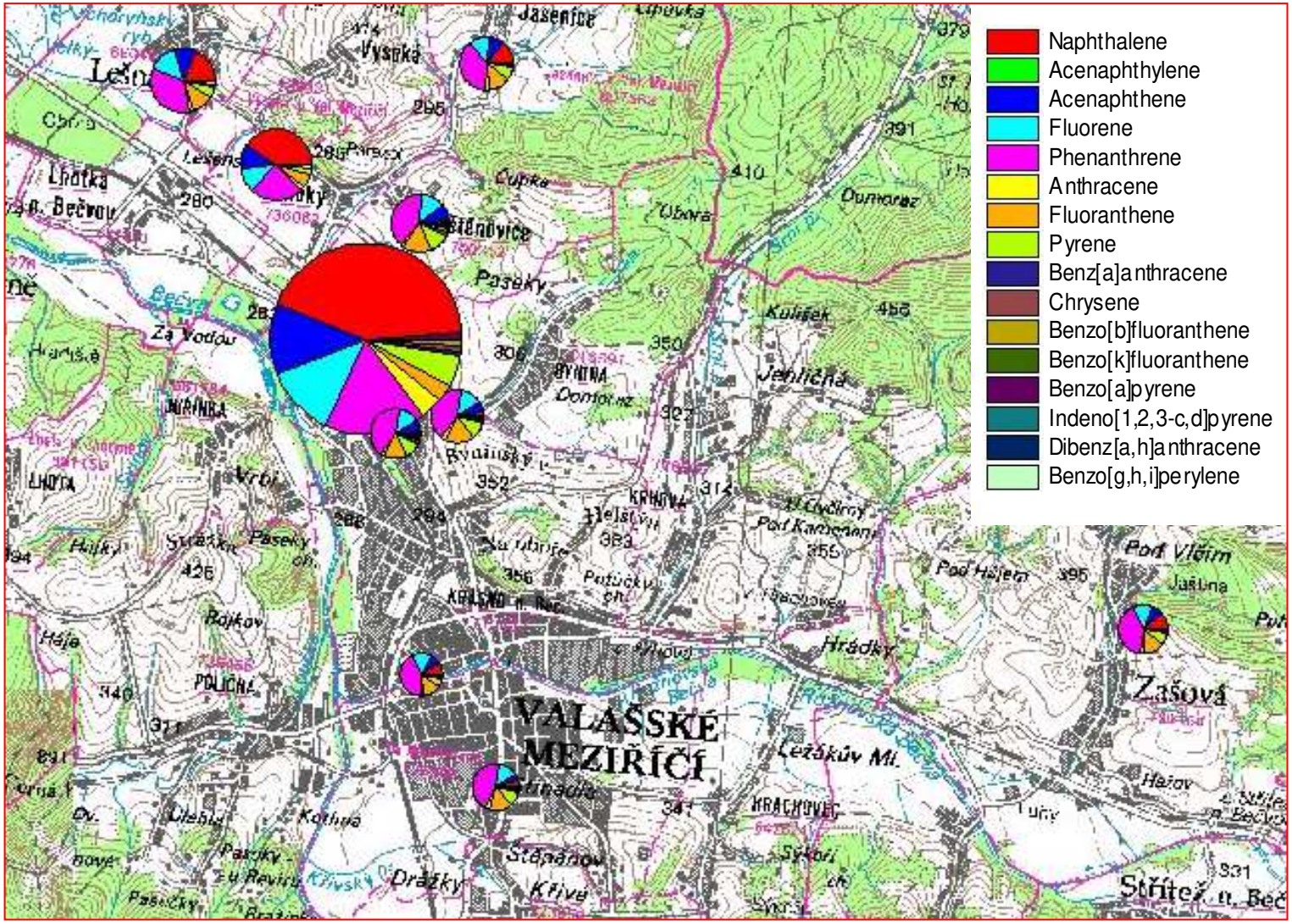


Spolana Neratovice

CMC a.s.

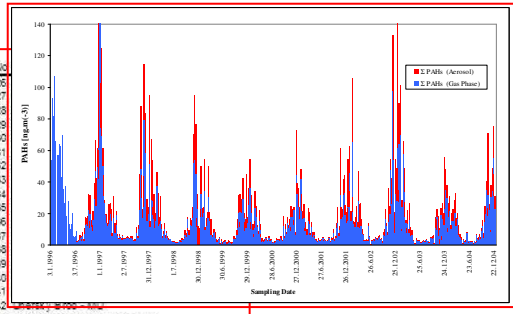


Distribution of PAHs in DEZA vicinity, 19/03-16/04/2004 - Biggest circle represents the total amount of 0.533 mg of PAHs sequestered on the filter



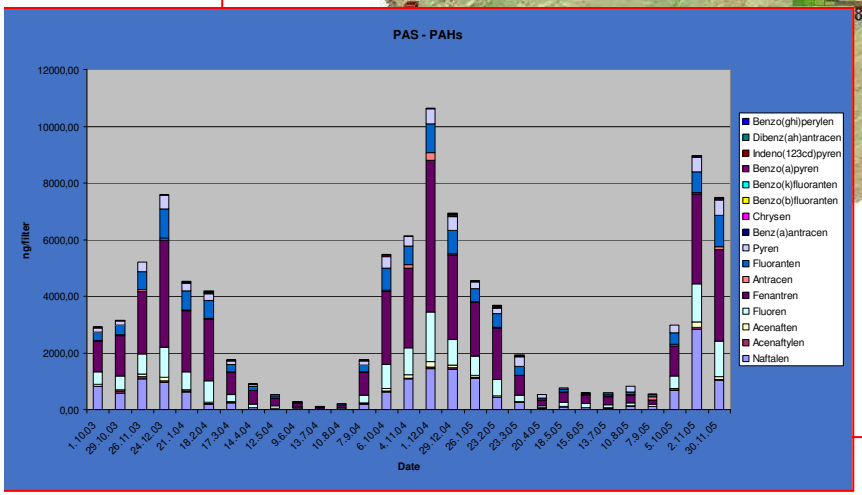
MONET-CZ - Monitoring of POPs in ambient air – passive sampling - Σ 16 PAHs [ng/filtr], January - December 2006

+PCBs, DDTs, HCHs, HCB, PeCB



No	Locality
1	Bílý Kříž (Beskydy)
2	Brno - Kotlářská
3	Brno - Kroftova
4	Buchlov
5	Chlum - Klet (Šumava)
6	Chusařlov (Šumava)
7	Jeseník
8	Košetice
9	Liberec - Rádlo
10	Liberec - Bedřichov
11	Liberec - centrum
12	Liberec - Chrastava
13	Liberec - Ještěd
14	Liberec - Rochlice
15	Liberec - Termizo
16	Mokrá - cementárna
17	Mokrá - cementárna AIM
18	Mokrá - Horákov
19	Mokrá - vyšlák Pozořice
20	Napajedla
21	Spolana-Ton
22	Neratovice - Spolana vrátnice
23	Neratovice - Spolana křižovatka
24	Neratovice - Spolana BCD
25	Neratovice - Spolana archiv
26	Valašské Meziříčí - Hvězdárna
27	Valašské Meziříčí - Jufinka
28	Valašské Meziříčí - Mštěnovice
29	Valašské Meziříčí - Příluky
30	Vizovice
31	Zlín - Svit
32	Svratouch
33	Sněžník (Děčín)

Legend



Bu Proje, Avrupa Birliği ve Türkiye Cumhuriyeti tarafından ortaklaşa finanse edilmektedir.

Contents

Local Monitoring

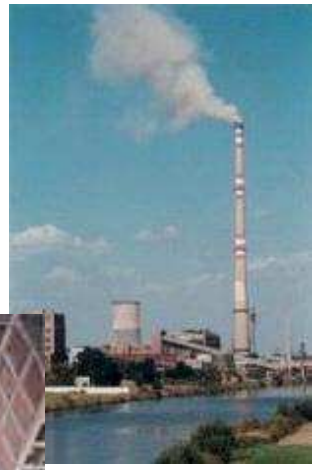
Spolana Neratovice, Czech Republic
Chemical factory – former producer of organochlorinated pesticides

POPs problems in Spolana - Ghost of the past

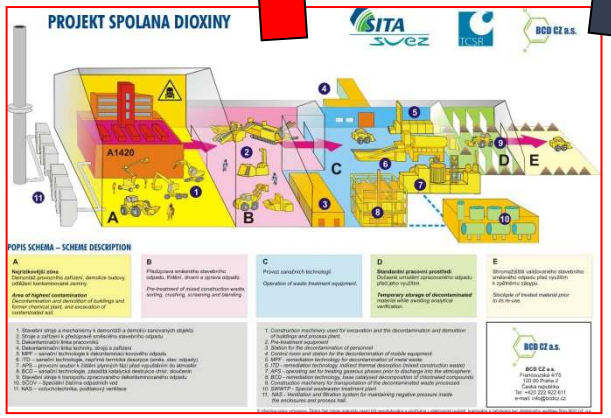
The Spolana Neratovice chemical site is a large chemical complex based on chlorine chemistry.

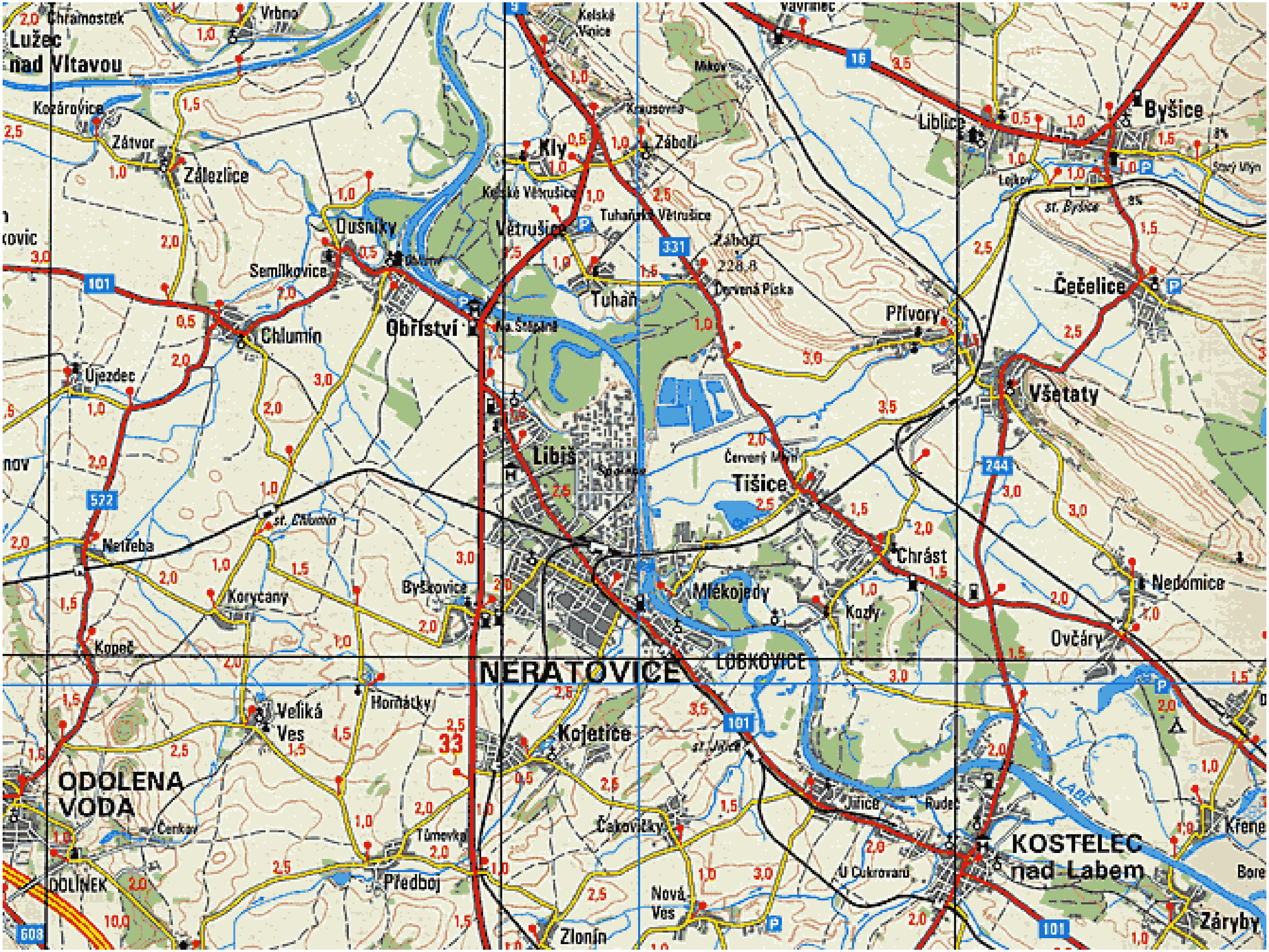
During the 1960s, the production unit called PCP (pentachlorophenol) produced insecticides and herbicides.

- 1961 – production of HCHs (13% γ) → pesticides + production of TrCBz → production of TeCBz and HCB
- HCB → pentachlorophenolate Na → PeCP
- TeCBz → trichlorophenolate Na → 245-T → Agent Orange
- High contents of PCDDs/Fs



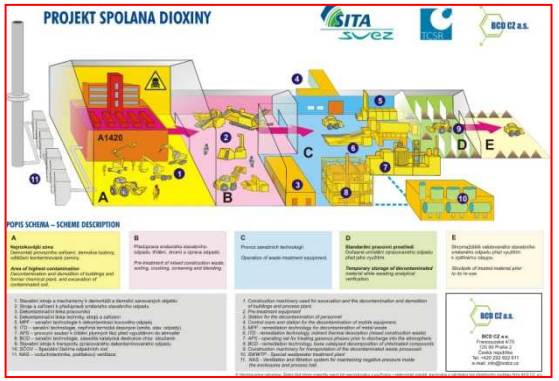
Spolana Neratovice

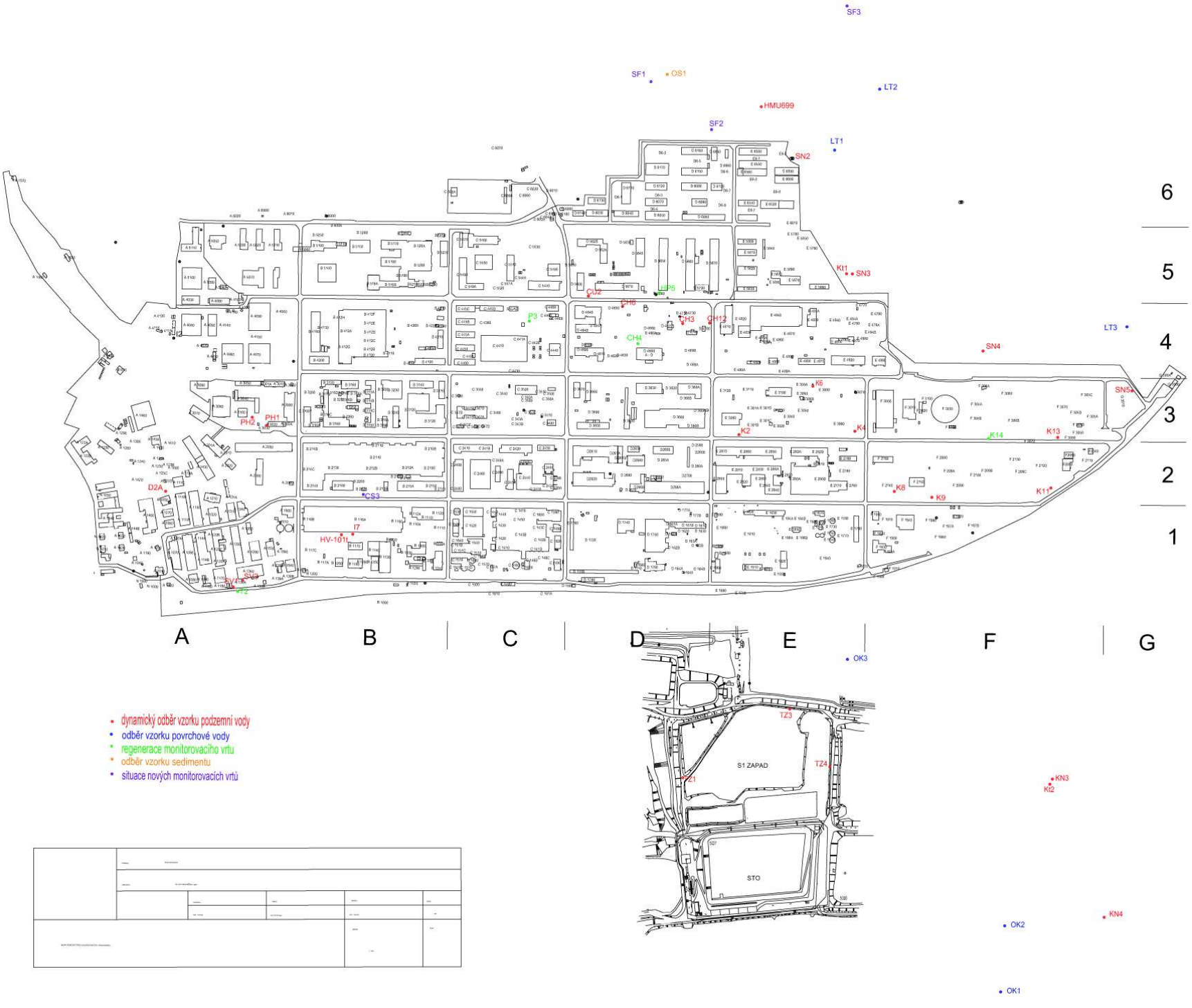



Lužec nad Vltavou
Chramostek
Vrbno
Kozárovice
Zátvor
Zálezlice
Dušníky
Semilkovice
Chlumín
Obříství
Újezdec
Netřeba
Korycany
Kopeč
Byškovice
ODOLENA VODA
Čenkov
DOLÍNEK
Veliká Ves
Horňátky
Předboj
Tůmovka
Kelské Vinice
Kly
Kelské Větrušice
Větrušice
Tuhaňské Větrušice
Tuhaň
Záboří
Krausovna
Mikov
Červená Píska
Libiš
Spolana
NERATOVICE
LOBKOVICE
Mlékojedy
Tišice
Červený Mlýn
Kojetice
Čakovičky
Nová Ves
Zlonín
Jiřice
Kozly
Chrást
Přívory
Všetaty
Čečelice
Liblice
Byšice
Lobkov
Nedomice
Ovčáry
KOSTELEC nad Labem
U Cukrovaru
Záryby
Křenek
LABE
Vavřinec
33

Protection of environment

- Enclosure of contaminated buildings A 1420 a A 1030
- Treatment of all waste inside the building with concrete soil
- Maintain of negative air system
- Anti flood protection
- Anti noise protection and its monitoring
- Monitoring emissions and ambient air
- Monitoring health of workers
- RECETOX research and monitoring activities




SF3
SF1
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LT2
HMU699
SF2
LT1
SN2
KI1
SN3
LT3
SN4
SN5
K1
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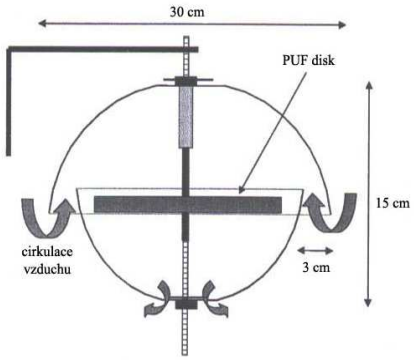
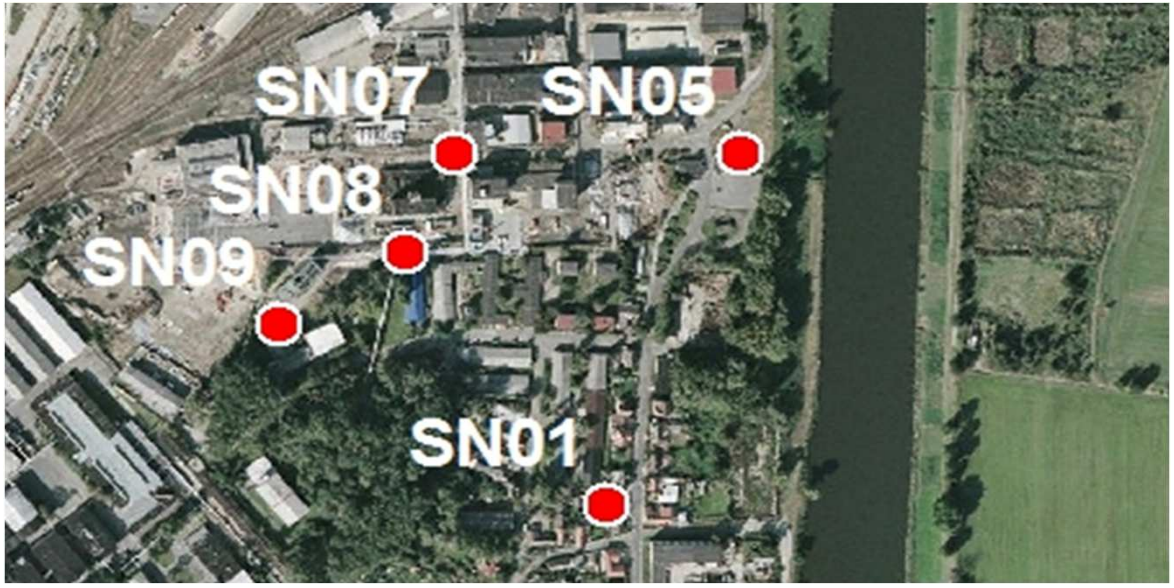
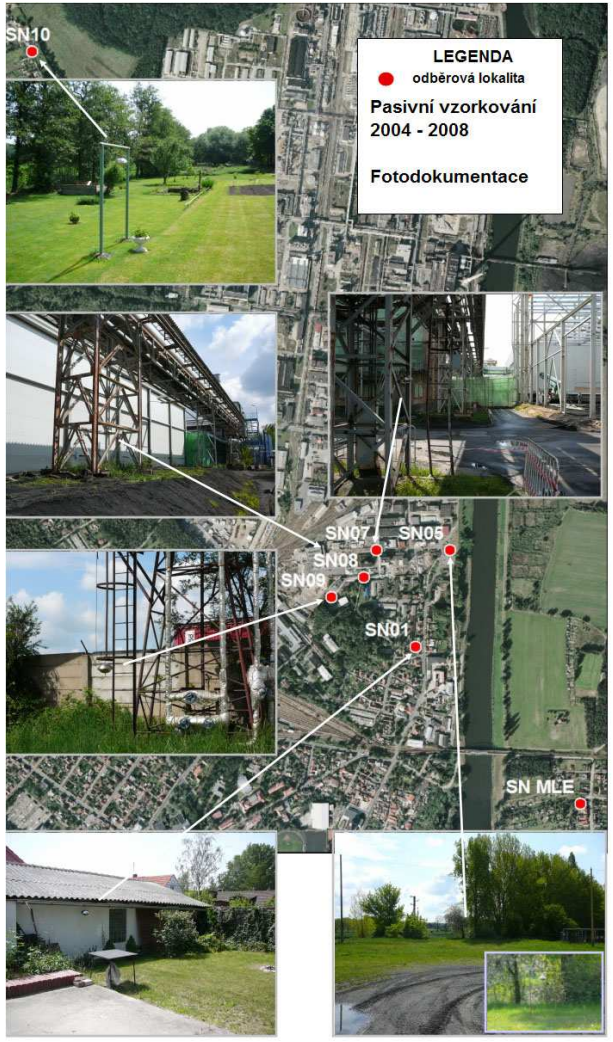
K4
K6
K8
K9
K11
K13
K14
CH1
CH2
CH3
CH4
CH5
CH6
CH12
P3
PH1
PH2
D2A
CS3
I7
HV-1011
SV1
SV2
SV3
VT2
6
5
4
3
2
1
A
B
C
D
E
F
G
OK3
TZ3
TZ4
TZ1
S1 ZAPAD
STO
KN3
KI2
KN4
OK2
OK1
dynamický odběr vzorku podzemní vody
odběr vzorku povrchové vody
regenerace monitorovacího vrtu
odběr vzorku sedimentu
situace nových monitorovacích vrtů

Příloha č. 1: Situace odběrných bodů 1 : 1 000

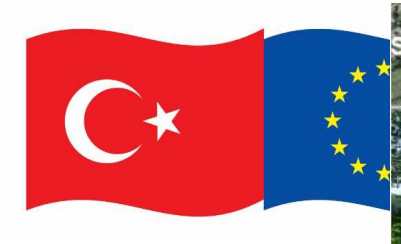
Long term monitoring of ambient air using the passive samplers (RECETOX 2004 – 2008)





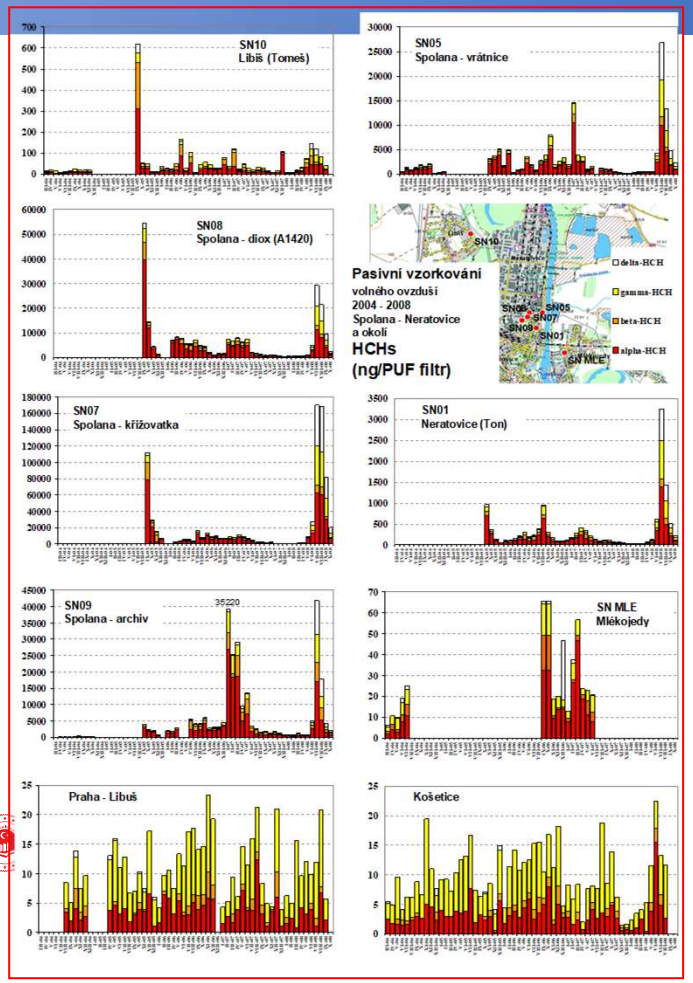


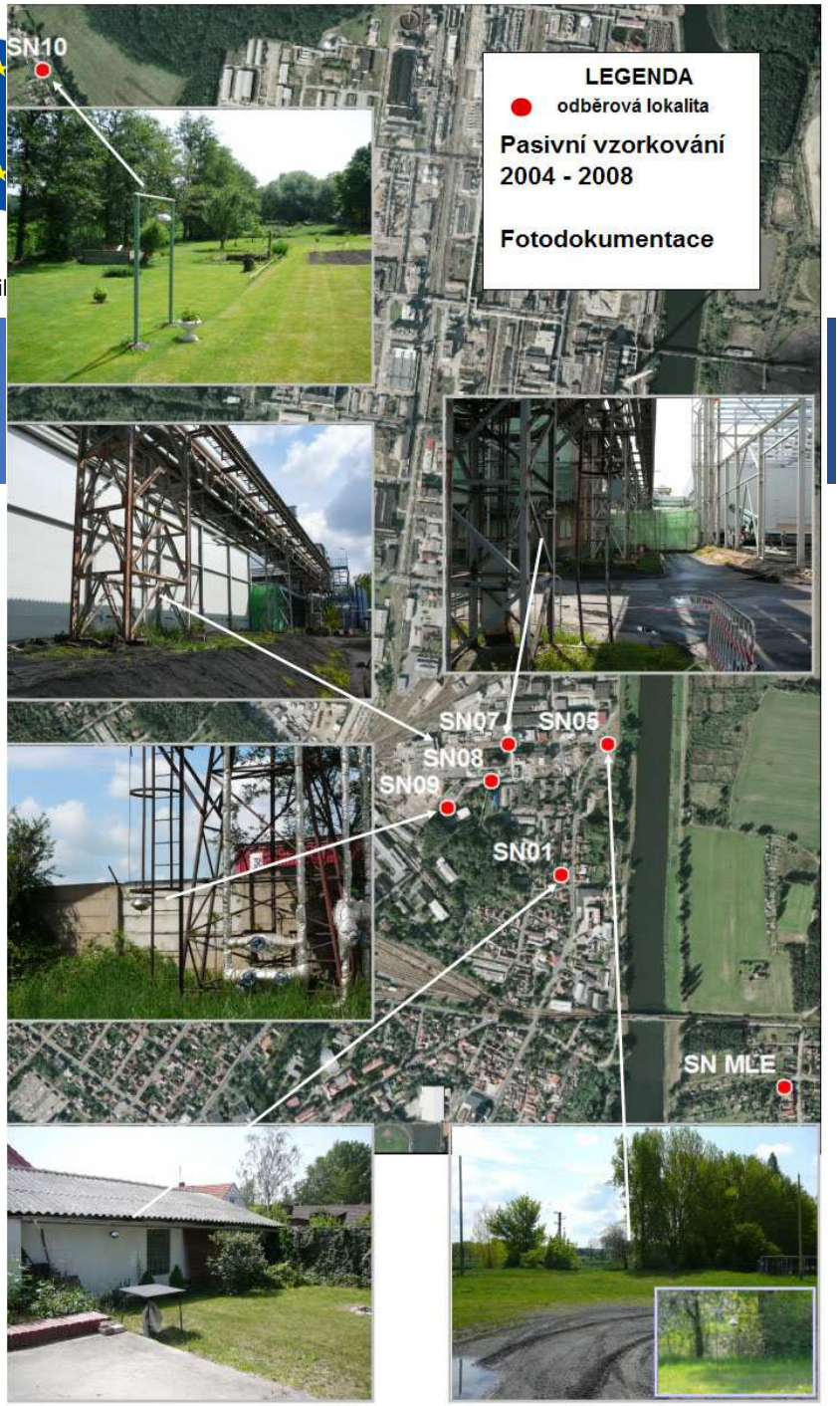
Monitoring of remediation – case of Spolana Neratovice – relative levels of HCHs in ambient air (ng/filtr)



Bu Proje, Avrupa Birliği ve Türkiye
tarafından ortaklaşa finanse edil

Post remediation monitoring





Remediation in Spolana

240 000 000 €

And what δ ??

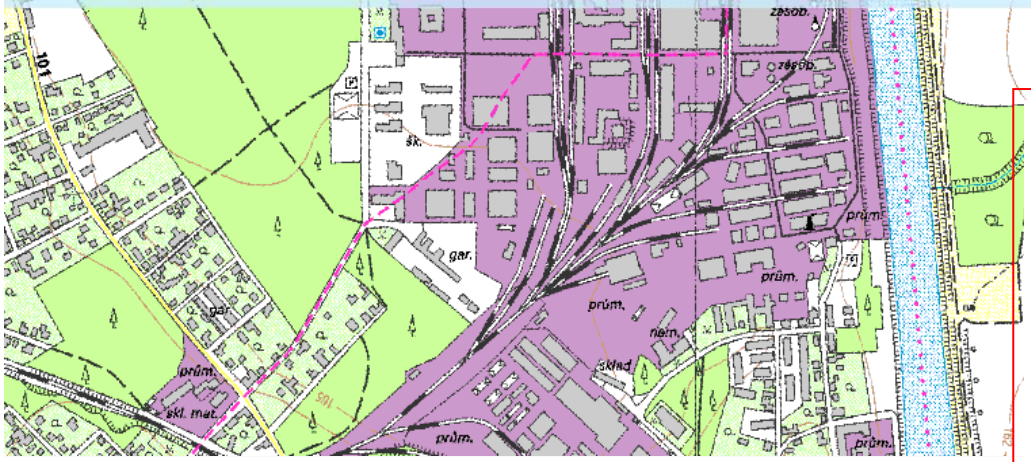
Spolana Neratovice, CR

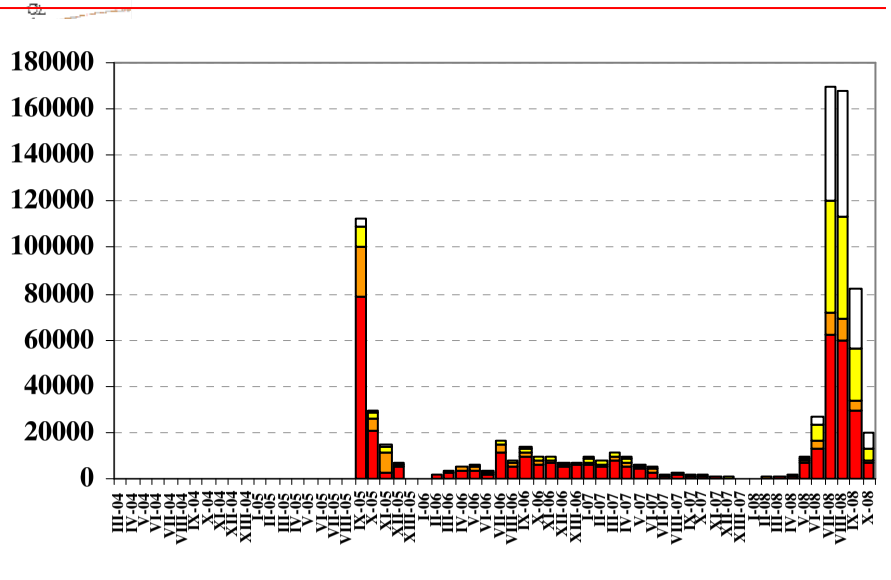
Former producer, highly contaminated site

Remediation – by using of BCD technology – effective, successfull, but not complete

What we know about this site ???

What happens under surface ???



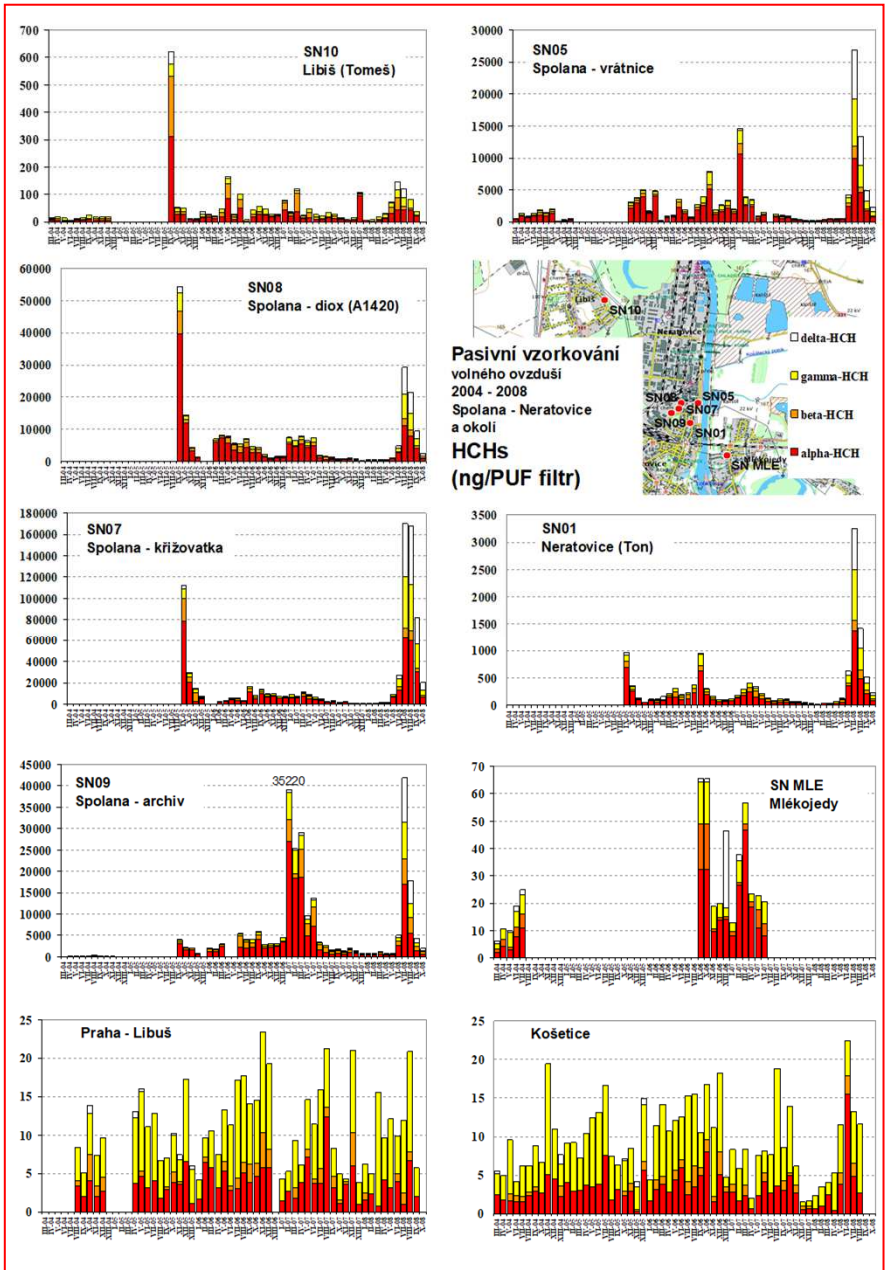


Country background
Košetice in this time –
below 10 ng filter^{-1}

δ ??

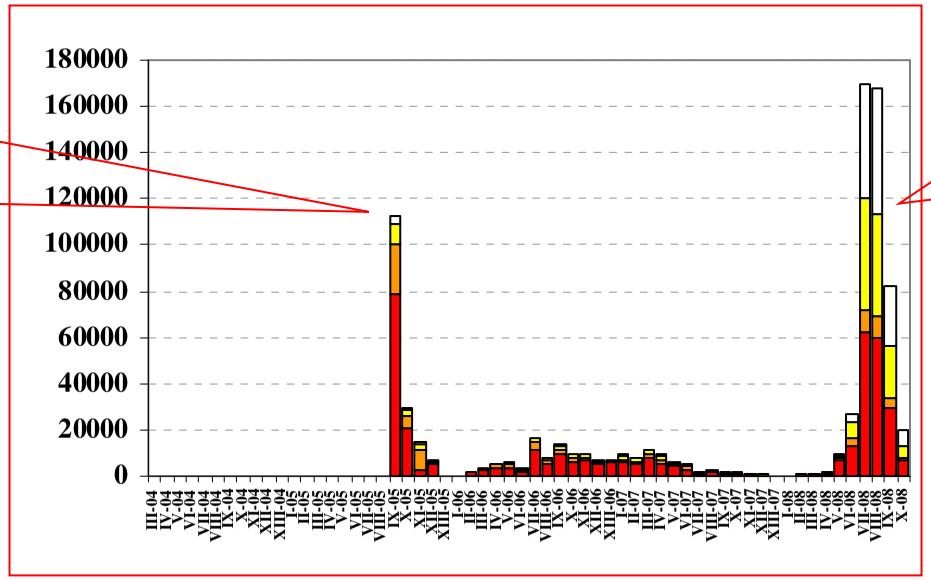
δ

MONET-CZ/Spolana – log term trends – HCHs – 2004 – 2008 [ng/filter]



MONET-CZ/Spolana – levels of HCHs – 2005 – 2008 [ng/filter] – Spolana crossroad

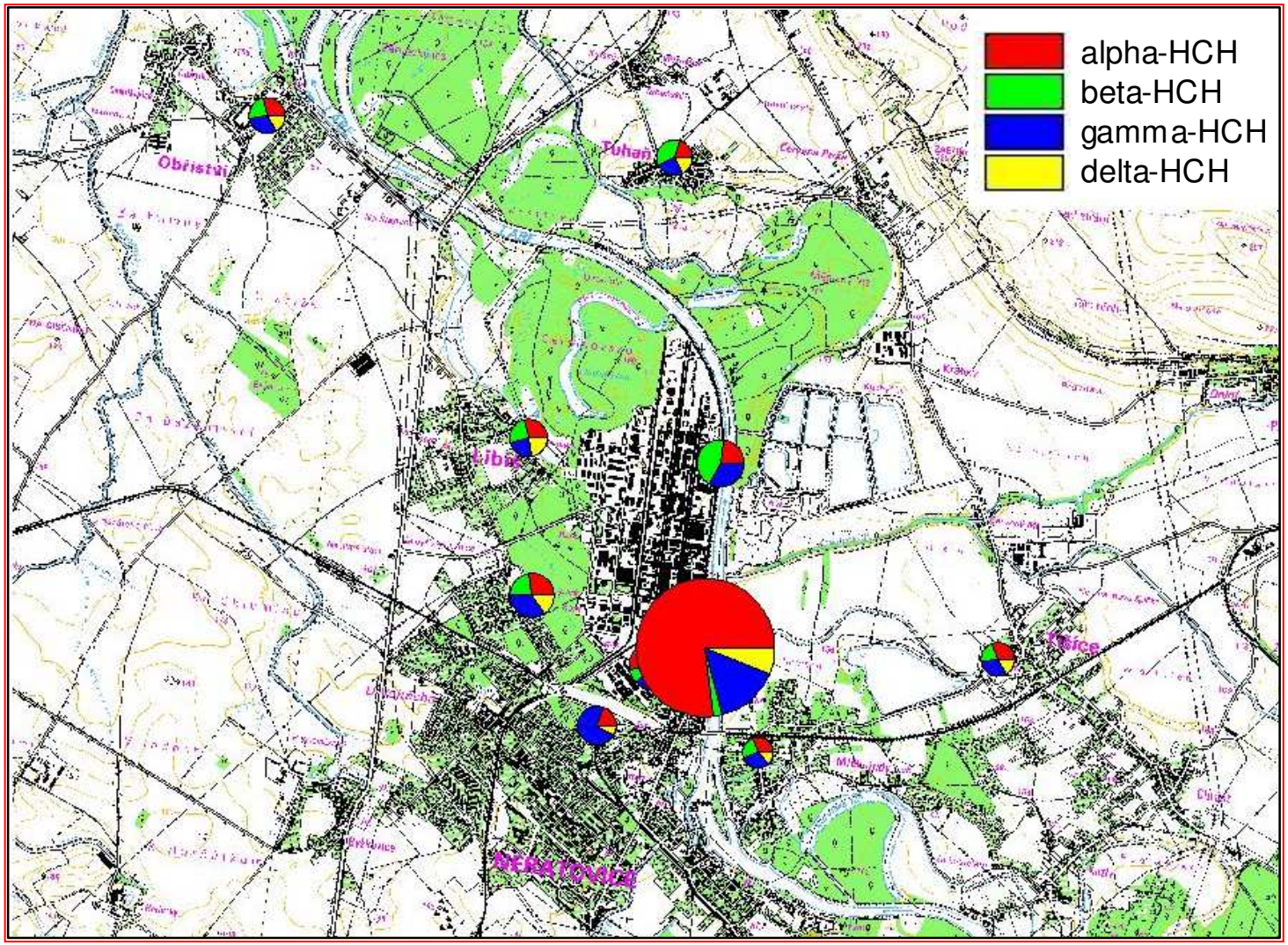
August 2005



Summer 2008

Distribution of HCHs in SPOLANA vicinity, 16/02-15/03/2004

Biggest circle represents the total amount of 445 ng of HCHs (a sum of α, β, γ, δ-HCH) sequestered on the filter



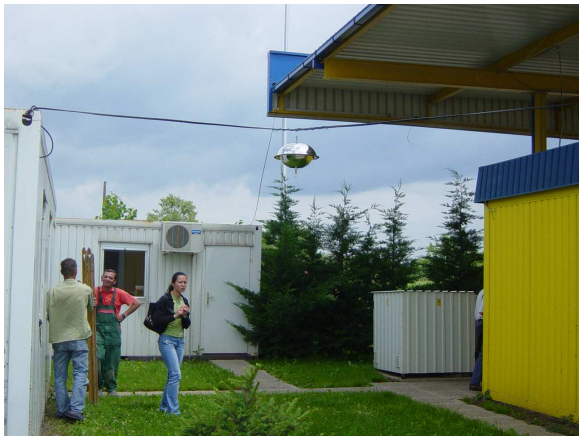
Monitoring of remediation – case of Spolana Neratovice – relative levels of HCHs in ambient air (ng/filtr)

EU Project APOPSBAL

Former Yugoslavia – environmental consequences of Balkan wars

EU Project APOPSBAL

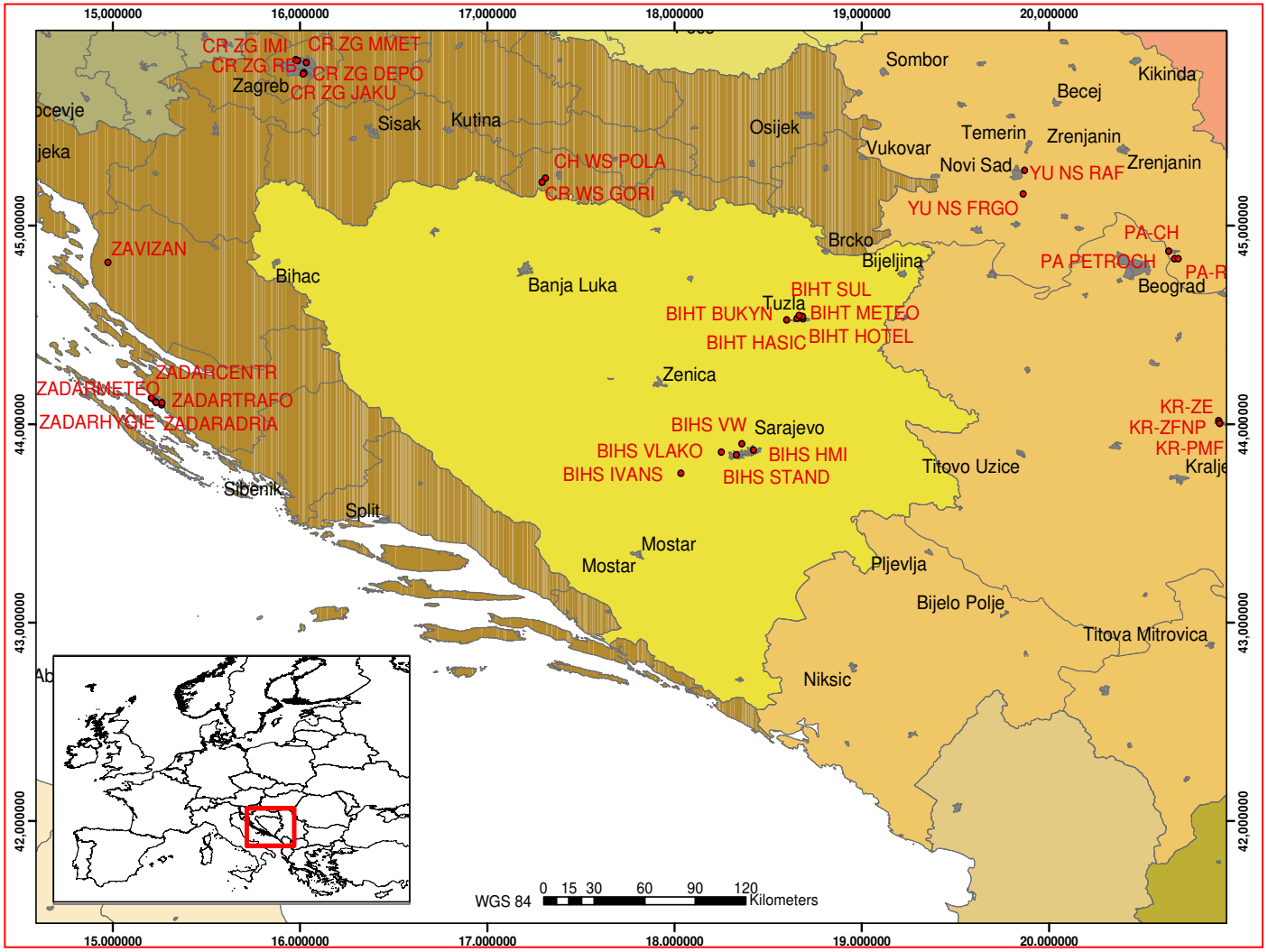
Assessment of the selected POPs (PCBs, PCDDs/Fs, OCPs) in the atmosphere and water ecosystems from waste materials generated by warfare in former Yugoslavia



Klanova, J.; Kohoutek, J.; Cupr, P.; Holoubek, I. Are the residents of former Yugoslavia still exposed to elevated PCB levels due to the Balkan wars? Part 2: Passive air sampling network. Environ. Int. 2007, 33, 727-735

Skarek, M.; Cupr, P.; Bartos, T.; Kohoutek, J.; Klanova, J.; Holoubek, I. A combined approach to the evaluation of organic air pollution - a case study of urban air in Sarajevo and Tuzla (Bosna and Hercegovina). Sci. Tot. Environ. 2007, 384, 182-193

APOPSBAL – RECETOX sampling sites



APOPSBAL – passive sampling – identification of hot spots

Klanova, J.; Kohoutek, J.; Cupr, P.; Holoubek, I. Are the residents of former Yugoslavia still exposed to elevated PCB levels due to the Balkan wars? Part 2: Passive air sampling network. Environ. Int. 2007, 33, 727-735

Skarek, M.; Cupr, P.; Bartos, T.; Kohoutek, J.; Klanova, J.; Holoubek, I. A combined approach to the evaluation of organic air pollution - a case study of urban air in Sarajevo and Tuzla (Bosna and Hercegovina). Sci. Tot. Environ. 2007, 384, 182-193

Boršov u Kyjova, Czech Republic
Fire of pesticide storehouse

Boršov u Kyjova

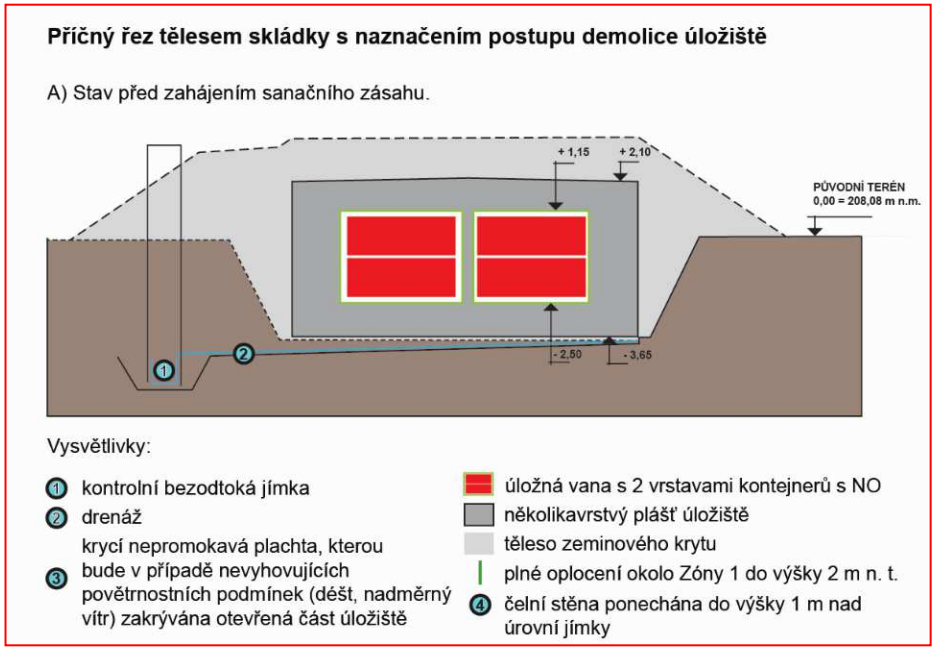
Site history

- Former pesticides storage used in 1980s
- Damaged in 1988 by huge fire; 20 000 people evacuated
- HW generated by fire temporary deposited at the site in a underground sarcophagus

Boršov u Kyjova – basic information

Basic information

- Temporary sarcophagus was constructed as a double wall reinforced concrete construction; 31 x 10,5 m x 5,5 m.
- Nearly 700 tons of waste – partially burnt agrochemicals and other polluted waste



Monitoring

Before entering the sarcophagus:

Monitoring of the ambient air

- field measurements of CH_4, HCN, NH_3, H_2S, C_xH_y, CO_2, CO a O_2

- ambient air sampling for lab analyses (PM10, hydrogen cyanide, pesticides (organochlorinated, triazins and acid pesticides)

Sarcophagus check by microcamera

Findings: above limits (atrazin, prometryn, MCPA a MCPP); acceptable exposure limits not exceeded; need of full protection of workers (masks, filters, disposable suit)

Contamination of the Baroque Theater at the Castle in Český Krumlov with organochlorine and organotin pesticides and its solution

Český Krumlov

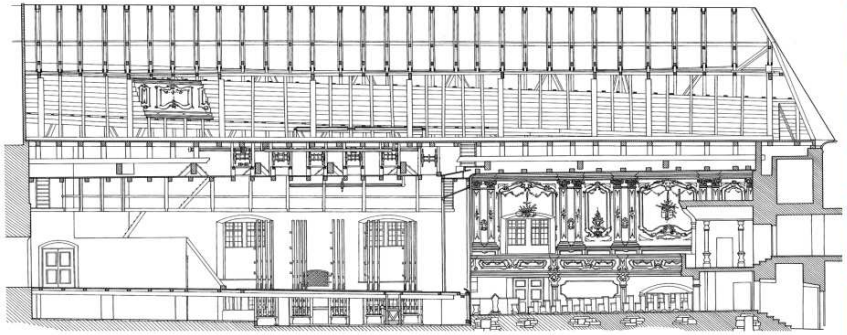
Historic Centre of Czech Krumlov is an excellent example of a small central European medieval town whose architectural heritage has remained intact for more than five centuries.

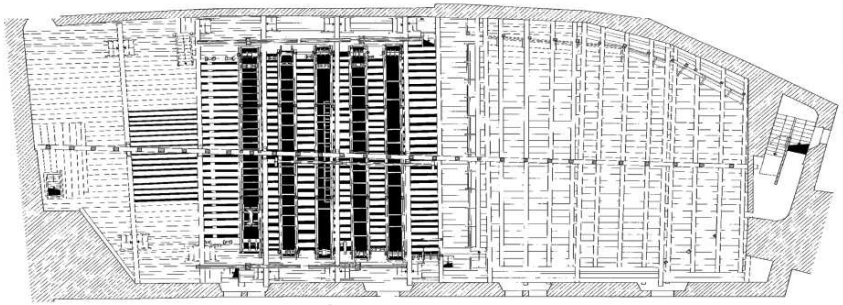
Baroque castle

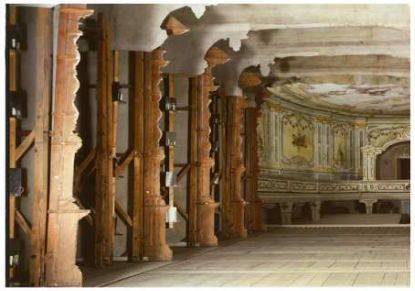



Czech Republic - Český Krumlov, historic center, UNESCO heritage, historic site with exceptional value.

Baroque theatre







Mašinérie, jevištní technika zámeckého divadla, je po letech soustředěného zájmu z nejpodstatnější části obnovena. Některé funkce barokní jevištní techniky v provazišti a v krovu především rumpály létacích strojů, rumpály na sufitové osvětlení, rumpál v krovu (snad rumpál na mraky nebo alegorie) a také principy vedení lanovodů sufit a prospektů ještě nejsou dostatečně poznány a pochopeny. Musíme doufat, že při dostatečné píly a vytrvalosti najdeme odpovědi a řešení v archivních zdrojích nebo v samotné jevištní technice krumlovského divadla či konstrukčních principech divadel jiných. Je nepochybné, že obnovená barokní jevištní technika snese nejpřísnější srovnání a je vzorem pro vetšinu pracovišť v celém divadelním světě.

Theatre contamination

Reasons of contamination

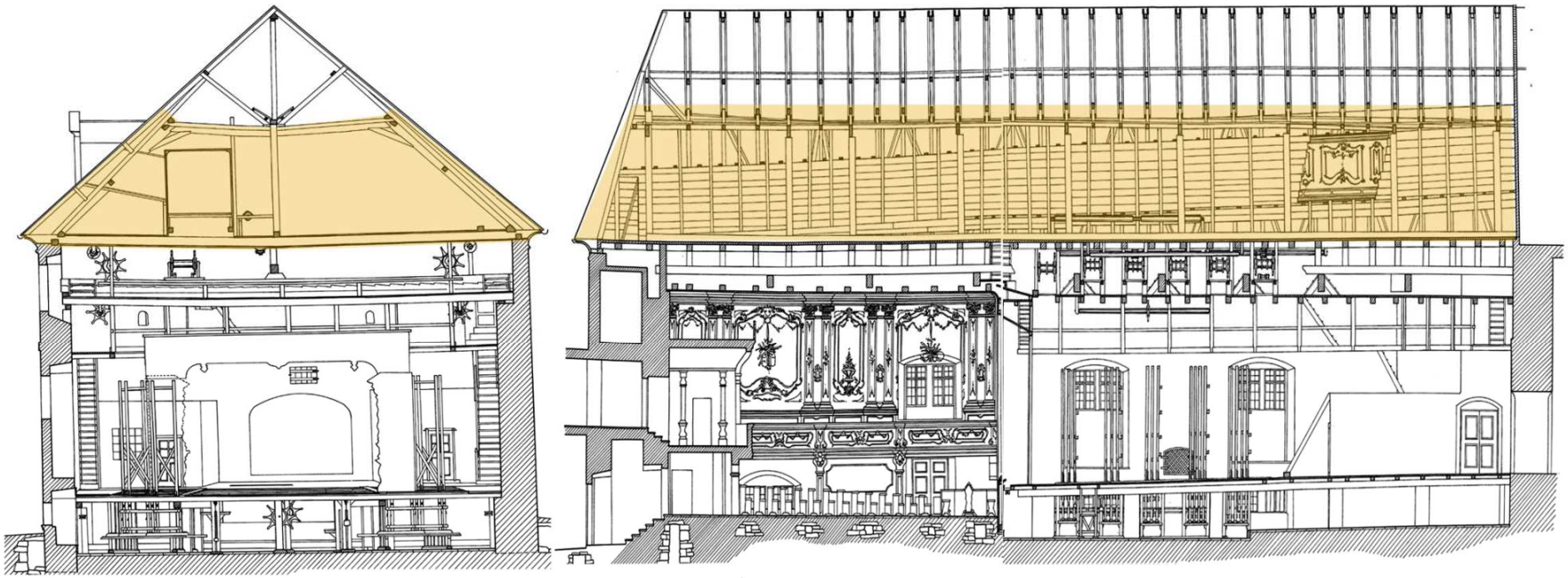
Improper application without proper preparation: přípravky typu Lastanox (Sn_{org}), Pentalidol (5% PCP, 2% DDT, 0,1% γ-HCH) and methylbromid

Suspicion of technological discipline: uniform application and application to a dust layer deposited on horizontal surfaces

Effects: in the early 1990s, a longer stay in the theater resulted in irritation of the eyes, mucous membranes and skin

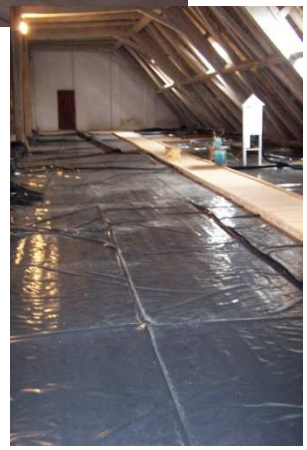
Decontamination: during the 1990s the amount of contaminated dust and rubble was removed (approx. 5 tons + 500 kg in the second stage)

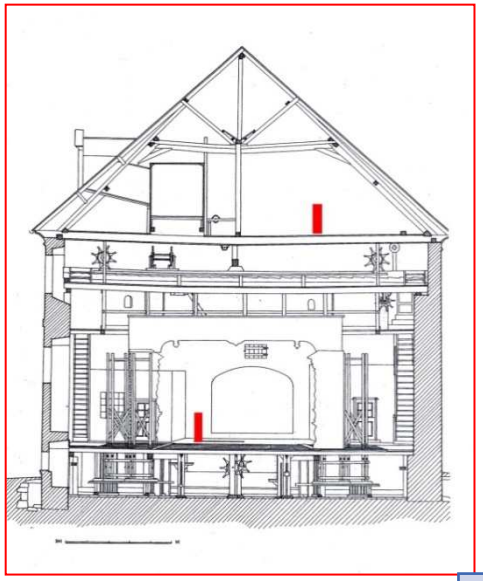
Extent of contamination of the truss structure

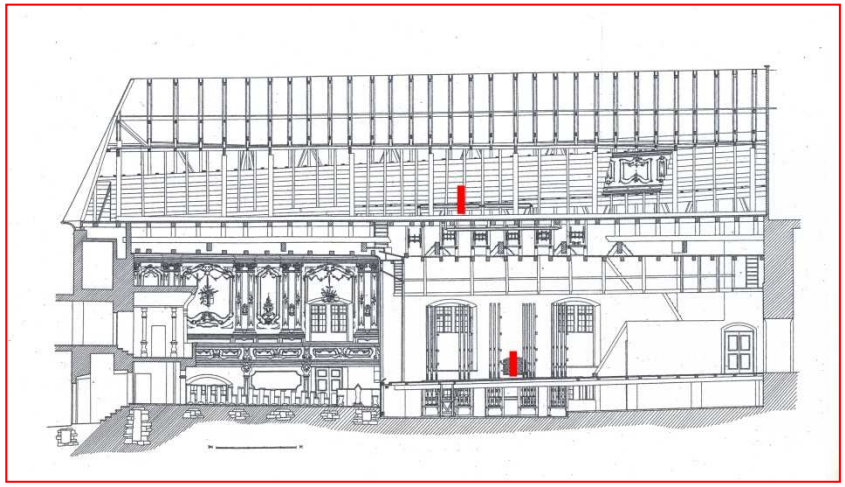


Zámek Český Krumlov, krov barokního divadla, rozsah kontaminace konstrukce krovu.

Air sampling







Air sampling in 2001: in the auditorium, on the stage, in the upper rope yard and in the theater floor

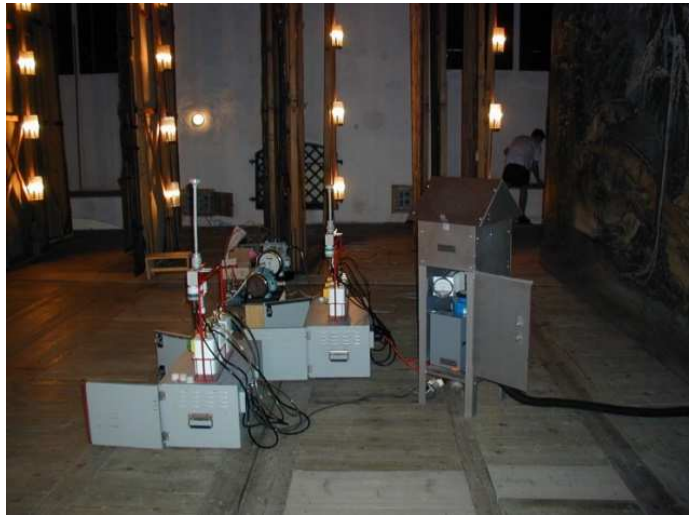
Sampling in the years 2003 to 2005: in parallel at two sampling points - the stage and the floor of the theater

Sampling of POPs (OCPs): according to US EPA methodology TO-13 (sampling time 12 hours; collected volumes approx. 200 m^3)

Sampling of organotin substances (Snorg): according to the NIOSH methodology (sampling time 8 hours; collected volumes approx. 0.4 m^3)

Testing of passive samplers

- **2004 - 2006 - the attic space of the chateau theater was used as a test chamber for testing the effectiveness of POPs capture from the open air within the preparation of monitoring of POPs in the open air within the MONET program of the RECETOX center.**



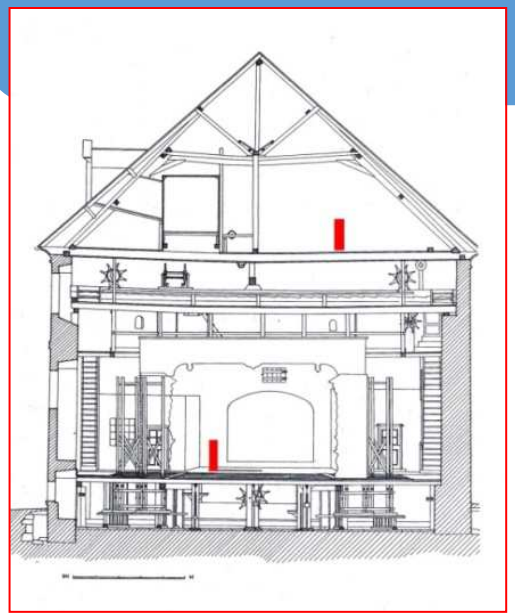
Two sampling campaigns in 2017

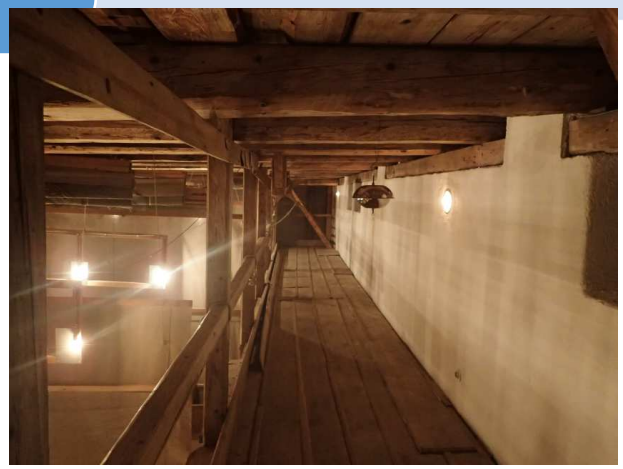
July

- Warmer period, more intense leakage
- Higher frequency of visits to the theater - higher flow in its premises

December

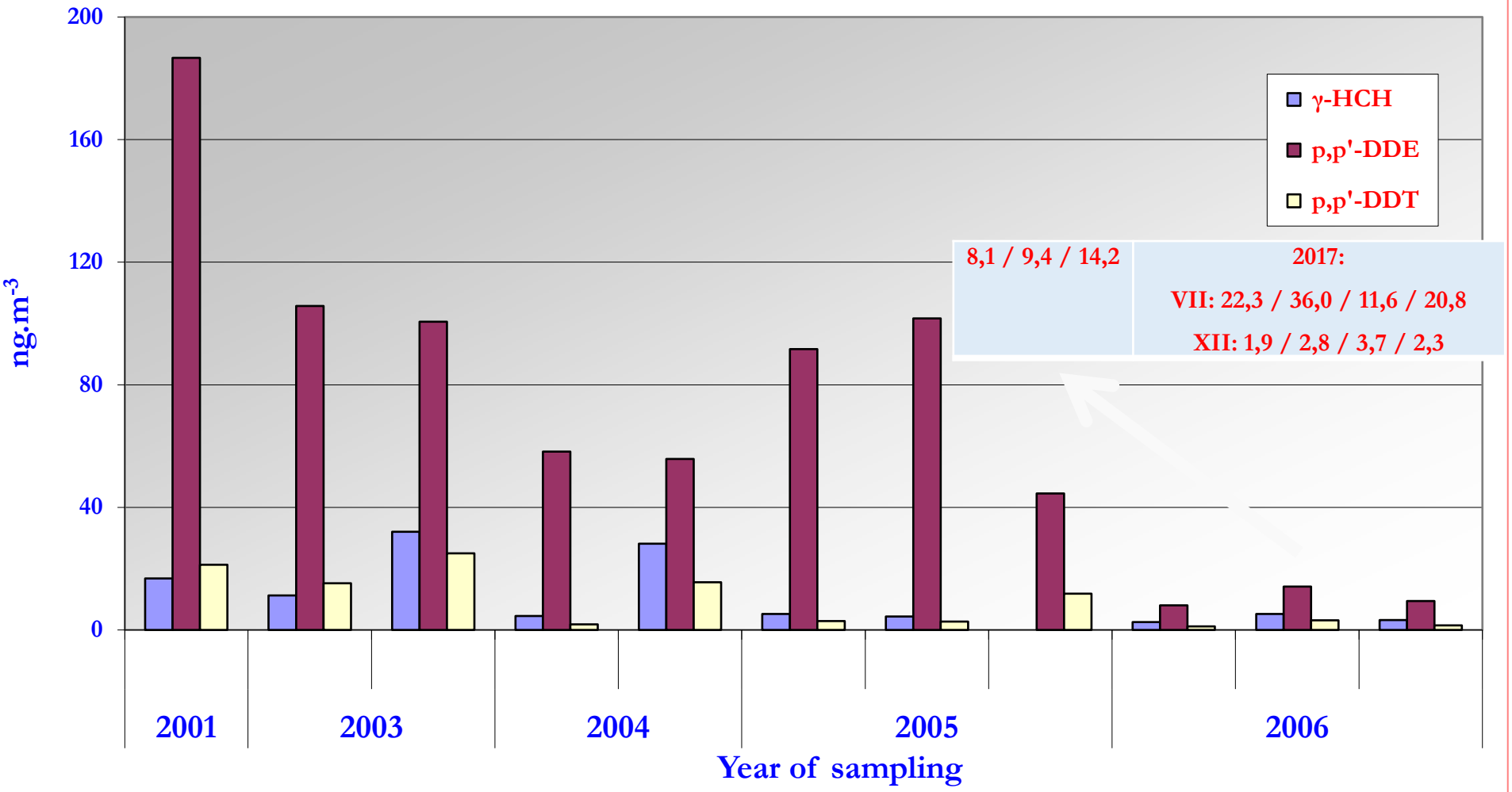
- Colder period with lower evaporation
- The theater space is practically closed





Results of measurements

Selected POPs in the air on the grounds of a baroque theater in the years 2001 - 2006/2017



Planned measures

Závažná degradace prostředí krovu aplikací insekticidních látek na bázi polychlorovaných bifenylů (PCBs), organochlorových pesticidů (DDT, Lindan) a jiných organocíničitých látek.

Free deposition of pesticide dust

Bu Proje, Avrupa Birliği ve Türkiye Cumhuriyeti tarafından ortaklaşa finanse edilmektedir.

TEŞEKKÜR EDERİM…

T.C. ÇEVRE VE ŞEHİRCİLİK BAKANLIĞI

Çevre ve İklim Eylemi Sektör Operasyonel Programı

Kalıcı Organik Kirleticiler

UNDP