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FACULTY OF NATURAL SCIENCES
Comenius University Bratislava

ŠTÁTNY GEOLOGICKÝ ÚSTAV DIONÝZA ŠTÚRA
MENTE ET MALLEO

WATER QUALITY

DANURELY WS project

Webinar, 2 April 2025
10.00 – 11.00 AM

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Influence of environmental loads in the urbanized area on groundwater quality

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Introduction

- SGIDS has been carrying out tasks related to monitoring more than 300 environmental loads (EL)
- This part is focusing on the result of groundwater quality in selected heavily polluted sites:
  - Representing mainly: by industrial activities, waste management facilities, raw industrial extraction sites, landfills..
- Every type of EL is associated with specific pollution with occurance of high levels of typical contaminants
- EL usually have negative influence on groundwater quality (also for the other parts of environment)

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Methodology

- **Monitoring of groundwater in the areas of ELs is systematic observation of time changes of concentrations of selected pollutants indicative for given site**
- **The analytical results at individual sites are compared with relevant legislation**
  - **For groundwater – Directive of the Ministry of Environment of the Slovak rep. No. 1/2015-7 on elaboration of the risk analysis of contaminated area**
  - **This Directive defines Indication (ID) and Intervention (IT) criteria:**
  - **ID – concentration limits of pollutants, which endanger human health and environment, this situation requires monitoring of polluted area**
  - **IT – critical concentration levels of pollutant, excess of which in a given landuse scenario assumes a high likelihood of endangering human health and the environment – detailed geological investigation**

	objekt	dátum odberu	chlóretén/vinylchlorid [µg/l]	1,1-dichlóretén /DCE [µg/l]	cis-1,2-dichlóretén /DCE [µg/l]	trans-1,2-dichlóretén /DCE [µg/l]	1,2-dichlóretén /DCE (cis, trans) [µg/l]	1,1,2-trichlóretén /TCE [µg/l]	1,1,2,2-tetrachlóretén/PCE [µg/l]	1,1,1-trichlóretán [µg/l]
1										
2	*ID - indikačné*		*5,00*	*10,00*	*25,00*	*25,00*	*25,00*	*25,00*	*10,00*	*50,00*
3	*IT - intervenčné*		*10,00*	*20,00*	*50,00*	*50,00*	*50,00*	*50,00*	*20,00*	*100,00*
4	PD35-5	2017-08-21	-0,20	-0,20	4,60	-0,20	4,60	146,00	112,00	-0,20
5	PD35-5	2018-04-11	-0,20	-0,20	2,10	-0,20	2,10	0,60	144,00	-0,20
6	PD35-5	2018-09-19	-0,20	-0,20	1,60	-0,20	1,60	14,30	24,80	-0,20
7	PD35-5	2018-11-12	-0,20	-0,20	1,40	-0,20	1,40	0,40	29,30	-0,20
8	PD35-5	2018-11-14	-0,20	-0,20	1,20	-0,20	1,20	0,60	73,10	-0,20
9	PD35-5	2019-05-06	8,10	1,30	-0,20	-0,20	0,00	3,30	2,90	-0,20
10	PD35-5	2019-11-14	-0,20	-0,20	2,50	0,30	2,80	3,40	161,00	-0,20
11	PD35-5	2020-03-31	-0,20	-0,20	2,10	-0,20	2,10	2,00	103,00	-0,20
12	PD35-5	2020-10-26	-0,20	-0,20	2,40	0,50	2,90	1,50	121,00	-0,20
13	VN35-1	2017-03-01	1,50	-0,20	-0,20	-0,20	0,00	-0,20	-0,20	-0,20
14	VN35-1	2017-05-29	-0,20	-0,20	-0,20	-0,20	0,00	-0,20	-0,20	-0,20
15	VN35-1	2017-08-21	-0,20	-0,20	-0,20	-0,20	0,00	32,70	10,00	-0,20
16	VN35-1	2017-11-21	-0,20	-0,20	-0,20	-0,20	0,00	71,20	5,50	-0,20
17	VN35-1	2018-04-10	-0,20	-0,20	-0,20	-0,20	0,00	51,80	7,00	-0,20
18	VN35-1	2018-06-26	-0,20	-0,20	1,90	-0,20	1,90	0,90	5,70	-0,20
19	VN35-1	2018-09-19	-0,20	-0,20	-0,20	-0,20	0,00	5,30	-0,20	-0,20
20	VN35-1	2018-11-12	-0,20	-0,20	-0,20	-0,20	0,00	0,50	-0,20	-0,20
21	VN35-1	2019-05-06	-0,20	-0,20	0,30	-0,20	0,30	11,50	0,60	-0,20
22	VN35-1	2019-07-03	-0,20	-0,20	-0,20	-0,20	0,00	-0,20	-0,20	-0,20
23	VN35-1	2019-09-03	-0,20	-0,20	1,00	-0,20	1,00	2,70	5,90	-0,20
24	VN35-1	2019-11-14	-0,20	-0,20	-0,20	-0,20	0,00	76,40	5,20	-0,20
25	VN35-1	2020-03-31	-0,20	-0,20	-0,20	-0,20	0,00	2,00	0,90	-0,20
26	VN35-1	2020-10-26	-0,20	-0,20	-0,20	-0,20	0,00	5,20	1,20	-0,20
27	VN35-2	2017-03-01	-0,20	-0,20	0,50	-0,20	0,50	15,20	8,80	-0,20
28	VN35-2	2017-05-29	-0,20	-0,20	0,70	-0,20	0,70	19,80	8,20	-0,20
29	VN35-2	2017-08-21	-0,20	-0,20	0,90	-0,20	0,90	161,00	30,00	-0,20
30	VN35-2	2017-11-21	-0,20	-0,20	27,50	-0,20	27,50	47,30	27,60	-0,20
31	VN35-2	2018-04-10	-0,20	-0,20	-0,20	-0,20	0,00	10,70	5,90	-0,20
32	VN35-2	2018-06-26	-0,20	-0,20	0,40	-0,20	0,40	3,70	5,00	-0,20
33	VN35-2	2018-09-19	-0,20	-0,20	1,60	-0,20	1,60	53,50	5,40	-0,20
34	VN35-2	2018-11-12	-0,20	-0,20	-0,20	-0,20	0,00	0,20	1,00	-0,20
35	VN35-2	2019-05-06	-0,20	-0,20	0,30	-0,20	0,30	6,80	5,20	-0,20
36	VN35-2	2019-07-03	-0,20	-0,20	-0,20	-0,20	0,00	0,40	5,50	-0,20

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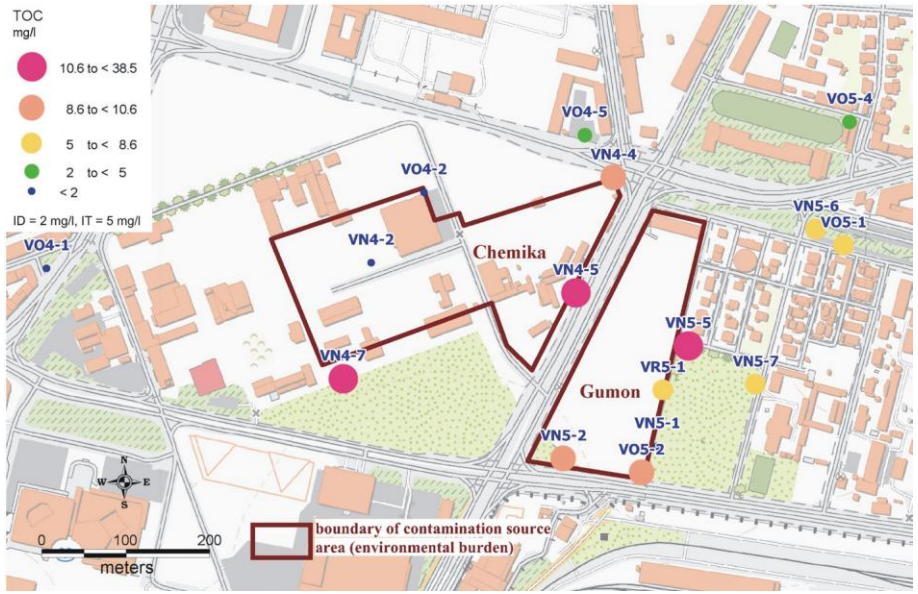
Examples

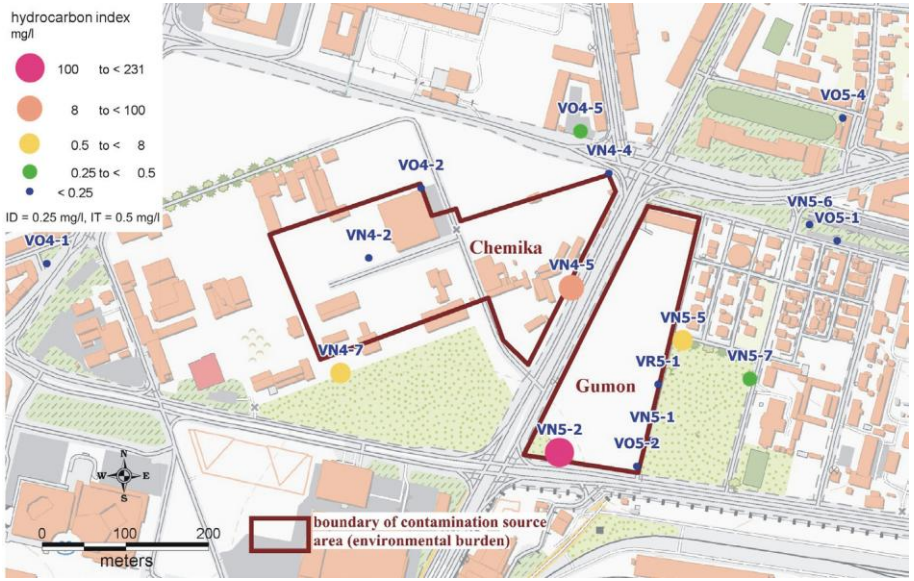
- **ELs contamined sites:**
- **Bratislava – former factories Chemika and Gumon**
- **Piešťany – former factories Chirana and Tesla**
- **Sereď – landfill dump and former Nickel plant area**
- **Bratislava – CHZJD landfill**
- **Krompachy – Kovohuty (metalurgical plant area)**

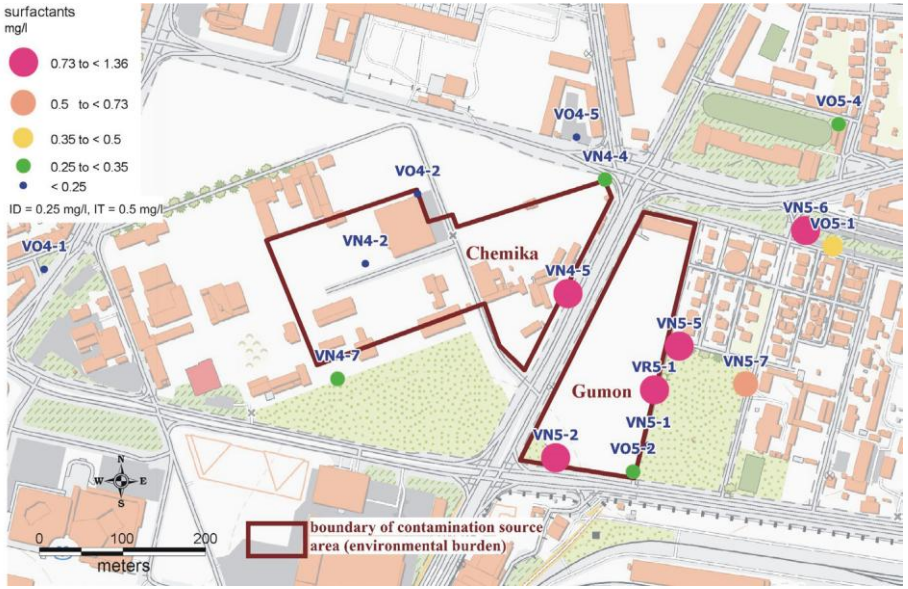
Bratislava – former factories Chemika and Gumon

- **Chemika**
- **focused on production of paintes, lacquers and distribuction, for example of epoxies and asphalts, and at the same time pumped chlorinated hydrocarbons, mineral, acids and other chemicals (close down in 1990)**
- **Consequences: high levels of chlorinated hydrocarbons, C_{10}-C_{40} hydrocarbon index, PAH..**
- **Gumon**
- **was in operation until 2005, focused on production electrical insulating materials, bakelity, artificial asphalt..**
- **Consequences: high levels of polycyclic aromatic hydrocarbons, C10-C40 hydrocarbon index...**
- **After bombing Apollo Refinery in 1944 (located nearby Chemika-Gumon fact.), oil pollution began spreading through environment**

Bratislava – Chemika	unit	mean	median	standard deviation	minimum	maximum	number	ID value	IT value	number of samples >ID	number of samples >IT
NH_4^+	$mg.l^{-1}$	1.82	0.64	2.87	<0.05	13.6	39	1.2	2.4	3	10
Cl^-	$mg.l^{-1}$	171	131	200	24.2	1,121	39	150	250	10	3
TOC	$mg.l^{-1}$	10.3	3.1	14.8	<0.5	68.9	33	2	5	4	15
COD_{Mn}	$mg.l^{-1}$	7.38	1.59	10.9	<0.5	37.3	31	5	10	2	8
surfactants	$mg.l^{-1}$	0.48	0.14	1.11	0.02	6.1	35	0.25	0.5	7	6
hydrocarbon index (C_{10}-C_{40})	$mg.l^{-1}$	236	0.17	981	<0.02	4,715	38	0.25	0.5	4	11
1,1-dichloroethene	$\mu g.l^{-1}$	0.44	0.2	1.59	<0.1	10	38	10	20	0	0
cis 1,2-dichloroethene	$\mu g.l^{-1}$	4.76	1	8.57	<0.1	41.1	38	25	50	1	0
tetrachloroethene	$\mu g.l^{-1}$	12.4	0.7	30.7	<0.2	170	38	10	20	2	7
trichloroethene	$\mu g.l^{-1}$	2.82	0.2	5.23	<0.1	22.7	38	25	50	0	0
chloroethene	$\mu g.l^{-1}$	2.62	0.2	8.89	<0.1	50.8	38	5	10	2	2
benzene	$\mu g.l^{-1}$	7.87	<0.2	31.4	<0.2	176	32	15	30	0	2
chlorobenzene	$\mu g.l^{-1}$	16.8	0.2	83.0	<0.1	471	32	15	30	0	1
toluene	$\mu g.l^{-1}$	1.88	<0.2	8.79	<0.2	50	32	350	700	0	0
xylene	$\mu g.l^{-1}$	1.67	<0.2	5.33	<0.2	30	32	250	500	0	0
anthracene	$\mu g.l^{-1}$	7.82	0.021	45.7	<0.003	278	37	5	10	1	1
phenanthrene	$\mu g.l^{-1}$	73.2	0.163	436	<0.003	2,652	37	5	10	3	2
fluoranthene	$\mu g.l^{-1}$	4.20	0.018	23.7	<0.003	144	37	25	50	0	1
fluorene	$\mu g.l^{-1}$	10.1	0.1	57.6	<0.015	351	37				
chrysene	$\mu g.l^{-1}$	7.79	0.01	45.5	<0.003	277	37	0.1	0.2	1	8
naphthalene	$\mu g.l^{-1}$	2.77	0.105	12.8	<0.03	82.4	42	25	50	0	1
pyrene	$\mu g.l^{-1}$	16.1	0.036	91.7	<0.006	558	37	25	50	1	1
benzo(a)anthracene	$\mu g.l^{-1}$	16.0	0.014	95.6	<0.003	582	37				







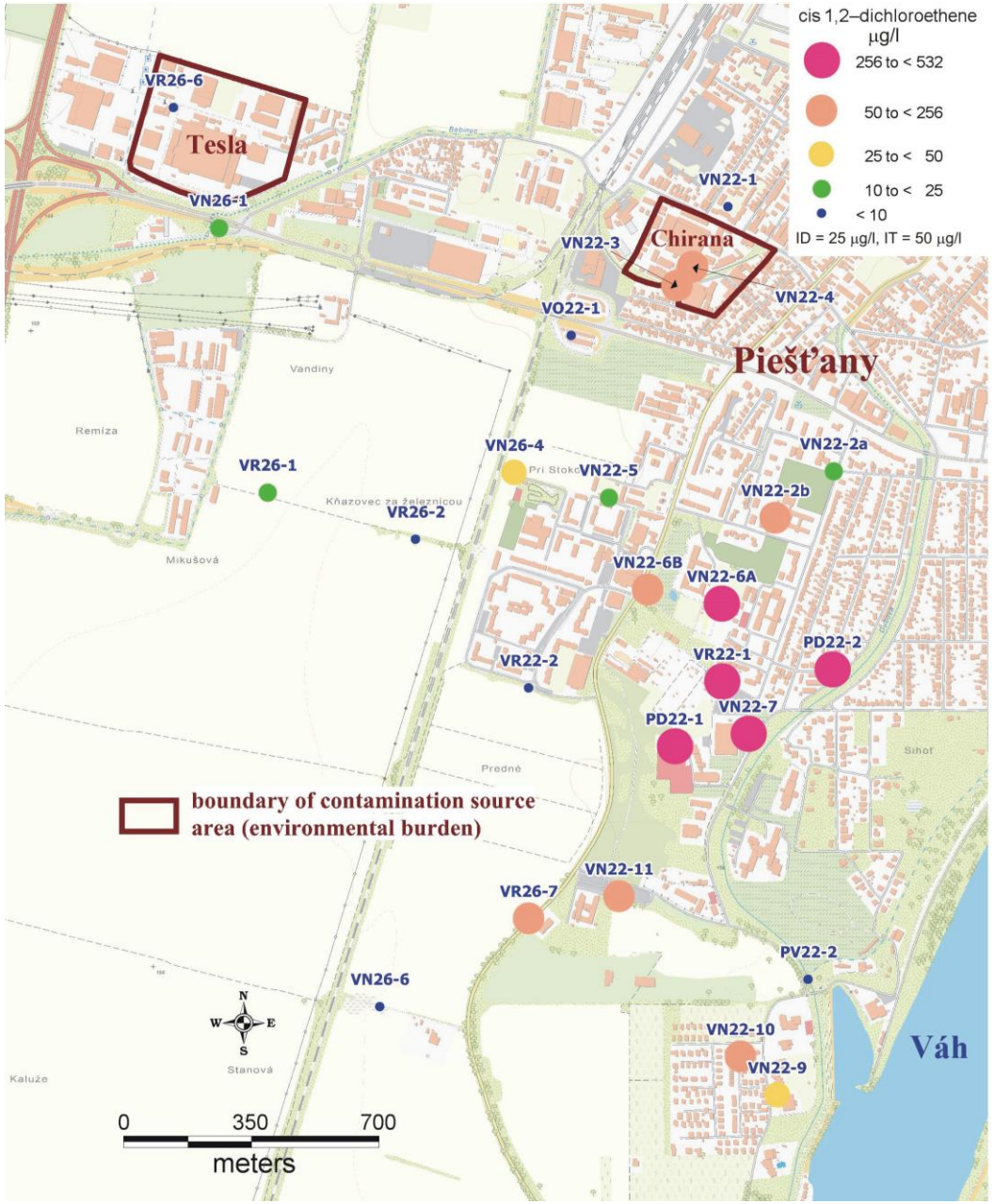
Distribution of selected pollutants in groundwater (median concentrations) – sites Bratislava Chemika-Gumon

Piešťany – former factories Chirana and Tesla

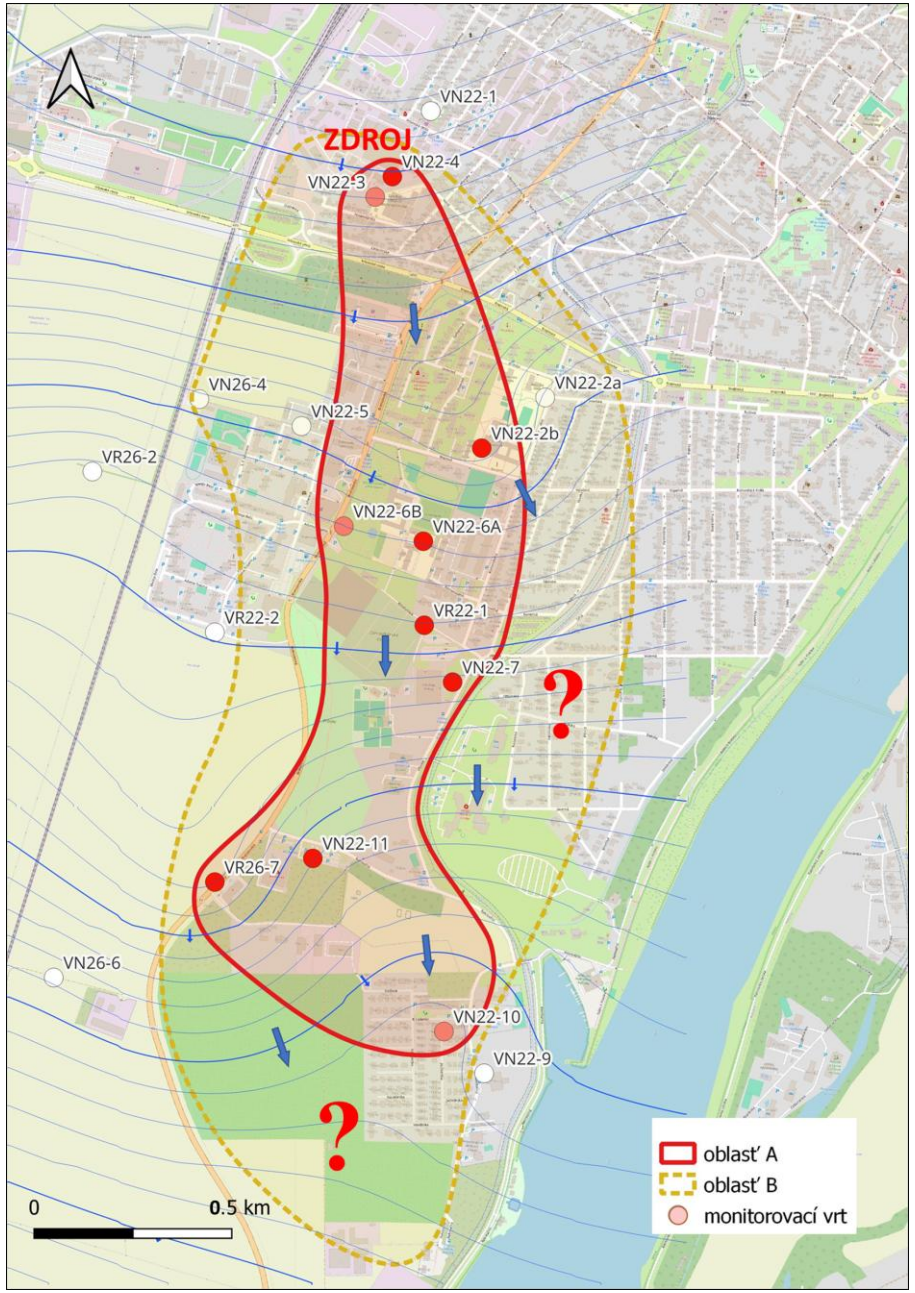
- **In Piešťany, contamination by aliphatic chlorinated hydrocarbons is caused by negligence in handling of hazardous substances and unsuitable storage and handling facilities (former Chirana and Tesla factories)**
- **Engineering production, dental equipment and manufacture of medical equipment dominated in the area. For the purpose of degreasing, especially 1,1,2-trichloroethene and 1,1,2,2 tetrachloroethene were intensely used**

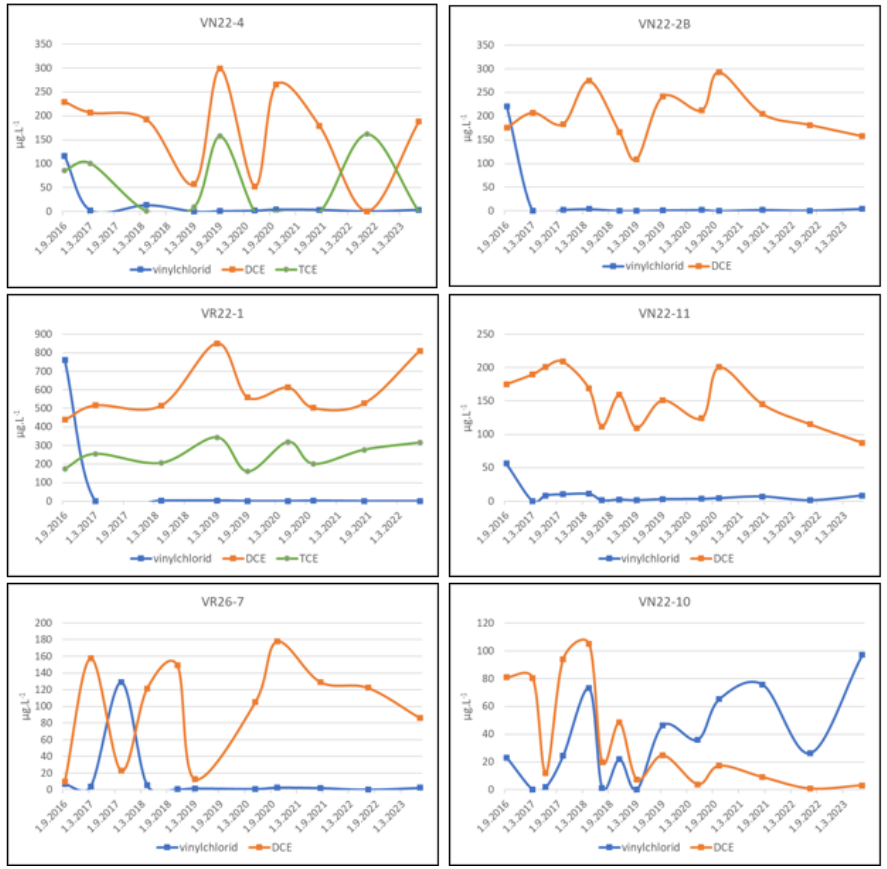
What is important ?

Groundwater pollution is large (reaches several km^2), the pollutants have been transported to a distance of about 2 km south of the former source and at present the highest detected concentrations of chlorinated hydrocarbons occur in the vicinity of the horticultural settlement SÍňava and Winter Stadium Piešťany



(median concentration of selected pollutants in groundwater)





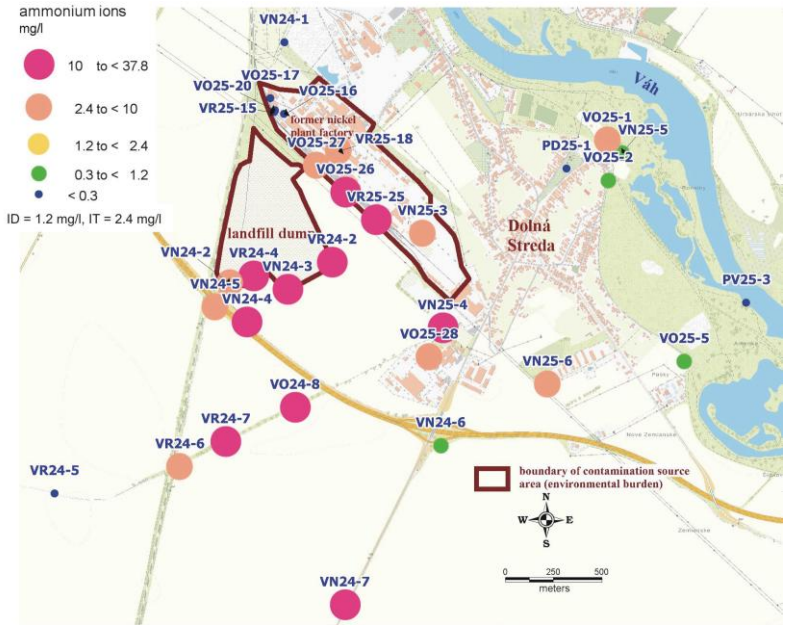
Yellow area – expected pollution of groundwater

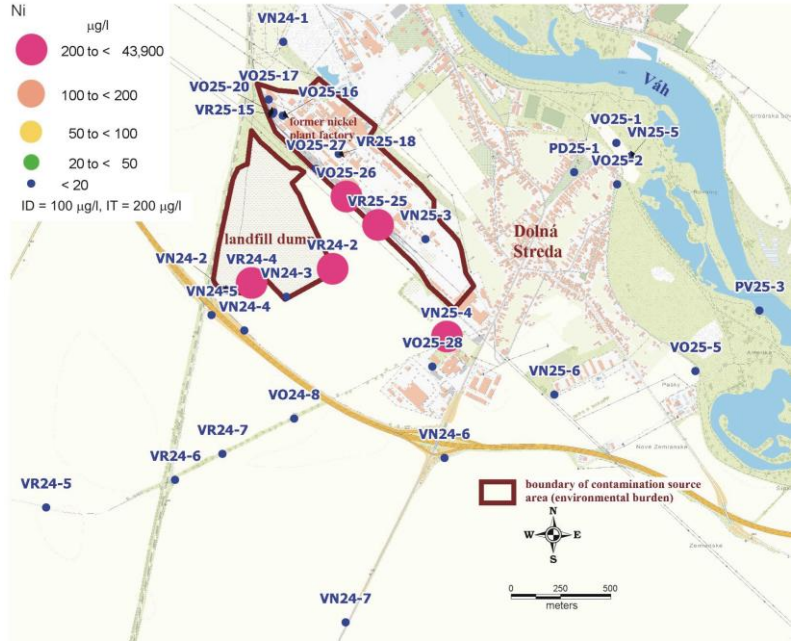
Red area - high probability of groundwater pollution

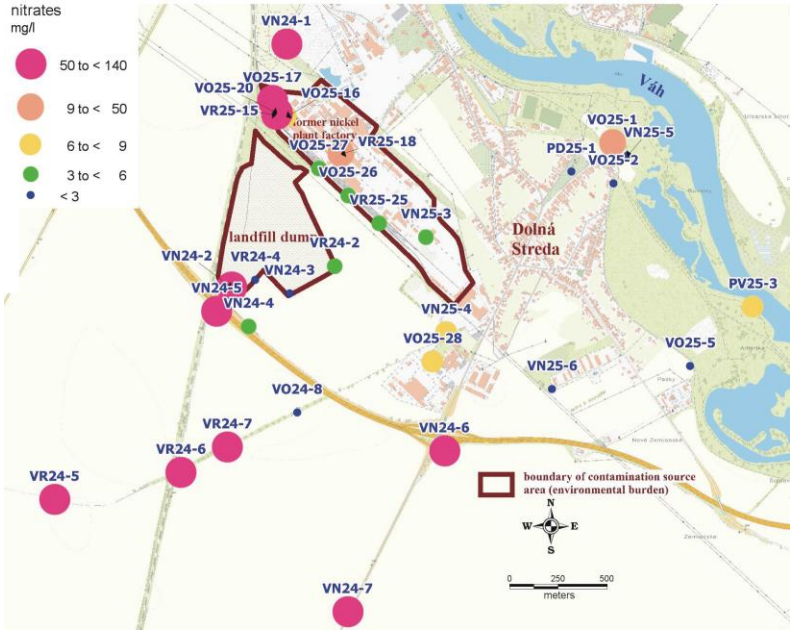
Verification: detailed geological investigation

Sered' – landfill dump and former Nickel plant area

- This region has been long affected by environmental pollution – mainly industrial action in the nickel smelters
- At present, major source of pollution is now deposited material – leach wasted mud
  - Consequences: high levels of NH_4^+, Ni, NO_3^-, SO_4^{2-}



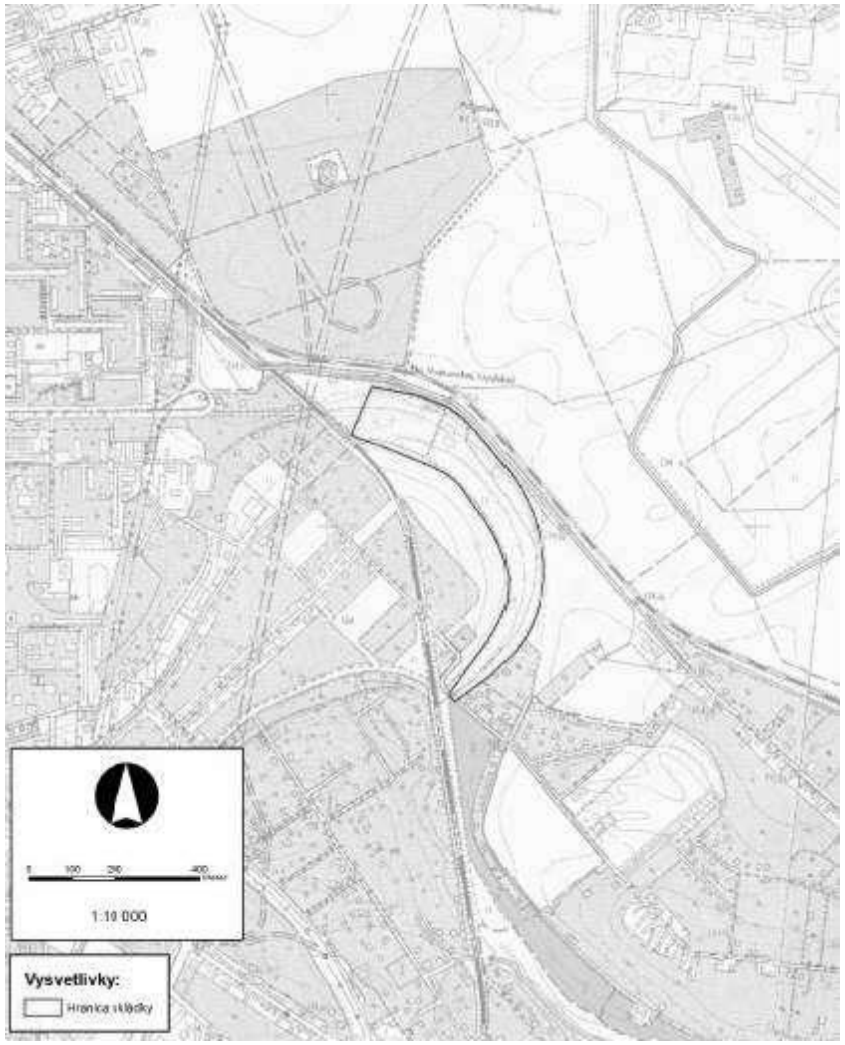




Distribution of selected pollutants in groundwater (median concentrations) – sites Sereď – landfill/Nickel plant area

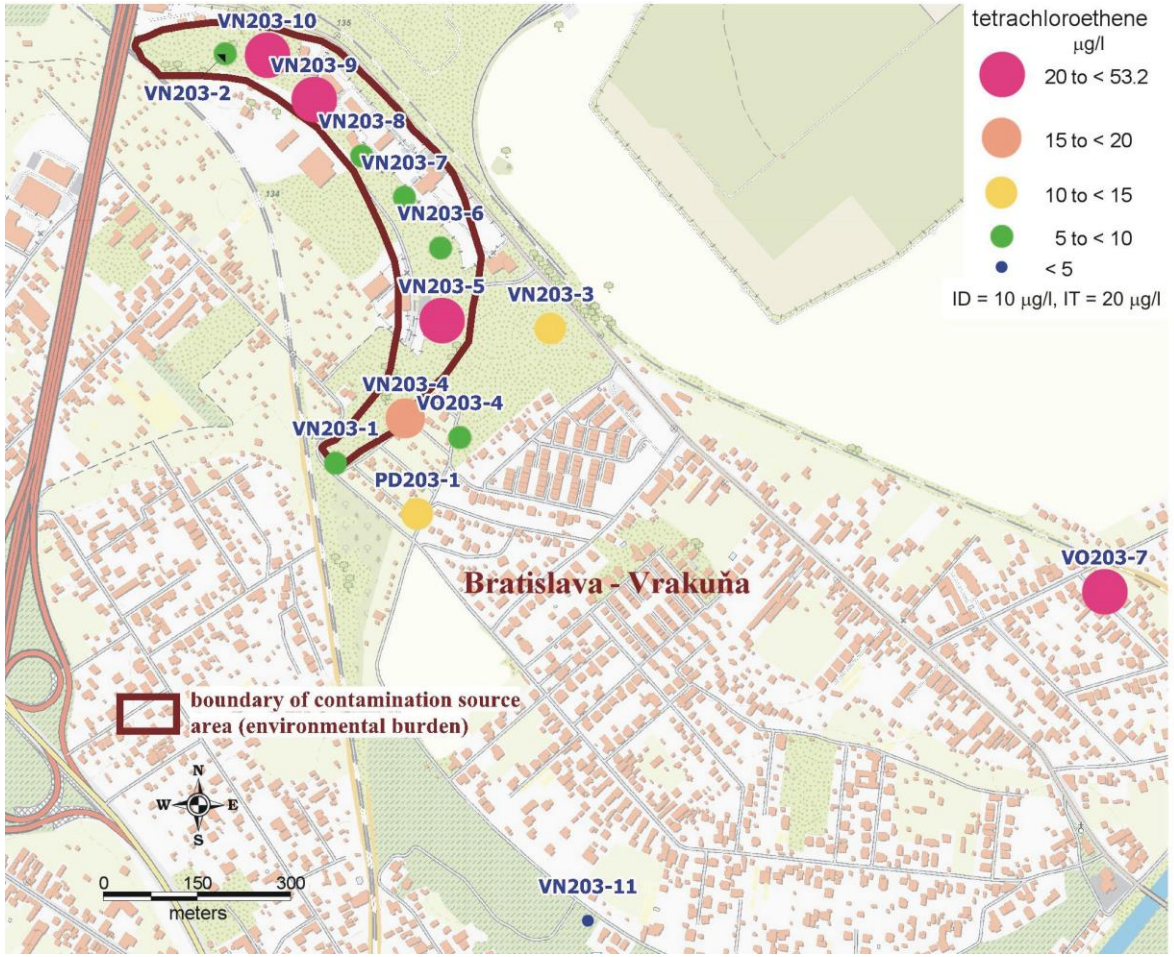
Bratislava – Vrakuňa – CHZJD landfill

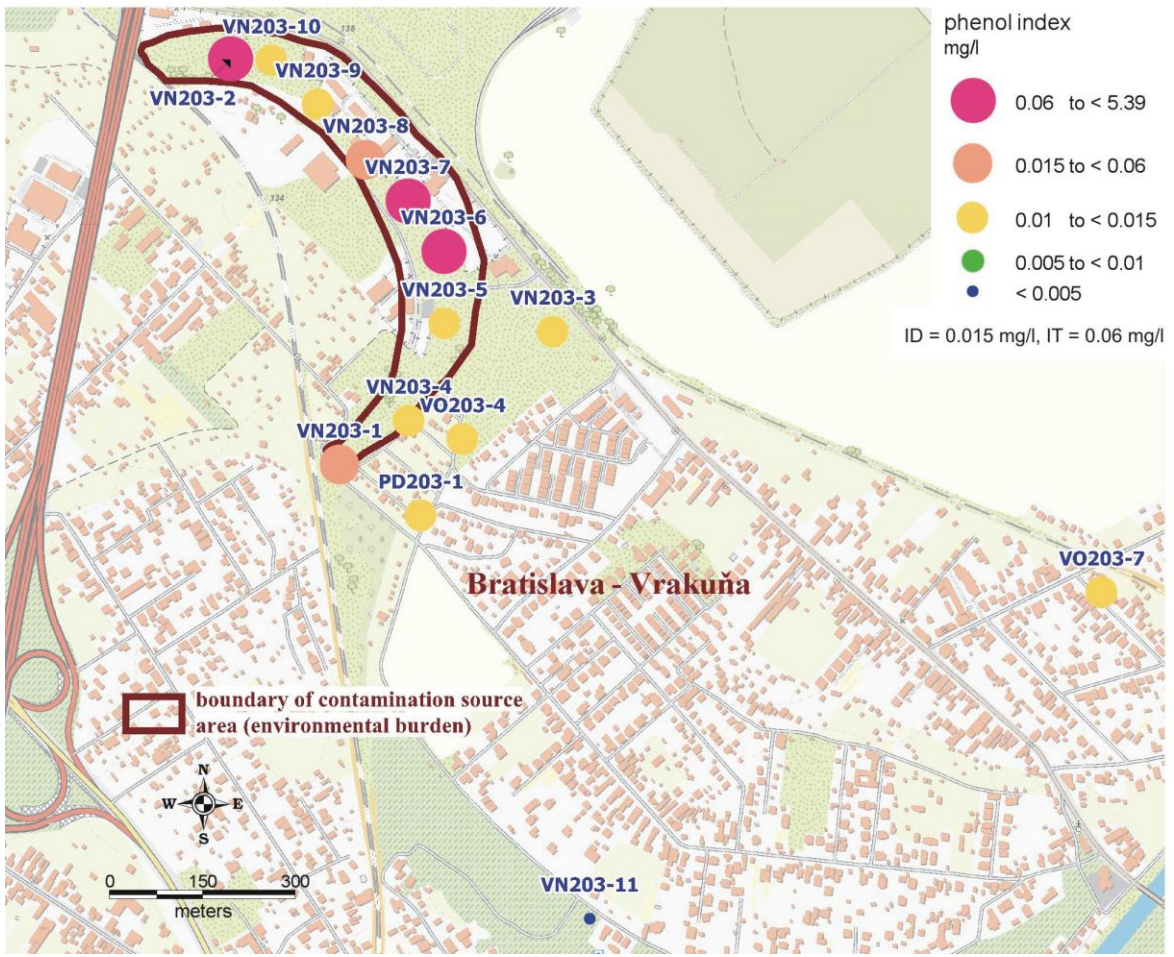
- **The landfill was set up in the former cut-off meander, of the Little Danube River and was dumped in waste from the production of chemicals, especially pesticides and herbicides**
- **The waste storage began in 1966 and ended in 1979**
- **Area – 46 500 m^2**
- **Volume of waste 90 000 m^3**
- **Consequences: high levels of pesticides, herbicides, chlorinated aromatic/alifatic hydrocarbon, PCB, BTEX, PAH, elements: As, Cl^-, NH_4^+...**



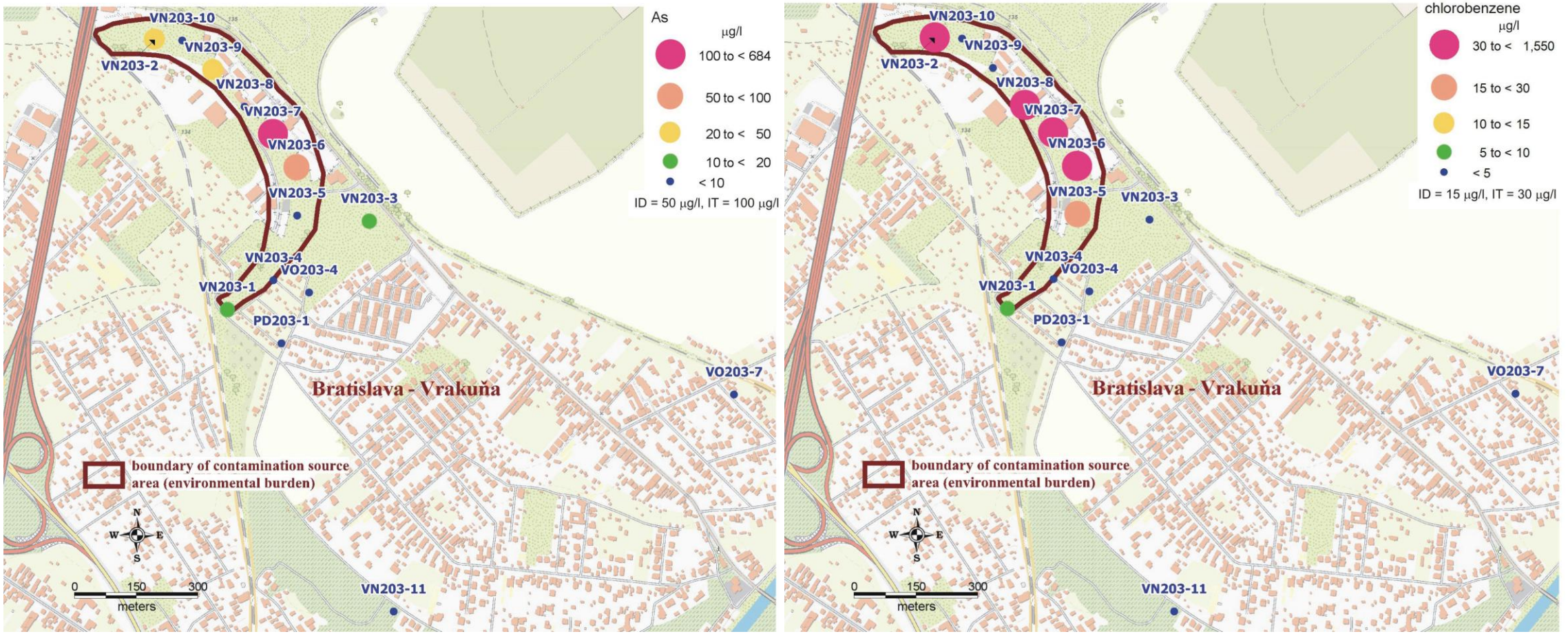
What is important ?

After running the power plant (Gabčíkovo) in 1996
→ rising of groundwater level on contamined sites
→ process of leaching of waste dump
→ bassically 30y of active moving of contaminants
→ endanger significant water source (Žitný ostrov)





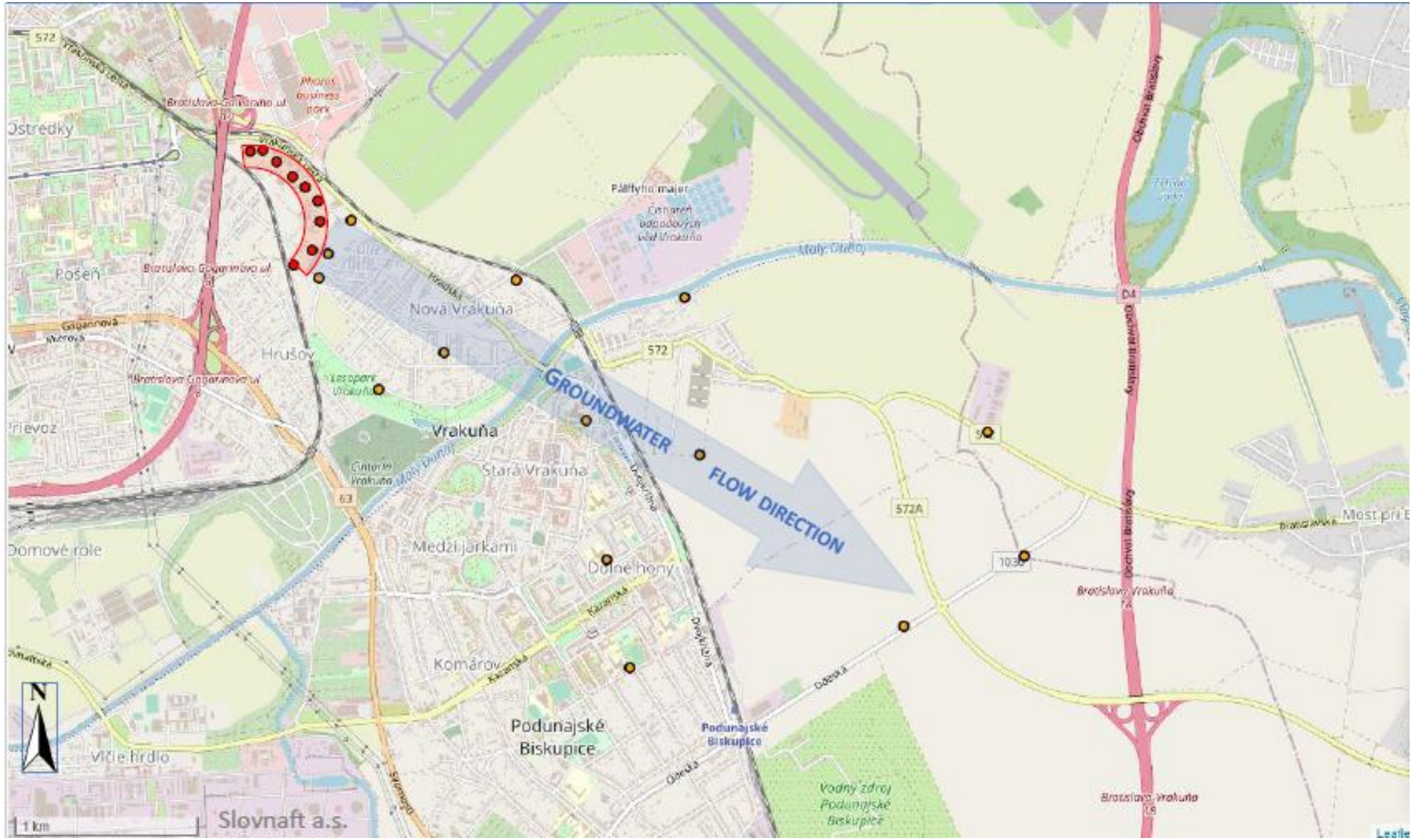
Distribution of selected pollutants in groundwater (median concentrations) – sites Bratislava – Vrakuňa – CHZJD landfill



Distribution of selected pollutants in groundwater (median concentrations) – sites Bratislava – Vrakuňa – CHZJD landfill

ID value = 0,1 µg.l^{-1}
IT value = 0,2 µg.l^{-1}

median concentrations – 2016 - 2022

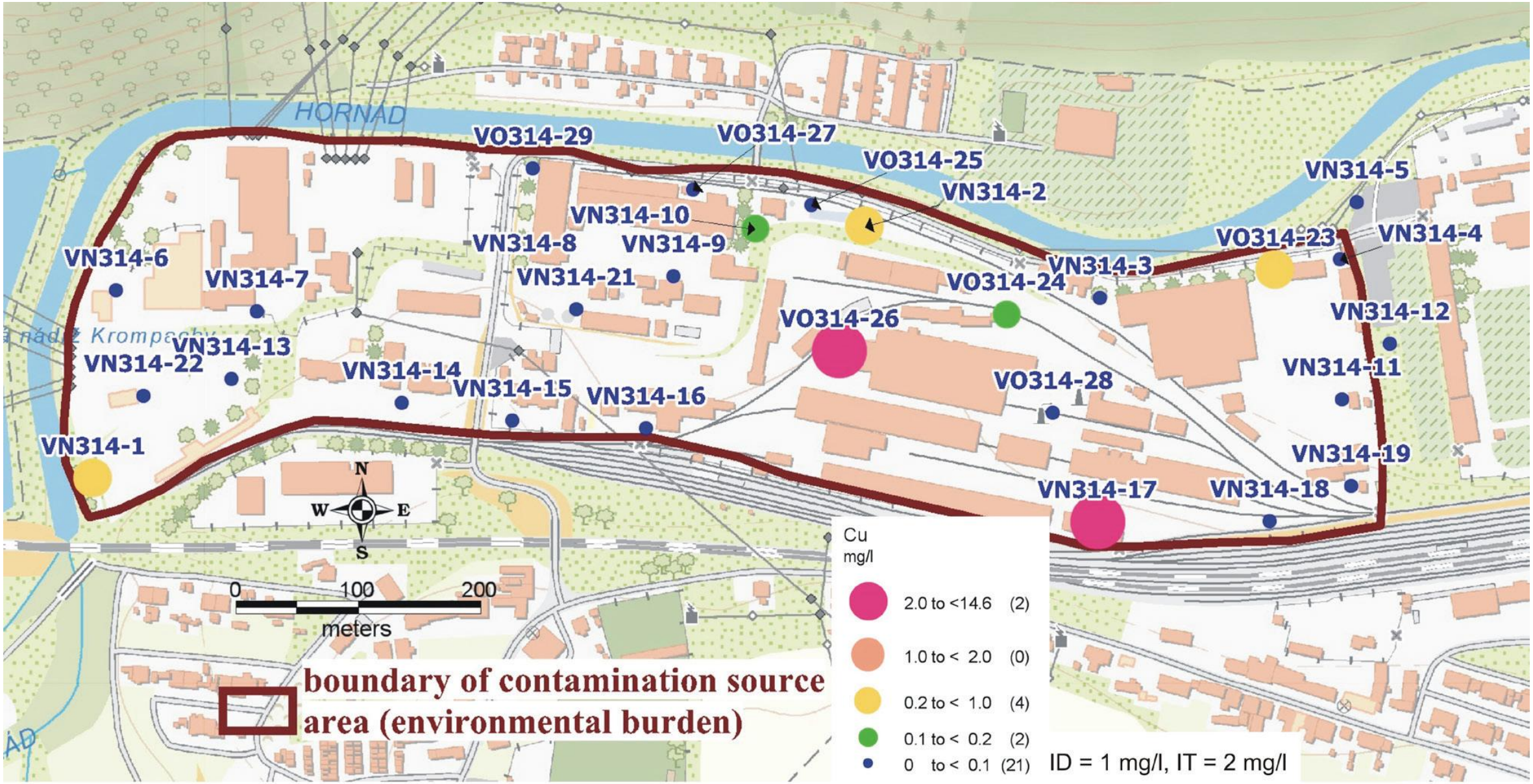

GROUNDWATER FLOW DIRECTION
Ostredky
Rošeň
Hrušov
Nová Vrakuňa
Vrakuňa
Stará Vrakuňa
Medzi jarkami
Dlhé hony
Komárov
Podunajské Biskupice
Vtčie hrdlo
Prievoz
Domové role
Slovnaft a.s.
Vodný zdroj Podunajské Biskupice
Most pri B
572
572A
63
D4
1 km

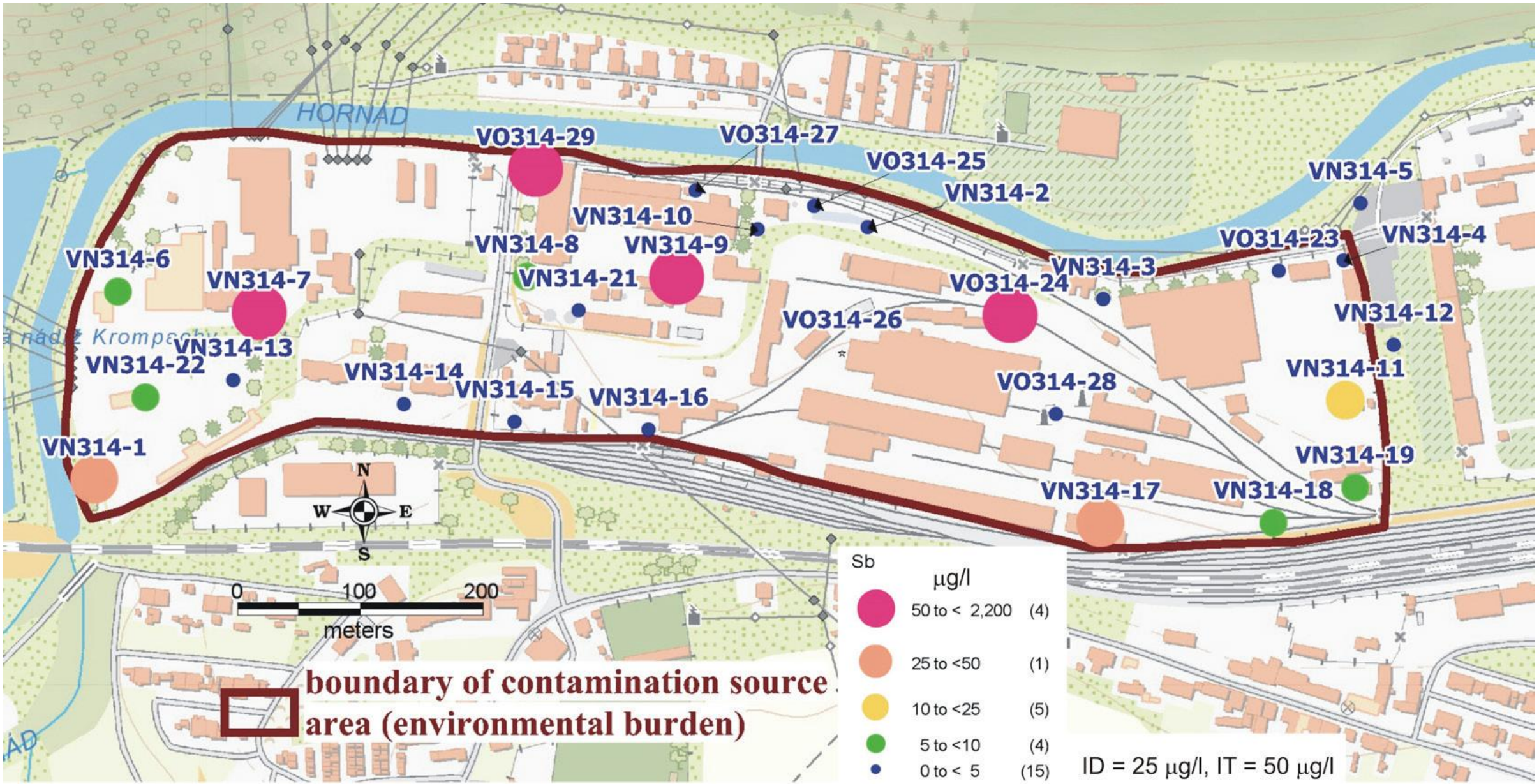
Krompachy – Kovohuty (metalurgical plant area)

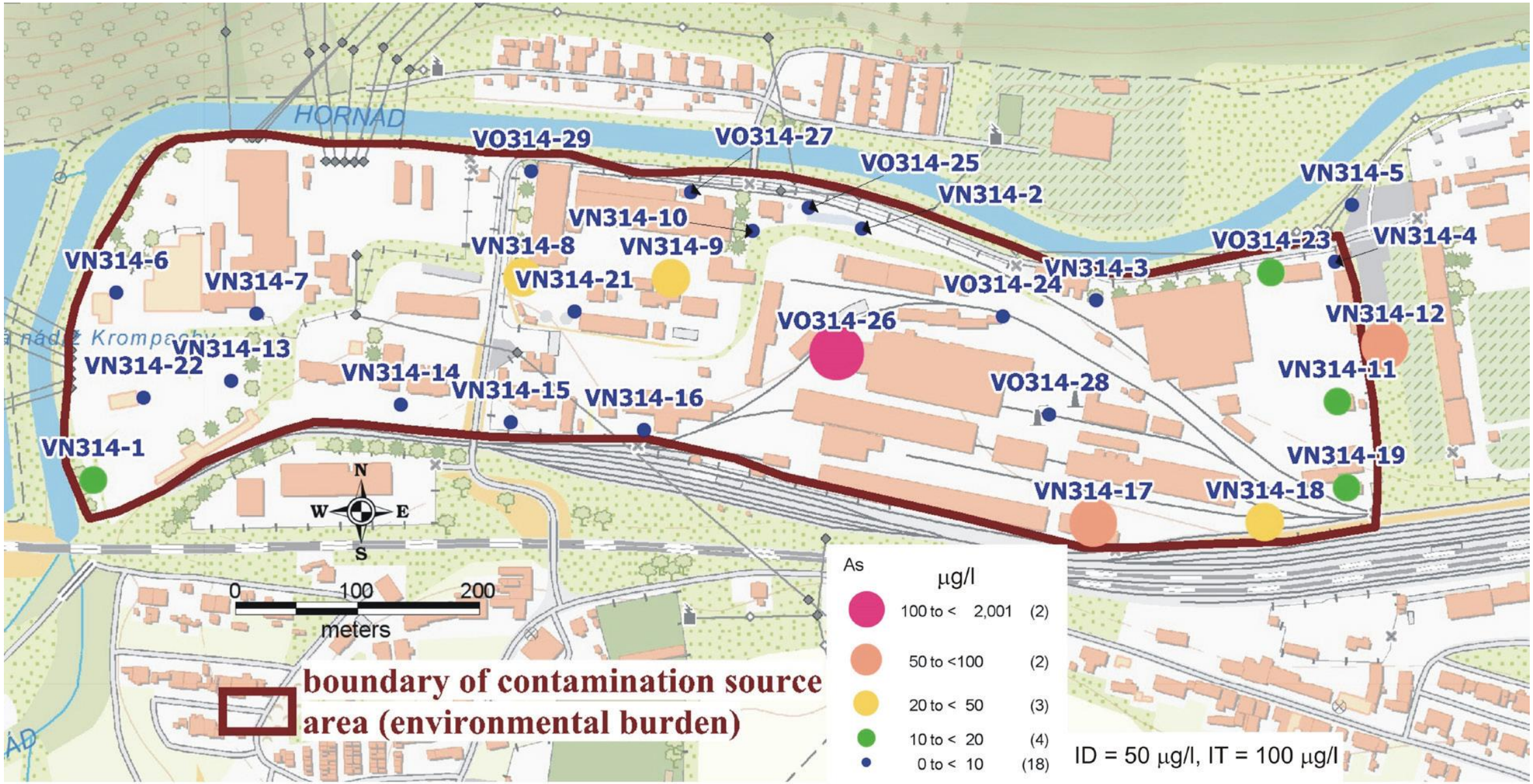
- **Processed ores and produced mainly copper and sulphuric acid**
- **At present, copper production continues in the form of copper wire, copper anode fabrication...**
- **Acid production was stopped**
- **Consequnences: very high levels of sulphate concentration (mean values more than 1,000 mg.l^{-1})**

  → also indicated by specific conductivity
- **Several trace elements (As, Sb, Cd, Cu, Ni, Zn)**

www.kovohuty.sk


HORNÁD
VO314-29
VO314-27
VO314-25
VN314-2
VN314-5
VN314-10
VN314-8
VN314-9
VO314-23
VN314-4
VN314-6
VN314-7
VN314-21
VN314-3
VO314-24
VO314-26
VN314-12
VN314-13
VN314-22
VN314-14
VN314-15
VN314-16
VO314-28
VN314-11
VN314-1
VN314-19
VN314-17
VN314-18
N
W
E
S
0
100
200
meters
boundary of contamination source area (environmental burden)
Cu
mg/l
2.0 to <14.6 (2)
1.0 to < 2.0 (0)
0.2 to < 1.0 (4)
0.1 to < 0.2 (2)
0 to < 0.1 (21)
ID = 1 mg/l, IT = 2 mg/l


HORNAD
VO314-29
VO314-27
VO314-25
VN314-2
VN314-5
VN314-10
VN314-8
VN314-9
VO314-23
VN314-4
VN314-6
VN314-7
VN314-21
VN314-3
VO314-24
VO314-26
VN314-12
VN314-13
VN314-22
VN314-14
VN314-15
VN314-16
VO314-28
VN314-11
VN314-1
VN314-19
VN314-17
VN314-18
N
W
E
S
0
100
200
meters
boundary of contamination source area (environmental burden)
Sb
µg/l
50 to < 2,200 (4)
25 to <50 (1)
10 to <25 (5)
5 to <10 (4)
0 to < 5 (15)
ID = 25 µg/l, IT = 50 µg/l


HORNÁD
VO314-29
VO314-27
VO314-25
VN314-2
VN314-5
VN314-10
VN314-8
VN314-9
VO314-23
VN314-4
VN314-6
VN314-7
VN314-21
VN314-3
VO314-24
VO314-26
VN314-12
VN314-13
VN314-22
VN314-14
VN314-15
VN314-16
VO314-28
VN314-11
VN314-1
VN314-19
VN314-17
VN314-18
N
W
E
S
0
100
200
meters
boundary of contamination source area (environmental burden)
As
µg/l
100 to < 2,001 (2)
50 to <100 (2)
20 to < 50 (3)
10 to < 20 (4)
0 to < 10 (18)
ID = 50 µg/l, IT = 100 µg/l

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Conclusions

- **The data obtained and the results of extensive monitoring contribute to the overall awareness of the effects of the environmental loads on the quality of groundwater (or other parts)**

- **The results of monitoring of ELs allow relevant authorities to take flexible measures to minimize risks and damages, set targets and scope for a detailed or additional investigation of the ELs and propose preventive or remedial measures**

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Thank You for your attention !