



SOME FEATURES OF SOIL CONTAMINATION BASED ON SOIL MONITORING SYSTEM IN SLOVAKIA

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Identification of factors in relation to soil contamination

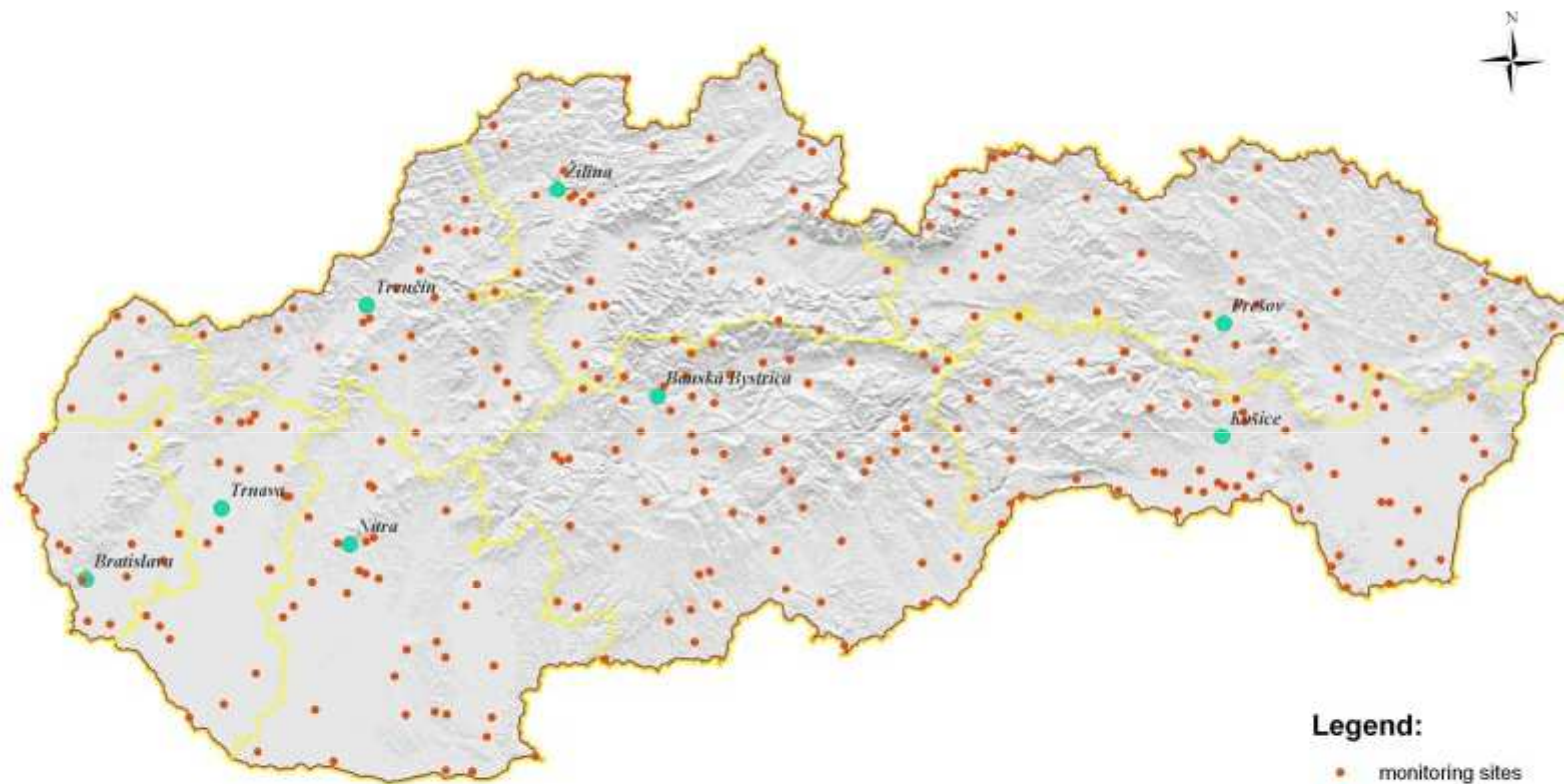
1. Natural (physical-geographical) factors include:

- ✓ climatic conditions (temperature, precipitation, evapotranspiration, speed and directions of wind)
- ✓ soil - lithological conditions (geology, soil type, texture, occurrence of geochemical anomalies, etc.)
- ✓ vegetation (type of vegetation, rooting, etc.)
- ✓ topography (slope, relief, elevation/altitude)

2. Anthropogenic factors include:

- ✓ land use and farming system (crop land, grassland, forest)
- ✓ use of fertilisers and organic manures
- ✓ irrigation, melioration practices
- ✓ other sources (sealing, mining, waste disposal, pollutant emissions)

SOIL MONITORING NETWORK ON AGRICULTURAL SOILS IN SLOVAKIA



25 12.5 0 25 50 km

Legend:

- monitoring sites
- district cities
- bound of districts

Measured risk elements in soil monitoring network in Slovakia

- Cd, Pb, Cu, Zn, Ni, Cr, Se, Co, As (aqua regia)
- Hg (total content, AMA 254)
- F_w (watersoluble fluorine measured by ionselective electrode)

Mean content of risk elements on agricultural soils in Slovakia

Soils	As	Cd	Co	Cr	Cu	Ni	Pb	Zn	Se	Hg
FM	10.8	0.7	8.8	39.1	34.0	37.0	54.3	122.8	-	0.2
ČA	10.0	0.4	7.8	42.9	22.7	29.6	21.1	75.6	0.2	0.06
ČM	10.0	0.4	7.8	42.9	22.7	29.6	21.1	75.6	0.3	0.1
HM	9.2	0.2	10.0	41.5	22.9	32.6	19.7	68.8	0.1	0.05
LM+PG	9.9	0.3	9.7	42.8	17.0	23.3	24.2	66.7	0.2	0.07
KM	14.8	0.3	12.6	52.2	28.9	29.2	27.0	93.5	-	-
RM	3.4	0.1	2.0	19.5	17.0	12.0	7.7	41.0	0.3	0.03
RA	13.1	0.5	11.8	55.2	30.6	42.0	36.3	103.1	-	0.13

Explanations: FM – Haplic Fluvisols, ČA – Mollic Fluvisols, ČM – Chernozems, HM – Cutanic Luvisols, LM+PG – Albeluvisols and Planosols, KM – Cambisols, RM – Regosols, RA – Rendzic Leptosols

Strongly polluted and secondary salined soils near waste deposits



Distribution of risk elements in soil profile of Gleyic Fluvisol (Siltic, Toxic) (WRB 2014)
(extracted with aqua regia) near aluminium waste deposits

Risk elements	Cd	Pb	Cu	Zn	Cr	Ni	As	Co	Se	Hg ¹
Topsoil (0 - 10 cm)	1.5	129.0	95.5	258.0	77.9	19.5	1.75	9.44	< 0.1	0.48
Subsoil (35 – 45 cm)	0.95	102.0	140.0	157.0	42.4	22.0	64.0	10.6	< 0.1	0.58

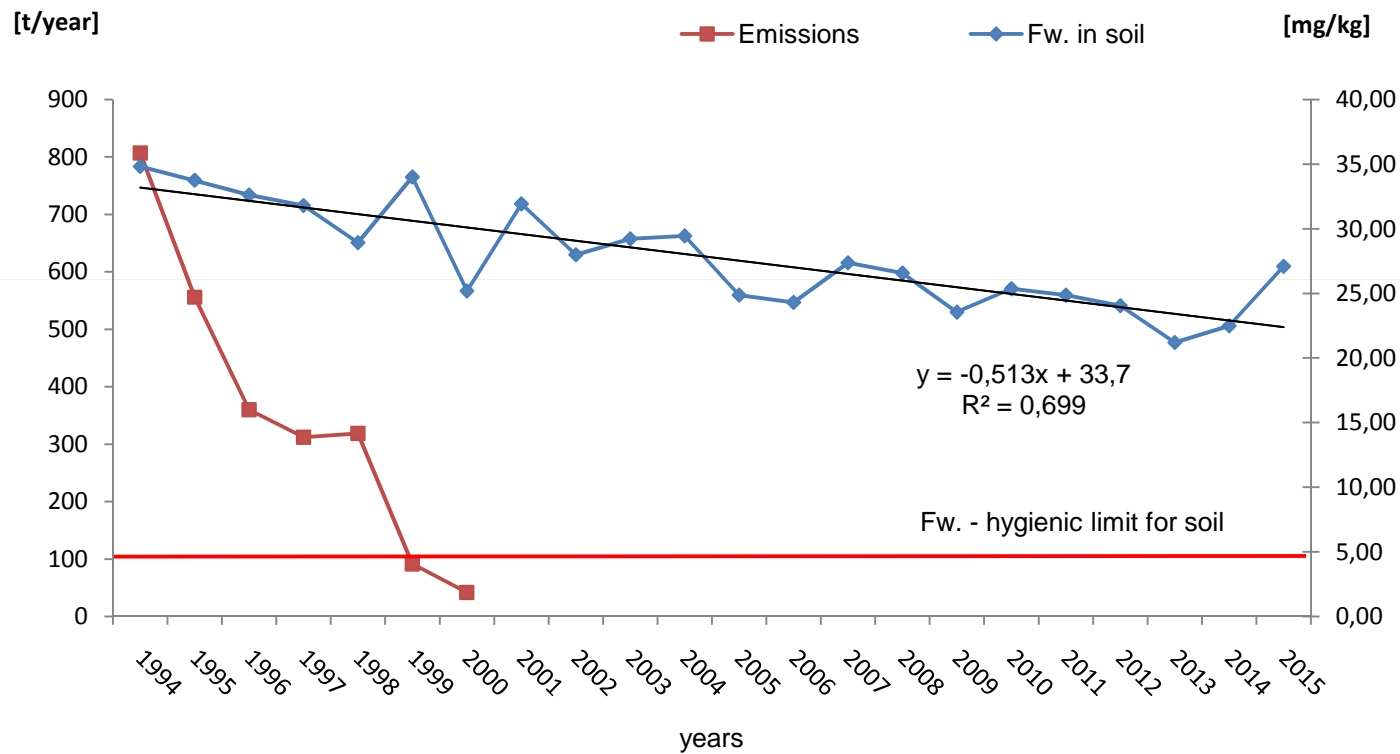
1 – total content (AMA analysator)

Parameters of salinity

Depth (cm)	Total content of salts (%)	ESP (%)	SAR	ECe (mS.m ⁻¹)	pH/H ₂ O
0-10	0.57	16.6	8.4	247	9.1
20-30	1.10	22.0	11.8	387	9.1
35-45	1.06	23.8	13.3	348	9.3
55 -65	0.93	46.9	37.5	382	9.2
75-85	1.31	51.9	44.8	359	9.3



Development of fluorine opposite Aluminium smelter on Planosol (Žiarska kotlina – depression)





Alkalization (Hačava Mg-smelter surroundings)



Depth cm	Mg mg.kg ⁻¹	pH/KCl	P (Mehlich III.) mg.kg ⁻¹	K (Mehlich III.) mg.kg ⁻¹	Cox %	C _{HA} /C _{FA}	Q ₆ ⁴
0 – 10	20 500	9.2	27.77 (low)	118.85 (low)	1.28	0.42	4.0
20 – 30	2 022	8.4	21.83 (low)	110.89 (low)	-	-	-
35 – 45	1 245	7.6	27.12 (low)	90.41 (low)	-	-	-
60 - 70	1 047	7.4	27.87 (low)	80.17 (low)	-	-	-

Occurrence of gray ash layer in Fluvisol soil profile
(Horná Nitra region) – hidden contamination



Alluvial deposit of contaminated site (Horná Nitra region)



Hidden contamination on alluvial deposits along Štiavnica river



Soil depth	Risk elements in mg.kg ⁻¹ (extracted with aqua regia)								
	Cd	Pb	Cu	Zn	As	Ni	Cr	Co	Hg ¹
0 – 10 cm	9.94	1238.00	111.00	1191.00	12.70	10.30	24.10	9.28	0.27
35 – 45 cm	9.89	1941.00	137.00	1340.00	14.30	5.35	15.30	14.00	0.10
50 – 60 cm	23.00	2057.00	229.00	2118.00	-	-	-	-	-

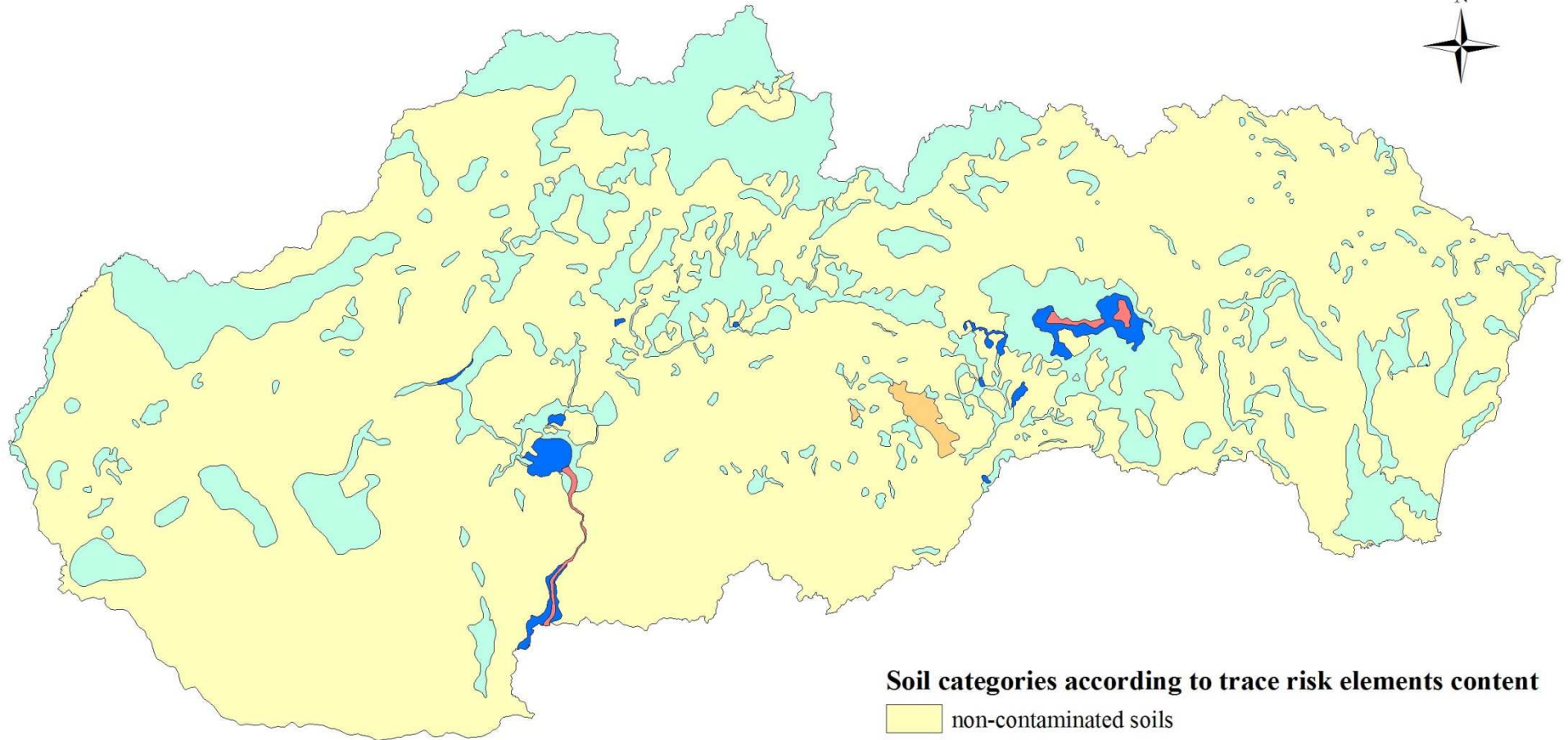
1 – total content (AMA analysator)

Soil depth	Bioavailable forms of risk elements in mg.kg ⁻¹ (extracted with 1M NH ₄ NO ₃)			
	Cd	Pb	Cu	Zn
0 – 10 cm	0.228	0.118	0.056	9.44






2 examples of anthropogenic and geogenic contamination

Locality	Soil	Depth (cm)	Concentration of heavy metals extracted with 2M HNO ₃ (mg.kg ⁻¹)					
			Cd	Pb	Cr	Ni	Cu	Zn
Veľké Rovné at Žilina	Cambisol	0 – 10	0.38	24.78	1.90	5.19	7.90	13.50
		20 – 30	0.12	11.10	1.80	5.35	8.50	11.30
		35 – 45	0.04	6.60	0.95	0.75	2.98	3.50
Ilija at Banská Štiavnica	Planosol	0 – 10	0.68	153.00	1.80	1.10	15.95	51.00
		20 – 30	0.75	155.35	1.60	0.65	16.52	49.60
		35 – 45	0.76	172.00	1.80	1.10	17.33	46.75

Soil contamination categories in the Slovak Republic

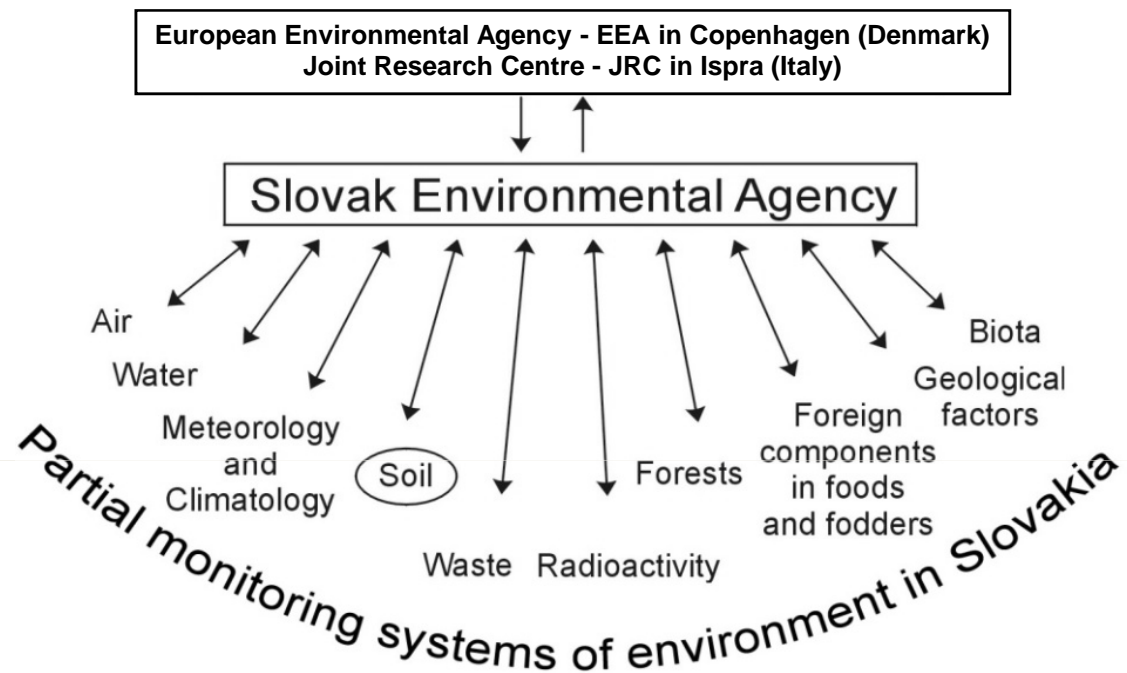


Soil categories according to trace risk elements content

-  non-contaminated soils
-  very slightly contaminated soils
-  contaminated soils
-  strongly contaminated soils
-  contaminated soils with $MgCO_3$



Implementation of soil monitoring system in Slovakia to EU



Evaluations of soil monitoring system is available on:

http://ism.enviroportal.sk/cms_poda (in Slovak)

Next links: www.enviroportal.sk, www.enviroportal.sk/environmentalne-temy/zlozky-zp/poda, www.enviroportal.sk/en/about-enviroportal

Conclusions

- soil contamination can be caused by anthropogenic or geogenic, resp. mixed influence
- the highest concentration of risk elements has been measured in the industrial areas and in the areas affected by geochemical anomalies influence
- from among the soil types the higher concentration of risk elements was determined on Fluvisols
- important is also „hidden contamination“ especially on agricultural soils which are often normally cultivated (the need to exclude them from agricultural use)
- contaminated sites situated on agricultural and forest land as well as in some residential areas as a result of old mining activities especially from the middle-age
- there is calculated about 20 thous. ha of strongly contaminated soils in the Slovak Republic (about 1.4 % of soil cover)
- on the basis of our obtained results no statistically significant change in soil contamination was observed during 20 years long monitoring process

Thank you for your attention

