Historical Mining Areas and Their Influence on Human Health

GEOHEALTH
The impact of geological environment on health status of residents of the Slovak Republic.

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ABSTRACT

Impact of potentially toxic elements (PTE) on the health status of population of the Slovak Republic has been studied in two historical mining areas with ore extraction from Middle Ages (the Middle Slovak Neovolcanics, the Slovak Ore Mts.) and one historical mining area with more than hundred years brown coal mining (Upper Nitra region). The contents of PTE were analysed in groundwater/ drinking water and soils. The health status of resident population was evaluated based on 43 health indicators classified according to the international classification of diseases (ICD, 10th revision), including mainly those indicators characterizing mortality on cardiovascular and oncological diseases. In these areas the health status of population living in municipalities with increased PTE contents (As, Pb, Zn, Cu, Cd, Hg and Sb) was compared with that in adjacent municipalities showing low PTE contents. A total of 138 contaminated and 155 non-contaminated municipalities of similar socioeconomic, natural and geochemical-geological character were compared. PTE contents in soils of polluted municipalities reported considerably increased levels - between 2 to 10 times higher in contrast to non-contaminated municipalities. On the other hand, PTE contents in groundwater were almost identical both in contaminated as well as non-contaminated areas and in majority of cases were below limit standard values for drinking water. Based on the assessment of the health status of population (using 43 health indicators), no significant difference in the health status of population in contaminated and non-contaminated municipalities has been reported.

OBJECTIVE

The main objective of this study was to assess how, and to what extent, the PTE contamination of the geological environment might influence the health status of residents living in the selected historical mining areas.

MATERIAL

Geological environment was evaluated based on chemical analyses of groundwater/drinking water and soils. Primary geochemical data were re-calculated through inverse distance method to obtain the mean values for each of evaluated municipalities (www.geology.sk/geohealth). Health status of residents was assessed via 43 health indicators (in accordance with ICD, 10th revision). Health data represented 10-year averaged values (1994-2003) and they were calculated and stamdardized for each of evaluated municipalities.

METHOD

The health status of residents living in contaminated and non-contaminated areas in three historical mining regions including Slovak Ore Mts, Middle Slovak Neovolcanics, Upper Nitra region (Fig. 1) (characterized with similar geological structure and socioeconomic status of population) was assessed and compared. The evaluated areas (municipalities) differ each other only by the contents of potentially toxic elements in geological environment (groundwater/drinking water and soils).

RESULTS

Basic characteristic of the selected chemical elements in groundwater and soils (environmental indicators) of the studied areas is given in Table 1. The characteristics of population health status in the evaluated contaminated and non-contaminated areas are presented in Table 2.

The contents of PTE in groundwater in contaminated and non-contaminated areas are practicaly the same. The content levels are predominantly very low, below the guideline values of Slovak Drinking Water Standards. In all three regions PTE levels in soils is significantly higher in contaminated areas that in non-contaminated areas.

The results obtained from the comparison of health indicators between contaminated and non-contaminated areas are surprising and contrary to the current assumptions. In general, poorer health status is predicted in areas contaminated with PTE. Nevertheless, our results suggest that the health status of populations in both, contaminated and non-contaminated areas is at the same level or slightly better in contaminated areas.

Fig. 1 Contaminated and non-contaminated areas of the Slovak Republic

Table 1 Selected values of environmental indicators in contaminated and non-contaminated areas of the Slovak Republic (mean values for all municipalities)

	MIDDLE SLOVAK NEOVOLCANICS		UPPER NITRA REGION		SLOVAK ORE MTS.	
	Contaminated area	Non contaminated area	Contaminated area	Non contaminated area	Contaminated area	Non contaminated area
Soils						
As	11.03	7.06	32.38	16.90	96.68	13.14
Cd	3.34	0.60	0.24	0.34	0.79	0.31
Cu	35.67	19.18	19.15	17.91	139.89	22.68
Hg	0.16	0.08	0.15	0.10	3.03	0.18
Pb	91.42	29.63	37.65	29.95	118.34	26.26
Sb	2.96	1.53	1.23	0.97	76.79	2.36
Zn	134.14	78.40	88.32	72.75	89.81	74.59
Ca	1.14	0.96	1.47	1.55	0.65	0.91
Mg	0.73	0.59	0.95	0.91	0.69	0.84
carbonates	0.86	1.21	1.74	2.14	0.62	0.22
Groundwater						
As	0.00194	0.00160	0.02096	0.00194	0.01217	0.00165
Cd	0.00139	0.00286	0.00444	0.00818	0.00054	0.00205
Cu	0.00263	0.00239	0.00129	0.00169	0.00413	0.00112
Hg	0.00014	0.00012	0.00015	0.00014	0.00016	0.00013
Pb	0.00198	0.00106	0.00107	0.00193	0.00163	0.00104
Sb	0.00024	0.00021	0.00019	0.00023	0.00941	0.00048
Zn	0.17592	0.25344	0.20046	0.15462	0.12486	0.12066
Ca	43.87	48.98	63.32	93.82	38.33	33.02
Mg	11.75	13.25	18.65	25.72	14.09	9.88
Ca+Mg	1.58	1.77	2.34	3.40	1.54	1.23

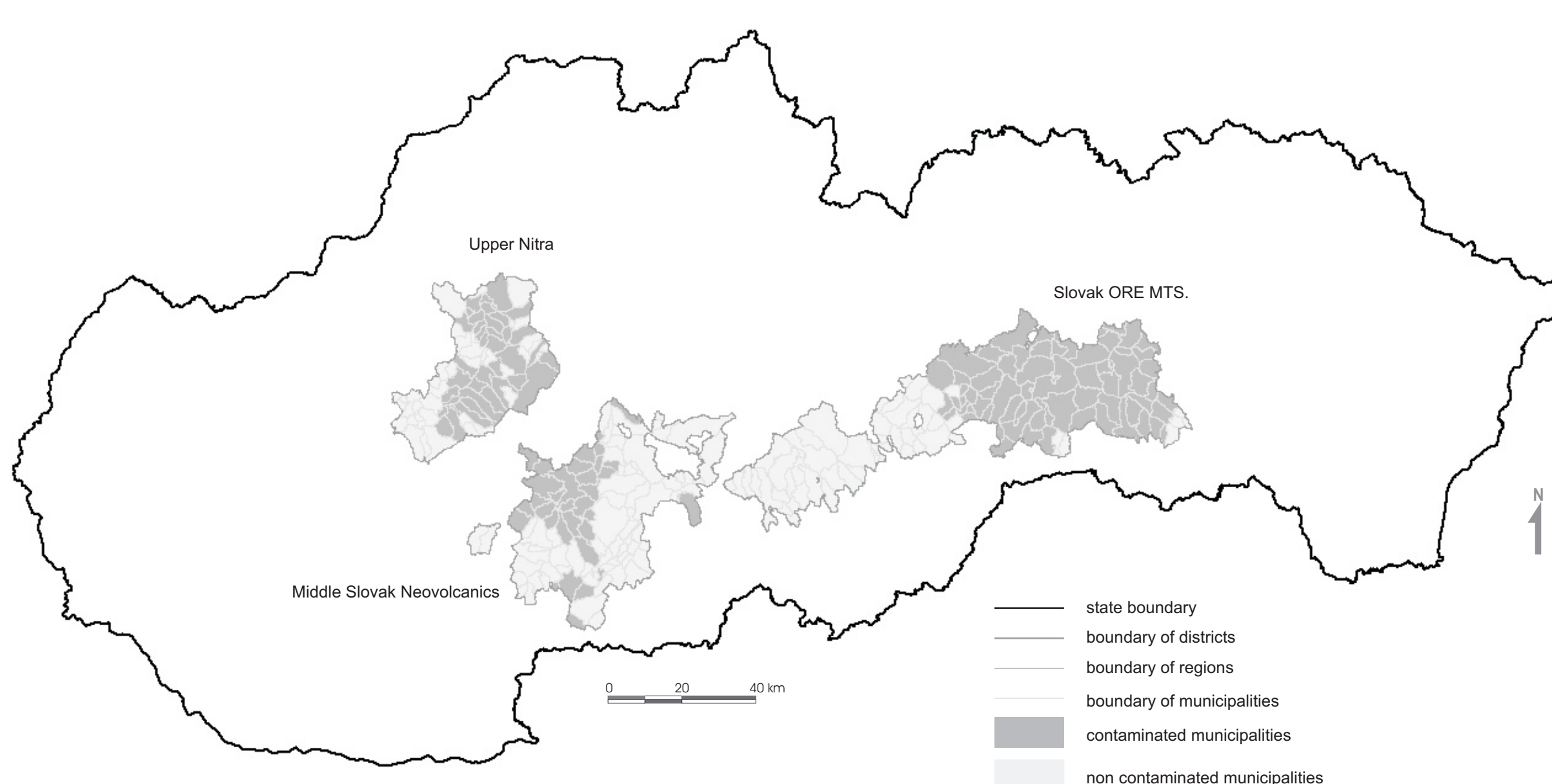Note: contents of elements for groundwater in mg.l^{-1}, Ca+Mg v mmol.l-1, for soils in mg.kg^{-1}, Ca, Mg in %

Table 2 Characteristics of population health status in contaminated and non-contaminated areas (data recalculated according to number of inhabitants in respective municipalities)

No.	Indicator	Description of indicator	MIDDLE SLOVAK NEOVOLCANICS		SLOVAK ORE MTS.		UPPER NITRA	
			Contaminated area	Non-contaminated area	Contaminated area	Non-contaminated area	Contaminated area	Non-contaminated area
Demographic indicators describing age structure of municipalities								
1	LEp	life expectancy at birth - population	71.10	70.99	71.12	71.53	73.55	73.45
2	LEm	life expectancy at birth – men	65.78	66.10	66.49	66.99	69.75	69.62
3	LEw	life expectancy at birth – women	75.96	75.65	72.88	74.95	77.06	77.13
4	A60+	proportion of population at age 60 and more	18.16	17.89	15.31	16.91	17.87	17.99
Crude mortality, premature								
5	SMRp	population	112.40	112.15	112.25	110.32	94.98	94.38
6	SMRm	men	122.67	117.58	115.75	111.37	94.07	91.57
7	SMRw	women	105.94	107.21	110.60	109.88	94.74	96.03
8	PYLL100	potential years of lost life	5244.41	5049.83	4527.48	4985.29	3485.95	3504.16
Relative mortality for selected cause of death								
9	ReC00-C97	malignant neoplasms	252.60	240.31	211.78	229.03	223.96	238.11
10	ReC15-C26	malignant neoplasms of gastrointestinal system	85.26	96.23	70.73	72.94	77.28	94.21
11	ReC16	malignant neoplasms of stomach	14.24	20.72	14.30	15.34	22.60	20.90
12	ReC18-C20	malignant neoplasms of colon and rectum	27.41	32.32	24.46	20.60	23.02	28.49
13	ReC30-C39	malignant neoplasms of respiratory system	55.44	46.94	45.58	51.67	50.09	43.19
14	ReC50	malignant neoplasms of breast	21.46	29.31	24.51	33.53	23.87	24.96
15	ReC64-C68	malignant neoplasms of urinary system	16.07	8.46	12.02	13.40	9.60	10.98
16	ReC81-C96	malignant neoplasms of orgnas for haematopoiesis	14.07	13.98	12.75	15.26	11.66	12.74
17	ReC91-C95	all leukemia	6.05	8.11	6.13	6.74	4.78	5.21
18	ReC00-D48	all neoplasms	241.58	242.61	212.62	229.40	223.83	240.48
19	ReE00-E99	endocrine, nutritional and metabolic diseases	21.52	16.63	17.45	16.49	20.92	14.73
20	ReI00-I99	diseases of the circulatory system	760.28	668.37	582.93	682.26	613.95	617.30
21	ReI21-I25	ischaemic heart disease	392.94	310.74	355.31	363.62	288.70	280.75
22	ReI63-I64	cerebral infarction and strokes	141.29	108.41	46.26	126.98	55.71	79.70
23	ReJ00-J99	diseases of respiratory system	82.12	101.82	73.29	79.76	52.40	49.87
24	ReK00-K93	diseases of the digestive system	87.79	74.58	42.05	48.67	52.40	42.30
25	ReN00-N99	diseases of urinary and reproductive system	17.62	15.99	11.57		17.83	12.21	10.66
Standardized mortality for selected cause of death								
26	SMRC00-C97	malignant neoplasms	103.88	100.01	104.66	99.71	93.86	98.75
27	SMRC15-C26	malignant neoplasms of gastrointestinal system	98.08	112.33	97.17	88.23	90.88	107.90
28	SMRC30-C39	malignant neoplasms of respiratory system	114.40	93.69	110.51	102.84	98.88	83.05
29	SMRC81-C96	malignant neoplasms of organs for haematopoiesis	91.45	92.29	97.83	110.76	79.44	87.30
30	SMRE00-E99	endocrine, nutritional and metabolic diseases	119.57	103.60	131.67	109.24	129.10	89.61
31	SMRI00-I99	diseases of the circulatory system	119.99	108.75	114.98	116.24	98.25	98.33
32	SMRI21-I25	ischaemic heart disease	100.30	104.62	137.26	118.20	91.62	86.94
33	SMRI63-I64	cerebral infarction and strokes	168.81	140.90	74.89	174.76	75.50	102.84
34	SMRJ00-J99	diseases of respiratory system	113.31	146.33	132.39	129.35	77.81	72.34
35	SMRK00-K93	diseases of the digestive system	127.85	151.96	99.01	96.85	96.77	82.22
36	SMRN00-N99	diseases of urinary and reproductive system	114.16	101.85	89.87	118.10	78.32	63.89
Potential years of lost life for selected cause of death								
37	PYLLC00-C97	malignant neoplasms	1216.72	1101.53	1062.55	1126.65	925.65	975.03
38	PYLLC15-C26	malignant neoplasms of gastrointestinal system	306.04	277.58	220.23	272.70	201.33	280.05
39	PYLLC30-C39	malignant neoplasms of respiratory system	242.30	227.34	200.19	232.48	193.05	151.50
40	PYLLI00-I99	diseases of the circulatory system	1170.12	1182.35	1116.08	1365.40	778.44	839.03
41	PYLLI21-I25	ischaemic heart disease	578.20	555.64	596.50	728.38	360.04	350.23
42	PYLLJ00-J99	diseases of respiratory system	245.71	286.85	272.24	266.66	74.51	71.90
43	PYLLK00-K93	diseases of the digestive system	585.14	596.79	391.31	415.26	351.55	219.86
	SUMA_NEG	SMRV-PYLLK	13670.19	13137.34	11679.16	13012.17	9431.74	9461.49

CONCLUSION

The main aim of this study was to objectively assess the potential impact of PTE on human health in historical mining areas. The health status of population in municipalities situated in contaminated and adjacent non-contaminated areas was compared across three studied regions of the Slovak Republic. Contamination of the studied areas has been documented mainly in soils, while the contents of PTE in groundwater/drinking water were approximately the same and below the limits of drinking water standards.

We found no significant impairment in the health of the population living in the areas with higher PTE contamination compared to non-contaminated areas. Surprisingly, no significant differences between the health status of population living in contaminated areas and that living in non-contaminated areas were observed. Finally, we can conclude that if groundwater/drinking waters used for drinking purposes show no PTE contamination, the local population inhabiting these historical mining areas might be at much lower risk than has been, in general, reported so far.