

## ECOLOGICAL GEOCHEMICAL INVESTIGATION OF THE NATIONAL PARK TERRITORIES OF BELARUS: METHODOLOGICAL ASPECTS

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### Abstract

Ecological geochemical investigation of the national parks of Belarus in order to organize a monitoring program was expedited by examining the elementary and geochemical landscapes on six different levels. These included: 1. Predominance of main type of geochemical migration (biogenic, abiogenic landscapes, natural-industrial systems); 2. Peculiarities of main type of geochemical migration (specificity of biological cycle of elements etc.); 3. Conditions (oxidizing, gley, reduction), pH, Eh, typomorphic elements, correlation between organic acids in soils, geochemical barriers; 4. Role of aerial migration of elements in agricultural zones (arable lands); 5. Geomorphological peculiarities of region (eluvial, superaqueous, subaqueous landscapes; mechanical geochemical barriers); 6. Influence of subsoil rocks composition (morainic, glaciofluvial, fluvial, lacustrine, bog, aeolian, loess deposits). This hierarchy was tested in a detailed field investigation of the «Braslav lakes» national park territory (~730 km<sup>2</sup>) in 1999—2000 and the «Narochansky» national park territory and its vicinity (~1000 km<sup>2</sup>) in 2001—2003.

### Introduction

Ecological and geochemistry studies of the territories of national park «Braslav lakes» (North-West of Belarus, total area ~730 km<sup>2</sup>) and national park «Narochansky» (North-West of Central Belarus, total area ~1000 km<sup>2</sup>) were carried out in 1999—2003. They include several stages of outdoor and laboratory investigations: 1. Sampling of soils and predominant types of plants at picked out stationary plots representing typical elementary and geochemical landscapes of the parks (future knots of the monitoring network, 12—14 plots in total); 2. Sampling of surface soil horizon (0—10 cm) and coniferous trees (needles of *Pinus sylvestris* L. and *Picea abies* Karst.) in all parks territories according to the net 2 × 2 km provided by the division of Braslav, Bogin, Druj, Dubrov, Zamosh forestries in the national park «Braslav lakes» and Konstantinov, Miadel, Naroch, Novo-Miadel, Sloboda, Syrmez, Uzla forestries in the national park «Narochansky»; 3. Analytical works in the Institute of Geological Sciences of the National Academy of Sciences of Belarus and Belarusian Scientific-Investigator Institute of Soils and Agrochemistry. Only standard methodologies of outdoor and laboratory investigations that we use for many years have been applied in these studies. All works were performed according to (1).

### Methods

Soil and plants sampling and preparing for the analyses was performed according to (1, 2). 1000 samples in total were collected, prepared and sent to analytical laboratories. Agrochemical properties of soils (humus, pH, pH<sub>KCl</sub>, hydrolytic acidity, sum of bases absorbed, Ca<sup>2+</sup>, Mg<sup>2+</sup>) were determined by standard methods (3) (see for example Tab. 1). Determination of total macrocomposition of soil samples (Na<sub>2</sub>O, MgO, Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, P<sub>2</sub>O<sub>5</sub>, S, Cl, K<sub>2</sub>O, CaO, TiO<sub>2</sub>, MnO, Fe<sub>2</sub>O<sub>3</sub>) was performed with help of roentgen-fluorescent method. Analyses of total microelement contents of soil and plant samples (B, P, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Sr, Zr, Cd, Mo, Ba, Pb) was held by means of emission spectrum analyses (Tab. 2, 3, 5). Mobile (able to migrate) forms of Cr, Mn, Fe, Ni,

Cu, Zn, Cd, Pb in soil samples were detected by extraction of 1 M HCl with atomic-adsorption technique (4) (Tab. 4). Data obtained are represented in Microsoft Word tables, Excel databases and ArcView GIS maps (Fig.).

## Results

Materials of investigation of stationary plots and all parks territories according to the net 2 × 2 km became the basis of «ecology passports» of knots of future monitoring network. The template of such passport (I. Information; II. Characteristics of soil: water-physical and physical-chemical characteristics, chemical composition; III. Vegetation: chemical composition) is represented in (1).

Table 1. pH values in humus horizon A<sub>1</sub> of the national park «Braslav lakes» soils

Forestry	n	x (limits)	σ	s <sub>x</sub> (σ/√n)	C (σ/x)
Druj	26	3.34 (2.86—4.64)	0.36	0.071	0.109
Braslav	29	4.84 (3.50—8.07)	1.21	0.23	0.251
Zamosh	31	4.20 (2.80—6.60)	1.14	0.20	0.272
Dubrov	13	4.67 (2.75—7.20)	1.54	0.43	0.331
Bogin	15	5.49 (5.30—5.60)	0.12	0.030	0.021
In total	114	4.40 (2.80—8.07)	1.22	0.11	0.277

Table 2. Mean concentration of chemical elements in podsolc soils (horizon A<sub>1</sub>) of the national park «Braslav lakes» territory, ppm d. w.

Forestry	n	Ti	V	Cr	Mn	Fe	Ni	Cu	Zr	Ba	Pb
Druj	26	729	9.6	5.2	117	3 800	7.7	8.5	347	251	9.9
Braslav	23	919	11.3	7.9	269	5 600	9.0	7.2	268	275	10.7
Zamosh	23	1 360	10.8	9.3	165	4 700	9.8	8.2	388	292	11.0
Dubrov	8	1 390	12.4	7.5	240	5 400	10.5	8.9	374	315	9.8
Bogin	5	1 210	11.2	9.0	229	5 500	9.8	11.4	446	294	11.0
In total	85	1 040	10.8	7.5	189	4 800	9.0	8.3	345	277	10.5

Table 3. Mean concentration of chemical elements in podsolc soils (horizon A<sub>1</sub>) of the national park «Narochansky» territory, ppm d. w.

Forestry	n	Ti	V	Cr	Mn	Fe	Ni	Cu	Zr	Ba	Pb
Konstantinov	44	1 219	12.1	8.3	203	6 400	10.6	9.6	442	310	11.7
Syrmez	45	1 021	8.8	9.1	119	4 500	8.7	6.5	309	294	9.8
Naroch	45	1 153	11.1	8.2	187	6 600	11.0	10.2	338	294	12.2
Miadel	32	1 658	11.8	8.1	203	5 400	8.8	6.7	414	337	12.3
Novo-Miadel	33	1 627	13.2	11.5	230	9 000	12.2	10.1	343	313	11.8
Sloboda	8	1 688	21.5	14.4	228	9 900	15.0	10.6	339	316	12.9
Uzla	38	1 269	11.4	9.9	200	5 100	10.6	8.4	407	296	11.1
In total	245	1 306	11.6	9.3	189	6 200	10.5	8.7	373	306	11.5

Table 4. Mean concentration of chemical elements mobile forms in different substrata of stationary plots soils of the national park «Braslav lakes», ppm d. w.

Substratum	n	Cr	Mn	Fe	Ni	Cu	Zn	Cd	Pb
Sand*	14	0.43	1.2	220	0.01	0.32	2.7	0.06	0.91
Loam	5	0.89	48	705	0.25	0.73	4.0	0.08	5.4
Peat*	7	0.64	12	690	0.52	1.4	9.8	0.08	8.8

\* — Median.

Table 5. Mean concentration of chemical elements in *Pinus sylvestris* L. needles of the national park «Braslav lakes» territory, ppm d. w.

Forestry	n	A*	B	P	Ti	Mn	Fe	Ni	Cu	Zn	Ba	Pb
Druj	9	2.3	7.3	1 660	3.3	263	92	1.9	3.8	12.4	6.8	0.48
Braslav	7	3.5	4.8	1 480	11.8	54	135	0.41	1.9	18.0	9.0	0.54
Zamosh	25	2.7	12.6	1 950	9.3	313	121	1.1	3.3	13.7	7.4	0.53
Dubrov	5	3.3	14.5	1 560	22	150	300	0.61	3.3	21	7.9	1.5
Bogin	11	3.2	15.1	1 560	5.8	156	143	0.38	3.9	19.5	5.9	0.94
In total	57	3.0	11.5	1 740	9.1	229	138	0.98	3.3	15.8	7.3	0.69

\* — Ash content, %.

### Discussion

Results obtained on the first stage of study showed that elementary and geochemical landscapes of the park should be investigated on different levels for interpretation of received data: 1. Predominance of main type of geochemical migration (biogenic, abiogenic landscapes, natural-industrial systems); 2. Peculiarities of main type of geochemical migration (specificity of biological cycle of elements etc.); 3. Conditions (oxidizing, gley, reduction), pH, Eh, typomorphic elements, correlation between organic acids in soils, geochemical barriers; 4. Role of aerial migration of elements in agricultural zones (arable lands); 5. Geomorphological peculiarities of region (eluvial, superaqueous, subaqueous landscapes; mechanical geochemical barriers); 6. Influence of subsoil rocks composition (morainic, glaciofluvial, fluvial, lacustrine, bog, aeolian, loess deposits).

### Conclusions

Detailed comparative ecology geochemical characteristic of the national parks will be made in the final stage of the study (winter of 2003/2004). In the basis of it there will be the materials of investigating of stationary plots and the results of sampling of humus soil horizon and coniferous plants in the net of 2 × 2 km. A series of geochemical maps allowing to obtain the regularities of distribution of chemical elements in soils and plants of the national parks is planning to be build (see an example, Fig.). The latter will probably give the possibility to find new (disregarded) sources of pollution of the environment on the investigated territories.

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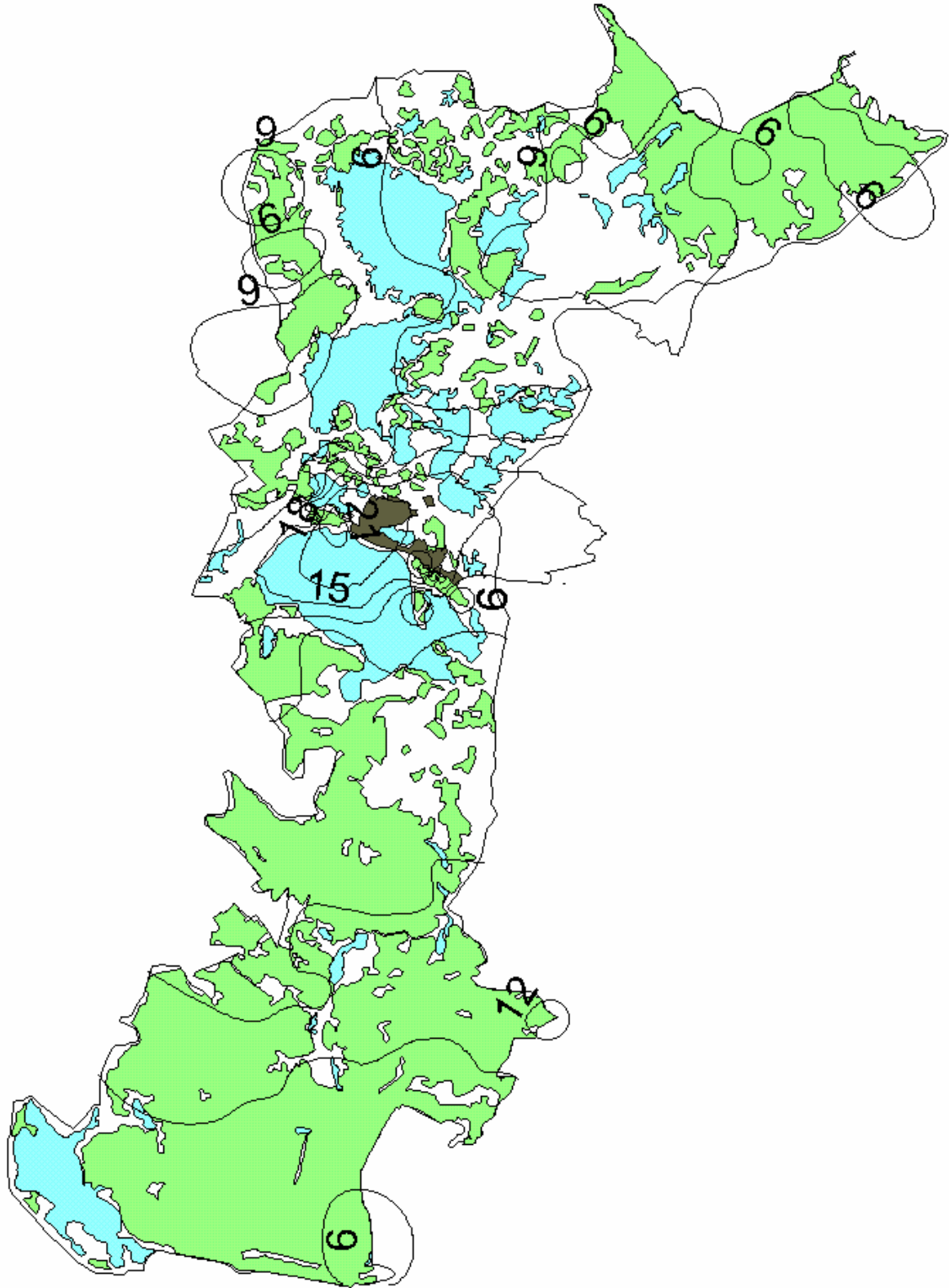


Fig. Cr concentration in humus horizon (0—10 cm) of the national park «Braslav lakes» podsol soils, ppm d. w.