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Metropolitan areas: the problem of geochemical background

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The geochemical background is one of the most important and problematic criteria of environmental geochemistry, especially in highly urbanized territories. The correct choice of background is the basis for generation of all further envirogeochemical pollution models and restoration measures. A comparison of two approaches was made on an example of the soil database (~800 samples) for Mar'ino Municipal District of Moscow Metropolitan Area. Data processing and map generation were made in the ECOSCAN multi-functional data processing software.

Soil pollution maps generated by ECOSCAN showed completely different geochemical patterns. In the case of regional background application, the whole Mar'ino district territory was covered by anomalies of chemical elements in the soil. No background areas were revealed, and a few local baseline areas were contoured. The application of baseline approach resulted in a completely different, better structured soil pollution pattern, which gives more information on possible pollution sources and reveals the baseline areas within the area studied. Besides the baseline areas, transitional areas from baseline to anomaly-forming state were allocated. We classify them as areas of unstable baseline conditions. At a given moment of time these transitional urban ecosystems exist in unstable equilibrium state, and their further development can follow two ways – either to the baseline or to the anomalous state.

Thus, the application of the baseline approach in envirogeochemical assessment of highly urbanized territories gives better results in pollution mapping and geochemical data interpretation as compared to the traditional for Russia application of regional background parameters.

Key words: urban soil, baseline concentration, regional background, transitional areas, ECOSCAN software

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INTRODUCTION

The geochemical background is one of the most important and problematic criteria in environmental geochemistry, especially in environmental geochemistry of highly urbanized territories. The background is precisely the value used for determination of environmental pollution levels, and a correct choice of the background is the basis for generation of all further envirogeochemical pollution models and reclamation measures.

The most versatile definition of background concentration as an average concentration of a chemical element within a homogeneous area located outside evident anomalies was proposed by A. P. Solovov (Соловов и др., 1990). This definition is similar to definitions given in the U. S. Glossary of Geology: background is "the abundance of an element, or any chemical property of a naturally occurring material, in an area in which the concentration is not anomalous" and in Dictionary of Environmental Science (Dictionary …, 1991): "concentration found … due to natural processes alone …".

However, it is quite evident that the "geochemical" background differs from "environmental" one. On the one hand, concentrations of chemical elements in urban environments are always the sum of two migration factors: natural (landscape geochemical conditions of particular territories prior to anthropogenic impact) and anthropogenic (impact of pollution intensity, distance from pollution source, etc.). On the other hand, from the point of view of exploration geochemistry, the territories potentially prospective for useful minerals are deliberately believed to be anomalous, but at the same time in environmental geochemistry, prior to the initiation of some economic activity (*e.g.*, beginning of a detailed survey of the prospective area accompanied by some disturbance of the natural substance flow), such territories are related to areas of baseline (background) concentrations of chemical elements.

Two background-related conceptions exist in applied geochemistry outside Russia: the "background concentration" and the "baseline concentration" or "baseline data". Baseline data is "… information accumulated concerning the biological, chemical, and physical properties of an ecosystem prior to the initiation of some activity that may result in the pollution of that ecosystem" (Dictionary …, 1991). Baseline concentrations present the existing level of air, soil, water, etc., quality in an area prior to the initiation of anthropogenic activities.

Thus, the baseline concentrations give the envirogeochemical standard of an ecosystem at a given moment of time and serve as an "environmental background", the starting point for the environmental state assessment of an ecosystem, and the standard for restoration of polluted areas to their natural baseline state.

Hence, the conception of baseline concentrations as the information on biological, chemical, and physical properties of an ecosystem, prior to the initiation of some activity that may result in the pollution of that ecosystem, seems to be the most appropriate for the choice of background in urban and metropolitan areas (Морозова, Москаленко, 2001).

METHODS

Following the existing uncertainty in the choice of background, we decided to compare both approaches, both conceptions on the basis of the soil database (~800 samples) for Mar'ino municipal district, one of the most polluted areas in Moscow Metropolitan Area (Буренков и др., 1997). Sampling of the soil A_1-horizon was conducted at a regular sampling grid, 100 m × 100 m, scale 1:10 000. All samples were analyzed on a wide range of chemical elements by OESA (Буренков и др., 1997).

The study of regional soil background parameters in Moscow Region began in IMGRE in 1976. The test area for background monitoring, the UNESCO reserve "Lake Glubokoye", lies to the west of Moscow City. The regional soil background data of Moscow Region and Moscow Metropolitan Area are widely used currently in the IMGRE researches (Самаев и др., 1999; Соколов, Астрахан, 1993, 1995), and we used these regional background data in our comparative study. The baseline values for Cd were added to a regional background from baselines calculated by ECOSCAN.

A comparison of two background conceptions (baseline processed by ECOSCAN and the choice of background data within the areas outside evident anomalies, *i.e.* regional background) was made in ECOSCAN (data processing and map generation). The ECOSCAN multi-functional geochemical data processing software, allowing to reveal and analyze the structure of a multi-variate geochemical field, was designed in IMGRE (Буренков и др., 1997). ECOSCAN determines the background on the baseline background basis.

RESULTS AND DISCUSSION

The soil database of the Mar'ino municipal district was processed by the basic ECOSCAN function, E_c, which includes two heuristic functions, E_s and E_t, calculated simultaneously in each grid site. Calculation of the SCAN function (E_s) shows the intensity of concentration values of chemical elements. Isolines of E_s function values contour the elemental behavior patterns, *i.e.* the baseline and various anomalous elemental geochemical fields revealed in the territory.

The ECOSCAN system uses a rather simple algorithm for estimation of baseline parameters. Baseline areas processed by E_s function and plotted by ECOSCAN are those where the behavior pattern of chemical elements comprises low concentrations, low variation coefficients and absence of interdependency in elemental spatial distribution (no stable associations of chemical elements are formed).

The SCAN function (E_s) has the following specific features: a) a nonlinear character, due to which the SCAN function is more sensitive to manifestations of synchronous increase (or decrease) of measured parameter values; b) the function doesn't depend on the number of parameters measured and analytical methods used (E_s can be adjusted to any kind of analytical methods); c) it allows to classify a study area by technogenic pollution types (in our

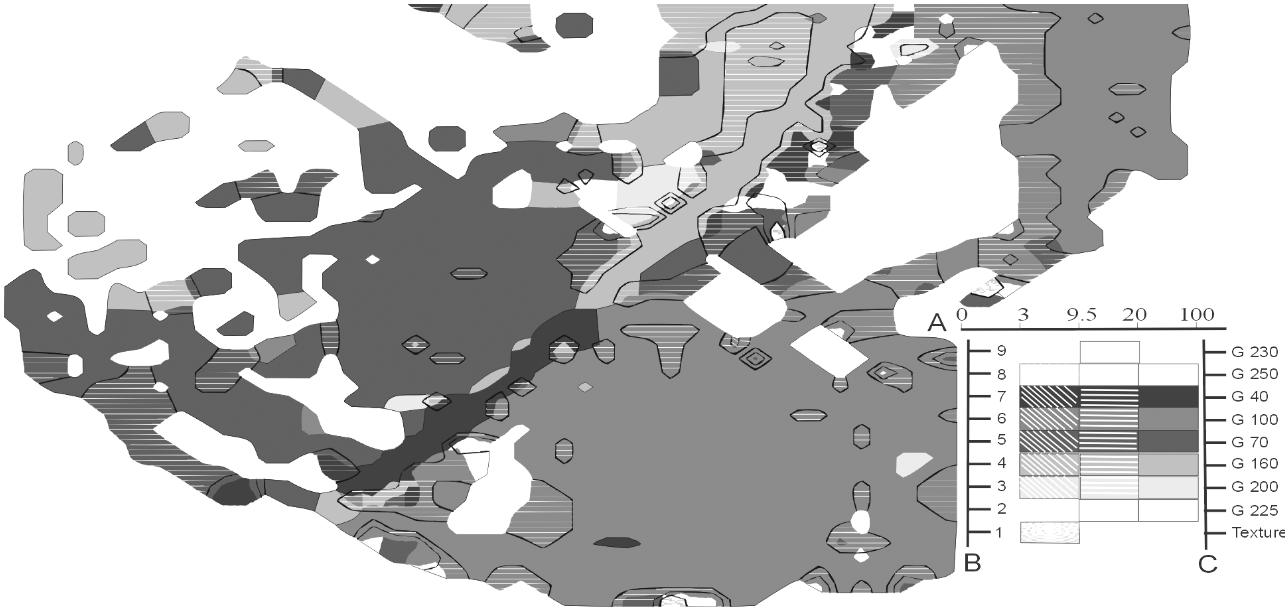

Fig. 1. Mar'ino Municipal District of Moscow Metropolitan Area: Integrated Soil Pollution (relative to regional background).
A – pollution intensity by SCAN (E_s) function values: E_s = 3.0–9.5 – transitional from baseline to anomaly-forming state areas in texture; E_s = 9.5–20.0 and 20.0–100.0 in hatching, E_s > 100.0 in color intensity within anomalous areas;
B – pollution types by type (E_t) function: type # 1 – transitional areas; ## 2–9 – pollution types revealed;
C – grayscale palette: texture – transitional areas; G 225…, etc. – colors of pollution types ## 2–9

1 pav. Maskvos Marjino municipalinis rajonas: bendras dirvoþemio uþterštumas (regioninio fono atþvilgiu).
A – taršos intensyvumas pagal SCAN (E_s) funkcijos reikðmes. Pereinamosios bûklës (ið bazinës á anomalijas formuojanèià) plotai, kai E_s = 3,0–9,5, parodyti tekstûra, o intensyvumas anomalinguose plotuose, kai E_s = 9,5–20,0 ir 20,0–100,0, parodytas brûkðniavimu, kai E_s > 100.0, – spalva;
B – tarðos tipai pagal tipø funkcijà (E_t): # 1 tipas – tarpiniai plotai; ## 2–9 – atskleisti taršos tipai;
C – pilkos spalvos paletë: tekstûra – tarpiniai plotai; G 225… ir t. t. – ## 2–9 tarðos tipø spalvos

case study, the E_s values vary from 9.5 to 100.0 and >100.0 within polluted areas, and from 3.0 to 9.5 within areas of unstable pollution).

The second heuristic function E_t automatically classifies the data by paragenetic (typomorphic) geochemical associations, *i.e.* reveals the pollution structure of a territory studied. A type is a spatially stable association of anomalous toxic substances.

Thus, the maps generated by ECOSCAN reflect a spatial geochemical model of a territory based on the georeferenced database processing at a given moment of time.

Soil pollution maps generated by ECOSCAN show baseline and altered baseline areas by E_s function (texture colors on maps, respectively, Figs. 1 and 2). The baseline areas allocated in Mar'ino Municipal District are characterized by low values of E_s function (from 0.0 to 3.0), *i.e.* a low content of chemical elements and low variation coefficients (Fig. 2).

Soil pollution maps show also anomalous areas in E_s isolines filled with the color reflecting the pollution type calculated by the TYPE function E_t (grayscale palette, see Figs. 1 and 2). The color palette depends on the variety of pollution types revealed (E_t function values). Hatching types (Fig. 1) or Arabic numbers (Fig. 2) indicate the pollution intensity (E_s values) within pollution types.

The first conception assumes the choice of background outside evident anomalies. So we took the regional soil background values of chemical elements for Moscow Region and Moscow Metropolitan Area (Самаев и др., 1999; Соколов, Астрахан, 1993, 1995). The second conception assumes baseline concentrations as the background, *i.e.* as the starting point for the environmental state assessment of an urban ecosystem or its components. We processed the same soil data set in the ECOSCAN system.

Both backgrounds, regional and baseline, processed by ECOSCAN, are listed in Table. Regional background values for As, Mn, Ti, Zr, and V are 6.6–1.2 times higher than baselines of these elements determined by ECOSCAN; this seems rather strange, especially for As, Ti, and Zr (Table 1). The regional background for Mn as a biophilous element seems to be correct; it has been established earlier (Москаленко, 1989) that urban pollution depresses Mn balance in plants and soil. The baselines for Ag, W, and Zn are 10.0–5.0–4.0 times higher, respectively, than the regional background. The baselines for Mo, Sb, Ni, Cu, Cr, Co, Pb, and Sn are 3.0–1.15

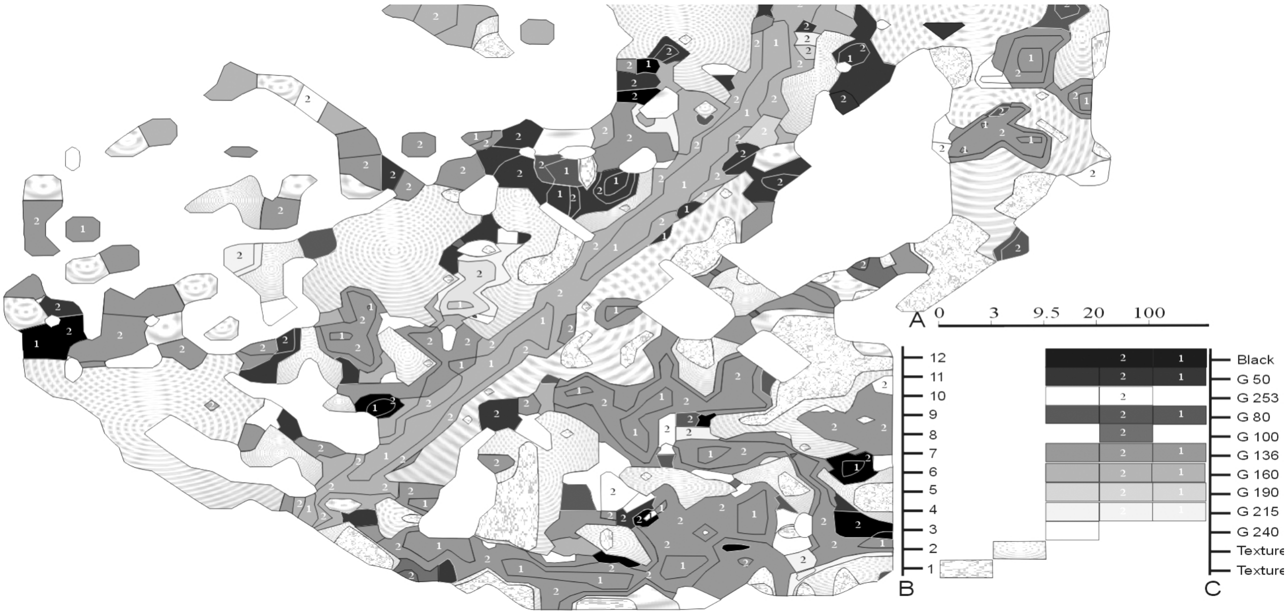

Fig. 2. Mar'ino Municipal District of Moscow Metropolitan Area: Integrated Soil Pollution (relative to baselines determined by ECOSCAN geochemical data processing software).

A – pollution intensity by SCAN (E_s) function values: E_s = 0.0–3.0 – baseline areas; E_s = 3.0–9.5 – transitional from baseline to anomaly-forming state areas; E_s = 9.5–20.0 in color, E_s = 20.0–100.0, >100.0 in Arabic numbers (2, 1) – intensity within anomalous areas;

B – pollution types by type (E_t) function: type # 1 – baseline areas for Mar'ino Municipal District; type # 2 – transitional areas; ## 3 – 12 – pollution types revealed;

C – grayscale palette: texture – baseline areas; texture – transitional areas; G 240 … black – colors of pollution types ## 3–12

2 pav. Maskvos Marjino municipalinis rajonas: bendras dirvoþemio uþterðtumas (bazinio fono atþvilgiu, nustatyto geocheminiø duomenø apdorojimo programine áranga ECOSCAN).

A – taršos intensyvumas pagal SCAN (E_s) funkcijos reikšmes: E_s = 0,0–3,0 – baziniai plotai; E_s = 3,0–9,5 – pereinamosios (ið bazinës á anomalijas formuojanèià) bûklës plotai; intensyvumas anomalinguose plotuose parodytas spalva, kai E_s = 9,5–20,0, o kai E_s = 20,0–100,0 ir >100,0, – dar ir arabiðkais skaièiais (2, 1);

B – tarðos tipai pagal tipø funkcijà (E_t): # 1 tipas – Marjino municipalinio rajono baziniai plotai; # 2 tipas – tarpiniai plotai; ## 3–12 – atskleisti taršos tipai;

C – pilkos spalvos paletë: tekstûra – baziniai plotai; tekstûra – tarpiniai plotai; G 240 … juoda – ## 3–12 tarðos tipø spalvos

times higher than the regional background values (Table 1). We think that enhanced contents of these elements – indicators of urban soil pollution are typical of urban ecosystems (in comparison with juvenile natural conditions).

Soil pollution maps generated by ECOSCAN showed completely different geochemical patterns of the same territory (Mar'ino Municipal District of Moscow).

In the case of ***regional background*** application we obtained a picture of total and stable pollution of the whole Mari'no Municipal District by four major paragenetic associations of chemical elements (Fig. 1). Three of them cover the whole territory of the Mari'no district, and the forth one lies along the railroad (Fig. 1). Pollution type # 6 shown in G 100 color – $Ag_{57.5}$[1] $Zn_{8.7}$ $W_{5.6}$ $Cd_{5.1}$ (Sn, Cu, Ni, Cr, Pb)$_{3.6–3.2}$ $Mo_{2.7}$ (Co, Bi)$_{1.8}$ has a high pollution intensity (Es values from 20 to 100 and higher). Some anomalies within this type have a lower pollution intensity. Pollution types # 5 shown in G 70 color – $Ag_{32.5}$ $Zn_{7.4}$ $Ni_{5.8}$ $W_{4.4}$ Cu_4 (Pb, Cr, Mo)$_{3.6–3.2}$ $Sn_{2.7}$ $CoCd_{2.0}$ and # 4 (G 160 color) – $Ag_{27.8}$ $Ni_{18.0}$ $Zn_{6.7}$ (Cu, Cr)$_{5.6–5.2}$ $W_{4.8}$ (Co, Mo)$_{3.7–3.5}$ $Pb_{3.0}$ $Sn_{2.5}$ $Cd_{1.5}$ have the same intensity pattern. The railroad pollution type (# 7) shown in G 40 color was outlined in the SW part of the Mar'ino District: $Ni_{29.3}$ $Cr_{7.0}$ (Co, Cu)$_{6.4–6.0}$. Four pollution types (## 2, 3, 8, and 9) have a local distribution character.

No background areas within the Mar'ino district were revealed, and a few baselines were found (type #1, texture color, see Fig. 1).

Application of ***baseline approach*** showed another soil pollution pattern, which is far better structured, gives more information on possible pollution sources, and reveals the baseline areas within the area studied. Five major paragenetic associations of chemical elements were found, and these pollution types have different spatial distribution peculiarities (Fig. 2).

[1] $Ag_{57.5}$, $Zn_{8.7}$, etc. – background-normalized contents of chemical elements (concentration coefficients).

Table. **Background values of chemical elements in Moscow Metropolitan Area**
Lentelë. **Cheminiø elementø foninës reikðmës Maskvos aglomeracijoje**

Chemical element Cheminis elementas	Concentration of chemical elements, ppm Cheminiø elementø koncentracija ppm		Ratios Santykiai	
	Regional background (a) Regioninis fonas (a)	Baselines for Mar'ino Municipal District (b) Marjino municipalinio rajono bazinis fonas (b)	a/b	b/a
Cu	27.0	**50.0**	0.54	**1.85**
Zn	50.0	**200.0**	0.25	**4.0**
Pb	26.0	**40.0**	0.65	**1.54**
Ni	20.0	**40.0**	0.5	**2.0**
Co	7.2	**12.0**	0.6	**1.67**
Cd	1.0 [1]	1.0	1.0	1.0
Cr	46.0	**80.0**	0.58	**1.74**
V	**83.0**	70.0	**1.2**	0.84
Mo	1.0	**3.0**	0.33	**3.0**
Ag	0.06	**0.6**	0.1	**10.0**
Mn	**1260**	600.0	**2.1**	0.48
As	**6.6**	1.0	**6.6**	0.15
Sb	2.0	**5.0**	0.4	**2.5**
W	1.0	**5.0**	0.2	**5.0**
Sn	5.2	**6.0**	0.87	**1.15**
Bi	1.0	**1.0**	1.0	1.0
Ti	**6000.0**	3500.0	**1.71**	0.58
Be	1.0	1.0	1.0	1.0
Zr	**420.0**	300.0	**1.4**	0.71

[1] *Regional background for Cd was not determined, and the baseline Cd content was used.*
[1] *Regioninis Cd fonas nebuvo nustatytas, buvo panaudotas bazinis Cd kiekis.*

Pollution type # 7 (G 137 color) is widely spread over the Mar'ino District territory: $Cd_{10.9}$[2] $Ag_{9.99}$ $Sn_{3.7}$ $(Cr, Ni, Zn, Cu, Bi)_{2.9–2.5}$ $Pb_{2.1}$. Pollution types #11 (G 50 color) – $Pb_{8.7}$ $Cu_{6.1}$ $Sn_{3.6}$ $(Ni, Zn)_{2.6–2.4}$ $(Ag, Cr, Mn)_{1.9–1.6}$; #12 (black color) – $Pb_{18.9}$ $Ag_{5.2}$ $Cd_{4.3}$ $(Sn, Cu, Ni, Zn)_{2.9–2.2}$ $Cr_{1.9}$, and #10 (G 253 color) – $Ag_{5.2}$ $Sn_{2.6}$ $(Ni, Zn, Cu)_{2.1–2.0}$ $(Pb, Cr)_{1.8}$ have local distribution patterns. Some local pollution types are characterized by Cd (# 3) and Be accumulation (# 3 and 8, see Fig. 2). The railroad-specific paragenetic association of chemical elements (pollution type # 6, G 160 color) stretches along the railroad cutting the whole Mar'ino District territory from NE to SW: $Ni_{15.1}$ $Cr_{4.1}$ $(Cu, Co)_{3.9–3.7}$.

Baseline areas were allocated mostly in the S, E and NE of Mar'ino District territory (Fig. 2: baseline type #1, texture color). Besides the baseline areas, transitional areas from baseline state to anomaly-forming state were found (Fig. 2: type # 2, texture color). These transitional areas are spread in the SW, W, NW, and NE of Mar'ino District. Local areas occur over the other part of its territory. We classify these transitional areas as areas of unstable or fluctuating pollution, *i.e.* areas of unstable baseline conditions. It means that at a given moment of time these transitional urban ecosystems exist in a state of unstable equilibrium. Depending on the situation their further development can take one of the two ways either to baseline or to anomalous state.

[2] $Cd_{10.9}$, etc. – baseline-normalized contents of chemical elements (concentration coefficients).

The study of physical-chemical and microbiological parameters in the soil conducted by Lev Ginzburg et al., 1997, proved the thesis of unstable equilibrium state of transitional areas. The soil in these areas showed the first signs of degradation and toxicity (Буренков и др., 1997).

The transitional areas require the most urgent nature protection measures due to their unstable status and quite possible chances to rescue them from pollution. The faster the soil recultivation measures would be undertaken, the more chances to improve the soil quality and bring the transitional areas back to the baseline state.

CONCLUSION

Thus, our small study and efforts in understanding the urban baselines showed that application of the baseline approach in envirogeochemical assessment of highly urbanized territories gives better results in pollution mapping and geochemical data interpretation, in comparison with the traditional for Russia application of regional background parameters.

The baseline concentrations of chemical elements give the envirogeochemical standard of an ecosystem at a given moment of time. Baselines serve as an "environmental background", the starting point for the environmental state assessment of urban ecosystems and a standard for restoration of polluted areas, and especially of unstable equilibrium (transitional) areas, to their baseline state.

The outlook, quality, and objectiveness of any envirogeochemical map depend essentially on the correct approach to the definition and choice of a background.

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MIESTØ AGLOMERACIJOS GEOCHEMINIO FONO PROBLEMA

Santrauka

Geocheminio fono reikðmës yra vienas svarbiausiø ir problemiðkiausiø aplinkos geochemijos kriterijø, ypaè itin urbanizuotose teritorijose. Teisingas foniniø reikðmiø parinkimas yra visø aplinkos geocheminës tarðos modeliø, taip pat aplinkos bûklës atstatymo priemoniø pagrindas. Pasitelkus dirvoþemiø geocheminiø tyrimø Marjino rajone, priklausanèiame Maskvos aglomeracijai, duomenø bazæ (800 mëginiø), buvo palyginti du poþiûriai á fonines reikðmes. Duomenys apdoroti ir þemëlapiai sudaryti duomenø apdorojimo daugiafunkcine programine áranga ECOSCAN.

Dirvoþemio uþterðtumo þemëlapiai, sudaryti su ECOSCAN, atskleidë visiðkai skirtingus geocheminius vaizdus. Taikant regionines fonines reikðmes, visà Marjino rajono teritorijà padengë cheminiø elementø kiekiø dirvoþemyje anomalijos. Neaptikta jokiø foniniø plotø, tik apibrëþti vietinio bazinio fono keliø teritorijø kontûrai. Taikant bazines fonines reikðmes, gautas visiðkai kitoks geresnës struktûros dirvoþemio uþterðtumo vaizdas, kuris suteikia daugiau informacijos apie galimus tarðos ðaltinius ir atskleidþia tiriamoje teritorijoje bazinio fono plotus. Be jø, lokalizuoti ir pereinamieji plotai – ið bazinio fono link anomalijø. Mes juos laikome nestabiliø aplinkosaugos sàlygø plotais. Dabartiniu metu ðios pereinamosios miesto ekosistemos yra nestabilios pusiausvyros, o jø tolimesnë raida galima link bazinës arba link anomalinës bûsenos.

Taigi bazinio fono taikymas itin urbanizuotø teritorijø aplinkos geocheminiams ávertinimams, kartografuojant uþterðtumà ir interpretuojant duomenis, nulemia geresnius rezultatus, negu tradicinis Rusijoje regioniniø foniniø reikðmiø panaudojimas.

Íàòàëèÿ Í. Ìîñêàëåíêî,
Ëåâ Í. Ãèíçáóðã

ÃÎÐÎÄÑÊÈÅ ÀÃËÎÌÅÐÀÖÈÈ: ÏÐÎÁËÅÌÀ ÃÅÎÕÈÌÈ×ÅÑÊÎÃÎ ÔÎÍÀ

Ðåçþìå

Ãåîõèìè÷åñêèé ôîí – ýòî îäèí èç íàèáîëåå âàæíûõ è ïðîáëåìíûõ êðèòåðèåâ ñîâðåìåííîé ýêîëîãè÷åñêîé ãåîõèìèè, îñîáåííî äëÿ âûñîêîóðáàíèçèðîâàííûõ òåððèòîðèé. Êîððåêòíûé âûáîð ôîíîâûõ ïàðàìåòðîâ ÿâëÿåòñÿ îñíîâîé äëÿ âñåõ ïîñëåäóþùèõ ýêîãåîõèìè÷åñêèõ ìîäåëåé çàãðÿçíåíèÿ è ïðèðîäîîõðàííûõ ìåðîïðèÿòèé. Ïðîâåäåí ñðàâíèòåëüíûé àíàëèç äâóõ ñóùåñòâóþùèõ ïîäõîäîâ ïðè îïðåäåëåíèè ãåîõèìè÷åñêîãî ôîíà. Èñïîëüçîâàíà áàçà äàííûõ ïî÷â ïî ÌÎ Ìàðüèíî, âêëþ÷àþùàÿ â ñåáÿ ñâûøå 800 ïðîá âåðõíåãî ãîðèçîíòà ïî÷â. Îáðàáîòêà äàííûõ è ñîñòàâëåíèå êàðò îñóùåñòâëÿëèñü ñ ïîìîùüþ ìíîãîôóíêöèîíàëüíîé ïðîãðàììû ÝÊÎÑÊÀÍ. Ñîñòàâëåííûå ñ ïîìîùüþ ýòîé ïðîãðàììû, íî èñõîäÿ èç ðàçíûõ ïîäõîäîâ êàðòû çàãðÿçíåíèÿ ïî÷â ïîêàçàëè ñîâåðøåííî ðàçíûå ãåîõèìè÷åñêèå îöåíêè.

Â ñëó÷àå ïðèìåíåíèÿ ðåãèîíàëüíîãî ôîíà ïî÷â ïîëó÷åíà êàðòèíà òîòàëüíîãî ïîêðûòèÿ ïî÷â ÌÎ Ìàðüèíî àíîìàëèÿìè. Ôîíîâûå ó÷àñòêè íå áûëè âûäåëåíû, îêîíòóðåíî ëèøü íåñêîëüêî ìåñòíûõ ó÷àñòêîâ áàçèñíîãî ñîñòîÿíèÿ ïî÷â.

Ïðèìåíåíèå áàçèñíûõ ïàðàìåòðîâ êàê ôîíà èëè òî÷êè îòñ÷åòà çàãðÿçíåíèÿ ïî÷â äàëî àáñîëþòíî èíóþ îöåíêó çàãðÿçíåíèÿ ïî÷â Ìàðüèíî, áîëåå ñòðóêòóðèðîâàííóþ, ñ èíôîðìàöèåé î âîçìîæíûõ èñòî÷íèêàõ çàãðÿçíåíèÿ è âûÿâëÿþùóþ ó÷àñòêè áàçèñíîãî ñîñòîÿíèÿ ïî÷â. Ïîìèìî áàçèñíûõ ó÷àñòêîâ, âûÿâëåíû òàê íàçûâàåìûå ïåðåõîäíûå îáëàñòè: îò áàçèñíîãî ñîñòîÿíèÿ ê ñîñòîÿíèþ ôîðìèðîâàíèÿ àíîìàëèè â ïî÷âàõ. Ìû ðàññìàòðèâàåì äàííûå ïåðåõîäíûå îáëàñòè êàê çîíû íåóñòîé÷èâîãî áàçèñíîãî ñîñòîÿíèÿ ïî÷â. Â íàñòîÿùåå âðåìÿ ýòè ïåðåõîäíûå ãîðîäñêèå ýêîñèñòåìû íàõîäÿòñÿ â ñîñòîÿíèè íåóñòîé÷èâîãî ðàâíîâåñèÿ. Èõ äàëüíåéøåå ðàçâèòèå ìîæåò ïðîòåêàòü â äâóõ íàïðàâëåíèÿõ: ê áàçèñíîìó èëè ê àíîìàëüíîìó ñîñòîÿíèþ.

Èòàê, ïðè êàðòîãðàôèðîâàíèè çàãðÿçíåíèÿ è èíòåðïðåòàöèè ãåîõèìè÷åñêèõ äàííûõ ïðèìåíåíèå áàçèñíîãî ïîäõîäà â ýêîëîãî-ãåîõèìè÷åñêîé îöåíêå ãîðîäñêèõ òåððèòîðèé äàåò ñóùåñòâåííî ëó÷øèå ðåçóëüòàòû ïî ñðàâíåíèþ ñ òðàäèöèîííî èñïîëüçóåìûì â Ðîññèè ðåãèîíàëüíûì ôîíîì.