ПРОБЛЕМИ ЕКОГЕОХІМІЇ ТЕХНОГЕННИХ ЛАНДШАФТІВ

UDK 631.4

P. V. Zhoomar, M. K. Chartko, A. A. Karpichenka

ECOGEOCHEMISTRY OF TECHNOGENIC LANDSCAPES: SITUATIONAL APPROACH

Belarusian State University, Belarus

This article is dedicated to new approaches which have been appeared in the ecogeochemistry of technogenic landscape. All of them are concerning to different types of ecogeochemical assessment of whole landscape and considering a group of ecological facilities connected with a lack of chemical elements or their abundance. Special emphasis has been done to the assessment of ecogeochemical situations in technogenic landscapes, to the identification of different level of its favourability for vital functions of organisms. A number of gradations of ecogeochemical situations is a function of the acting factors quantity with the regard for their inner division. They determine conditions of migration and concentration of chemical elements, excess or lack of which is adversely affect a health and vital activity conditions of a man.

Key words: technogenic landscape, geochemical landscape, classification, ecogeochemical situation.

П. В. Жумар, М. К. Чертко, О. О. Карпиченко

Білоруський державний університет, Білорусь

ЕКОГЕОХІМІЯ ТЕХНОГЕННИХ ЛАНДШАФТІВ: СИТУАЦІЙНИЙ ПІДХІД

Стаття присвячена новим підходам, які з'явилися в екогеохімії техногенних ландшафтів. Вони усі пов'язані з різними видами екогеохімічної оцінки ландшафту в цілому та розглядають угрупування екологічних умов, пов'язаних з надлишком або нестачею хімічних елементів. Особливо розглядається оцінка екогеохімічних ситуацій, визначені різні рівні її сприятливості для життєвих функцій організмів. Число градацій екогеохімічної ситуації є функцією кількості діючих факторів з врахуванням їх внутрішніх відмінностей. Вони визначають умови міграції та концентрації хімічних елементів, надлишок чи нестача яких негативно впливають на здоров'я та життєдіяльність людини.

Ключові слова: техногенний ландшафт, геохімічний ландшафт, класифікація, екогеохімічна ситуація.

П. В. Жумарь, Н. К. Чертко, А. А. Карпиченко

Белорусский государственный университет, Беларусь

ЭКОГЕОХИМИЯ ТЕХНОГЕННЫХ ЛАНДШАФТОВ: СИТУАЦИОННЫЙ ПОДХОД

Статья посвящена новым подходам, которые появились в экогеохимии техногенных ландшафтов. Они все затрагивают различные виды экогеохимической оценки ландшафта в целом и рассматривают группировку экологических условий, связанных с избытком или недостатком химических элементов. Особо рассмотрена оценка экогеохимических ситуаций, определены различные уровни ее благоприятности для жизненных функций организмов. Число градаций экогеохимической ситуации является функцией количества действующих факторов с учетом их внутренних различий. Они определяют условия миграции и концентрации химических элементов, избыток или недостаток которых отрицательно влияют на здоровье и жизнедеятельность человека.

Ключевые слова: техногенный ландшафт, геохимический ландшафт, классификация, экогеохимическая ситуация.

The growth of technogenic transformation of geosphere is strengthening at nowadays. Technogenesis generates new systems, which are radically differed from primary landscapes both structurally and functionally. Inculcating into the body of natural landscapes they becomes a huge consume of its resources and dominating constituent part at the same time. They concentrate on itself all streams of matter and energy, redistribute and accelerate them.

Thus landscape is radically reconstructs losing its initial functional and physiognomic peculiarities. It occurs due to large-scale displacement of rock massifs for a short time, due to the entrance of xenobiotics in amounts exceeding all limits of toxicity thus causing their contamination, due to the bearing out substances having useful particularities impoverishing its ecoecogeochemical specters. Thereby its main function, i.e. maintenance of secure vital activity of inhabiting organisms, disturbs.

The necessity of technogenic processes registration and inventarization is dictated by their intensification and spreading. It has been served for the development of theoretical footing of ecoecogeochemical analysis, assessment and mapping of landscapes.

THE CONCEPT OF TECHNOGENIC LANDSCAPES, THEIR ESSENCE AND CLASSIFICATION

The term of technogenesis is offered by A.E. Fersman (Fersman, 1955). He combined in this notion the aggregate of chemical and technical processes, caused by human economic activity. Their sequence is a redistribution of chemical elements on the earth surface.

Ecoecogeochemical aspect of technogenesis reveals in extraction of chemical elements from environment with their consequent concentration and regrouping; in chemical composition of compounds, where they are included; in creation of new substances; in dispersion of elements involved into technogenesis in the environment. That’s why the studying of processes of migration and accumulation of natural and tech-nogenic compounds in landscapes and the clarification of their influence on the landscape ecoecogeochemical situation and on the habitation conditions of organisms have become a leading direction of ecoecogeochemical researches of landscapes in nowadays.

A technogenic landscape is considered as relatively homogenous territorial complex, formed on the base of natural landscape, components of which directly or indirectly transformed to variable degree as a result of human production and recreation activity.

The term of anthropogenic landscape defines as well as tehnogenic landscape, i.e. as formed because of human economic activity (Milkov, 1973). According to our opinion as far as both definitions are identical then the comprehension of such landscape as a technogenic is more correct, because a man always transforms an environment with the aid of instruments of labour (technique).

CLASSIFICATION OF TECHNOGENIC LANDSCAPES

Any classification supposes a horizontal division of technogenic landscapes into groups, which are homogenous in one or another peculiarity.

We developed the system of ecoecogeochemical mapping on the base of our classify-cation of agrilandscapes. We also fulfilled their division into ecoecogeochemical districts (Chartko, 1990). If an agrilandscape is a particular case of technogenic landscape then its natural and production constituent parts are important for analysis. Usage of lands is lead to irreversible consequences for landscape natural basis independently on temporal intervals of technogenic impact. A new complex landscape system is differed from natural forms as a result of it.

Location of technigenic impact sources ideally should be realized in such way that their influence would be remained inside of their proper accommodating elementary landscape or ecoecogeochemical arena. Practically such things are not exist. The reverse is true fairly often. Thus technogenic impact zones of one object encompassed several landscapes differed by genesis and natural peculiarities. Especially it’s obviously on the example of agricultural lands. Borders of crop rotation fields are not coincided with landscape geometry. As far as each land is differed from the neighbor then each of them has a proper specification of technogenesis. It makes possible the formation of several new landscapes within a single solid natural landscape. In other words the technogenesis of one nature is able to form at the minimum two new landscapes inside of one old. This units differed by proper unique peculiarities of technogenesis are elementary technogenic landscapes, which defined as territorial complexes, homogenic in their physical nature (peculiarities of natural landscape) and kind of technogenic impact (peculiarities of technogenesis).

We have taken an attempt to develop our functional classification with the purposes of identification of the place of elementary technogenic landscapes within the system of other landscape taxonomic units as well as to determine an elementary operation unit for the assessments and mapping. Given classification is realized taking into account existed classifications: ecoecogeochemical (Chartko, 1990), typological classification of natural landscapes (Martsinkevich, 1989). The essential advantage of the first classification is a structure and hierarchy of selected units. Its formal part is taken as a basis for our case. The following classification units for technogenic landscapes were determined: genus, subgenus, group, kind and subkind. They are listed in hierarchic order and have been selected for agricultural landscapes (Chartko, 1990). This system may be used for the classification of all technogenic landscapes, but unit's contents and their selection criteria should be reconsidered simultaneously. It is realized and reflected in the tab. 1.

As far as visible in the table 1 two first units are selected according to natural peculiarities. That is why some objections concerning to their relation to technogenic landscapes are exist, but purely natural landscapes not touched by technogenesis are practically absent nowadays.

Classification of natural landscapes has been developed (Martsinkevich, 1989) and reflected on the landscape map of the Republic of Belarus. This map is an idealized landscape model, where technogenesis is practically excluded. The genus of landscapes has been detected by the genesis and age of landscape. We have taken it in such formulation and it is considered as a highest unit of technogenic landscapes and corresponds to its natural analogue. It is caused by the necessity to coordinate both the natural and technogenic landscape classifications.

The genus of landscapes is a unit where evident technogenic changes have already reflected in its inner structure. This unit is an environment of the technogenesis development, a natural matrix where technogenic processes are expanded in its cells. We are not considering the definition of landscape genus because it was done in detail (Martsinkevich, 1989).

Table 1

Classification units of technogenic landscapes and criteria of their identification

Classification units	Criteria
Genus	Belonging to the natural landscape in the genus rank (Martsinkevich 1989)
Subgenus	Buffer capacity of soils
Group	Direction of economic activity
Kind	Nature of technogenic impact within a group
Subkind	Specification of technogenesis nature

Subgenus is selected on the base of landscape sustainability to technogenic loads expressed by soil buffer capacity like most informative parameter. Buffer capacity, i.e. ability to resist to the technogenic impact, to mitigate it, is caused by soil lithology and organic matter concentration. This value is growing simultaneously with mineral particles sizes diminution and organic matter concentration increase. Detail criteria of subgenuses buffer capacity are adduced in the tab. 2.

A direction of economic activity within the territory is taken as a selective criterion for landscapes groups identification. Eight groups of technogenic landscapes were selected: agricultural, industrial, mining, forestry, transport-communication, settled, military and nature protective.

Table 2

Landscape subgenic criteria

Buffer capacity	Physical clay contents (%)	Organic matter concentration (%)
High	> 40	> 5.0
Medium	20 – 40	2.5 – 5.0
Low	5 – 20	< 5.0

There are distinctions in specification of economic use of landscapes. They are reflected in land use pattern. Each land type is carrying out certain functions within a group. This functional load is causing a differentiation of technogenic impact nature. That is why mentioned criterion is selected for a kind of technogenic landscapes.

Subkind of technogenic landscapes was identified by the specification of techno-genesis within a kind. This unit is smallest in hierarchy and may be considered like elementary technogenic landscape. It is homogenous and by its physical nature and by kind of technogenic impact. It has mainly identified for agricultural group. It may be not selected in case of absence of specific peculiarities on the level of landscape kind.

Two last units have own individual peculiarities depended on the economic activity line and, consequently, its individual specification within groups. That is why they have been considered separately for each group.

We shell considered inner structure of classification units on the example of technogenic landscapes of agricultural group. This group of landscapes is differed by soil use, mainly, its fertility as basic productive resource. Technogenic impact in this case has divided into arable, pastoral and mowing kinds. Each of them has its own nature and corresponds to landscape kinds of the same name.

Those landscapes, which are systematically cultivated and used for agricultural crops sowing, sites of greenhouses and fallow lands, are included into arable landscapes (Pomelov, 2004). Lands with sowing of preliminary crops at the meadow formation renovation and land reclamation etc., as well as temporally used for crop sowing in row-spacing areas, are not included into this set. The following subkinds have been selected among arable landscapes as well as among other kinds of given group: clear, drained, wetted, improved, drained-wetted, drained-wetted improved, drained improved.

Clear arable landscapes include grounds, which have never subjected to any land-improvement arrangements since the first ploughing. If draining works have been developed in the landscape occupied by tillage then such landscapes should to be considered as drained. If arable landscape has subjected to the temporal or permanent exceeded wetting then it ought to be related to wetted landscapes. Landscape will be accepted as improved in case of development any other land-improvement works on its territory. In case of combination of mentioned techno-genic peculiarities within the landscape area other subkinds may be derived, i.e. drained-wetted, drained-wetted improved etc.

Such landscapes where lands are occupied by natural or sowed grassy vegetation, which permanently used for pasture, should be indicated as pastoral landscapes

Mowing landscapes embrace grounds occupied by natural or sowed annual or perennial feed grasses assigned to skewing with the purposes of their drying, storage and following feeding of animals.

Subkinds for pastoral and mowing landscapes were selected according to such criteria of arable landscapes and have same definitions (clear, drained, improved etc.). All natural grasslands (pastoral or mowing) where land-improvement measures have never been realized are included into clear meadow landscape. Improved meadow landscapes are usually formed by feed grasses sowing or regular application of fertilizes. Waterlogged landscapes for both kinds are detected in case of extreme grade of wetting right up to water films formation on the land surface and development of boggy phytocenosis.

As far as is seeing from aforesaid, subkinds of landscapes are indivisible territorial units and they are differed by relatively homogeneity in their natural genesis and local specification of technogenic activity. Thus, subkind of technogenic landscapes is an elementary territorial unit, which is ideally right for different types of estimations (Zoomar, 2006). That's why it may be considered as an elementary technogenic landscape (ETL). We shell demonstrate it on example of following types of landscape ecoecogeochemical estimation: situaltional, structural and ecological. The first type is based on the situational approach, which have been successfully applied for needs of geoecology and ecological mapping (Kochurov, Zherebtsova, 1994; Preobrazhenski, 1990; Trofimov, 1997; Trofimov et al., 1998). The second type operates with different kinds of structures. The last type usually constructs itself on the base of second and expressed by different indices of diversity and abundance referring to ecoecogeochemical processes and phenomena, which for their part are directly correlated with ecological parameters characterizing species, populations and habitats (abundance, density, diversity etc.). We shell considered them below.

SITUATIONAL APPROACH IN THE LANDSCAPE ECOECOGEOCHEMICAL RESEARCH

Situational approach allows to consider not merely chemical elements in landscape, areas of their migration and concentration, but also factors, which caused their behavior. It permits to essentially extend a number of parameters, used at ecoecogeochemical assessments of landscapes. We introduced the definition of landscape ecoecogeochemical situation (LGS) for the purposes of landscape ecoecogeochemical assessments because traditional flow-oriented models sometimes are not applicable for the correct characterization of technogenic landscapes. LGS is a spatiotemporal aggregate of both technogenic and natural processes and phenomena influencing on the accumulation and redistribution of chemical elements, which lead to the forming of vital conditions of different grades of unfavourability for a man.

The estimation procedure always develops within ETL frontiers. It includes a registration of factors of impact on environment, which has predetermined conditions of migration, accumulation and redistribution of chemical elements and has formed unfavorability rates inside of a research area. Mentioned ecoecogeochemical factors (atom-spheric pollution, fluvial erosion, deflation etc.) compose individual combination for each ETL.

The identification of LGS areas by their unfavorability rate is realizable in two stages. On the first stage the data base of environment parameters should to be formed. It covers indices, which are able to influent on the migration ore concentration of elements. Then they ought to be localized in the space with the aid of GIS. Thus the spatial distribution of factors is established. Each acting factor area ought to be overlapped on the working basis (ETL network) during the second stage. Their spatial combinations of simultaneously acting factors forming LGS should to be determined for each ETL. It allows to reveal basic gradations of LGS unfavorability rate on the base of number of factors included into one combination taking into account inner gradation of each of them. A number of factors taking into consideration may be tended to infinity. It is limited by the scale of final map, by the coverage of the territory and area complexity.

The LGS assessment scheme is adduced on the fig. 1 where estimative procedure is shown on the example of few factors. In case of the impact of a single factor Fi (i = 1, 2, …, n) one mark subtracts from the highest rate of favorability for the appropriate ETL. If a factor has inner gradation then a number of mark correspond-ding to one or another grade must be subtracted from the remainder of favorability formed by other factors. It is reflected on the scheme. Highest index of favorability confers to forests, natural wetlands not touched by the melioration, gardens, parks etc. An atmospheric pollution as a factor (F1) is detected by the area of emission plume from a point emission source. Any ETL is guessed as a subjected to atmospheric pollution if a plume of pollutants covers more then 25% of its surface.

Thus a one mark at the minimum must be subtracted from the highest value of favorability as far as it's demonstrated on the figure or from the unfavorability rate formed by previous factors, i.e. LGS becomes for a one mark worse. If an ETL area covered by the emission plume is less then 25% LGS remains at previous state.

The estimation of chemical composition of soils fulfils within their root layer. A set of chemical elements included into the assessment is depending on the specification of local condition of soil pollution, i. e. elements lying into the composition of soil typomorphic pollutant. Such parameter as an element concentration clark is used like an unfavorability

parameter for soils. It calculates according to the formula as a proportion of element concentration (C) to its clark (Cc) (Chartko, 1981): Kc = C/Cc

If Kc > 1, then soil should to be considered like polluted and 1 mark confers to this factor. Contemporary processes of migration make an essential contribution into the unfovarability rate. Thus, for example, in case of the development of mechanical migration (soil erosion) (F2) it should to be considered by their evidence degree determined by the share of affected areas within ETL. It's differed into the small (less then 30%), medium (30 – 60%), great (more then 60%). Each of them has 1, 2 and 3 marks accordingly.

A group of processes concerned with drained peat destruction (organic matter mineralization, mechanical drawdown etc.) has been united into the factor of pea-tlands degradation. Unfavorability rate is depending on the peat layer thickness.

If it is more then 1 m. then 1 mark should to be given, else (in case of the thickness is less then 1 m) such unit has 2 marks.

Processes of impoundment, flood and waterlogging have been united into on e factor as well and 1 mark of unfavorability may be conferred to it.

Thus, a number of LGS gradations is a function of the acting factors quantity with the regard for their inner division. They determine conditions of migration and concentration of chemical elements, excess or lack of which is adversely affect a health and vital activity conditions of a man.

REFERENCES

Fersman A. E., 1955: Selected works. Vol. 3. (in Russian). Publishing House of the Academy of Science of the USSR, Moscow.

Milkov F. N., 1973: A Man and Landscapes: Outlines of Anthropogenic Landscapes Studies (in Russian). Mysl, Moscow.

Chartko N. K., 1990: Ecoecogeochemistry Of Agrilandscapes Of Belorussia and Their Optimization (in Russian). Thes. …Dr. Geogr. Sci. 11.01.01. Minsk.

Martsinkevich G. I., Klitsunova N. K., Kharanicheva G. T. et al., 1989: Landscapes of Byelorussia (in Russian). Universitetskoye, Minsk.

Pomelov A. S. (ed.), 2004: Land Surveyor's Dictionary Guide (in Russian). – Minsk.

Zhoomar P. V., 2006, Technogenic landscapes and their classification (in Russian). Khodr, Minsk.

Kochurov B. I., Zherebtsova N. A., 1994: Mapping of ecological problems and situations.

Geodesiya i Kartografiya. 5. pp. 43–47. (in Russian).

Chartko N. K., 1981: Landscape Ecoecogeochemistry. – Minsk: Belarusian State University, 1981.

Надійшла до редколегії 12.08.11