Classification of technogenic landscapes

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Abstract. Classification of technogenic landscapes was developed. The following classification units of technogenic landscapes have been determined: genus, subgenus, group, kind and subkind. The genus of landscapes has been identified on the base of belonging to the natural landscape in the genus rank, which unites areas similar in genesis and time of origin. Subgenus is selected on the base of landscape sustainability to technogenic loads expressed by soil buffer capacity like most informative parameter. The direction of economic activity on the territory is taken as a selective criterion for landscapes groups identification. Nature of technogenic impact within a group is a criterion determined for a kind of technogenic landscapes. Subkinds of technogenic landscapes has been identified by the specification of technogenesis within a kind.

Key words: landscape classification, technogenic landscape units, technogenic landscape identification

Introduction

The technogenic transformation of landscape sphere is intensified at the present period of social development. Large-scale substance transmission inside of geosystems, with the input of strange matters in amounts exceeding all toxicity limitation parameters, as well as consequent geosystems contamination, are caused by the increasing technogenesis. Simultaneously, the loss of useful matters is going on. The intensification and spread of technogenic processes cause a necessity of their registration and systematisation within landscapes belonging to different hierarchical levels. Under conditions of large-scale productive activity natural landscapes are almost not preserved.

Sources of technogenic impact are frequently placed in such way, that their impact zones cover several landscapes, which are differed both in genesis and their natural peculiarities. It's particularly noticeable on the example of agricultural lands. Crop rotation field boundaries are parceled out in such way that their spatial parameters are not corresponding to the natural landscape geometry. As far as each land is functionally differed from the neighboring that proper specificity of technogenesis is peculiar to each of them. It makes possible the formation new technogenic landscapes within solid integral natural landscape. There are different ways of consequent development of arable and pasture landscapes, which, for example, is formed inside the southern slope of morainal hill composed by light loams with soddy podzolic soil. They will be differed by both functionality and geochemical processes, which predetermine different ecological conditions. Thus, homogenous technogenesis by it nature is able to form at least two new (technogenic) landscapes within the old nature landscape. In other words the development of the classification of landscapes, based on the simultaneous analysis of their technogenic and natural constituents, is necessary and actual. Such classification is useful and convenient for the different kinds of landscape and ecological assessments. It may be served as a basis for the correction of existing schemes of zoning (division into district) for ecological, geochemical and land use purposes within

regional and local scales (1 : 10 000 – 1 : 600 000).

Despite the hotness and actuality of this problem, and some successes in the field of technogenic landscapes studies, geographers, ecologists, landscape researchers do not pay necessary attention to the development of its basic definitions and categories, as well as to the problem of their unification and classification.

Data and methods

We have taken an attempt to achieve this goal during the development of our functional classification. Given classification is realized taking into account existed classifications: geochemical (Chartko 1990), typological classification of natural landscapes (Martsinkevich et al. 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 table 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 (Klitsunova et al. 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 et.al. 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 et.al., 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 table 2.

A line 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.

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 technogenesis within a kind. This unit

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

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 considered separately for each group.

Results

Agricultural group of landscapes is differed mainly by soil use. Technogenic impact in this case has been divided into arable, pastoral and moving 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* (Land Surveyor's…, 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 technogenic 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.*

Moving 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.

Industrial group of landscapes consolidates manufacturing areas of enterprises. As a rule, industrial landscapes are differed with extreme level of natural components transformation. The share of covered surfaces (occupied by buildings and installations for manufacturing, administrative and storage functions) may be run up to 100%. Natural soil and vegetative cover is not preserved. It usually replaced by artificial grounds and plantations. This group of landscape is not merely a product of technogenesis, but it becomes a source of technogenic impact on surrounding territories.

The geochemistry of industrial group of landscapes is characterizes by almost absolute absence of biogenic migration of chemical elements and domination of technogenic migration. A matter taking part in migratory processes is mainly presented by compounds, which have not natural analogues.

Regular receipt of chemical elements has occurred due to some matter losses at feedstock reload, atmospheric

migration, diffusion and mechanical transference of manufacturing materials and wastes between their storage area and utilization zone.

The differentiation of industrial landscapes by kinds is based on the branch principle. Thus all manufacturing areas, which are similar by the products type and their functions; by production technology, feedstock and wastes composition should be integrated into one kind of landscapes. Consequently, there are following kinds of landscapes, which should be identified within given group: mechanical engineering and metalworking landscapes, landscapes of metallurgic, chemical, petrochemical, oil-refining, timber-working enterprises etc.

Individual specificity of technological processes of enterprises within the brunch is taken as a basis of landscape subkinds selection. Differences in technogenesis are caused by differences in manufacturing technology. They are mainly indicated by geochemical peculiarities, i.e. by structure and composition of pollutants incoming into environment. Thus, the chemical composition of atmospheric pollutants, sewage and grounds within the manufacturing area of mechanical engineering or metal-working plants will be differed from the same area of food industry enterprise.

Subkinds of technogenic landscapes of chemical industry areas may be considered as an example. Landscapes of enterprises for the production of ammonia and nitric fertilizes, sulphuric acid, soda, phosphoric acid and phosphoric fertilizes, synthetic fatty acids, isoprene, phenol and acetone, chemical fiber, polymers, plastic, mineral pigments etc. Each of listed subkinds is substantively diffrent from others by the element composition of wastes. Some element associations are adduced in the table 3.

A peculiarity of overwhelming majority of all chemical industry landscapes is a carbon emission presented by oxides and organic compounds. That's why this element hasn't been included into the element association, which characterizes a landscape.

Mining group unites landscapes formed as a result of the development mineral extraction works, ground transference at the construction and activity on the storing of minerals, industrial and household wastes. Kinds of landscapes within the group have defined by geomorphologic (morphometric) signs. There are following kinds of landscapes in the group: dumps / waste banks, sludge storages, tailing dumps, filtration fields, open-cast mines, dams, trenches etc. Subkinds of landscapes are established by the composition of stored or extracted material.

Table 3. Some subkinds of chemical industry landscapes (Timonin 2003)

Subkinds of landscapes of manufacturing areas	Chemical elements association
Ammonia and nitric fertilizes	Si, P, Na, N, Cu
Acrylonitrile	S, Na, N
Butadiene	Na, N, Cr
Fatty acids	S, N
Isoprene	N
Mineral pigments	Pb, Zn, Na, N, K, Fe, Cl, Ba
Plastic	Cr
Polyvinylacetate	Fe
Polymers	S
Polypropylene	Ti, Na, K, Cl
Polystyrene	Mg, Cl
Polyformaldehyde	Na
Soda	S, N, Ca
Phenol and acetone	Fe, Cl
Phosphoric acid and phosphoric fertilizes	Si, P, S, N, F
Chemical fiber	S, Na, N, Cu, Zn
Epoxy resin	Na

Territories occupied by large technogenic positive forms of relief formed as a result of solid wastes storage are referred to *dump landscapes*. Composition of dumps and corresponding landscape subkinds may be different: ashy, slag, saline, ground etc. If the dump composition is mixed then it should marked, e.g. ashy-slug. Ground composition should be indicated for ground dumps, e.g. chalk, sandy-clayey etc. In case of mixed dumps where there is no possibility to establish their prevalent composition they should be related to mixed undifferentiated, e.g. solid household wastes.

Areas occupied by large, geometrically regular (rectangular, trapezoid) technogenic forms of relief established for the storage of liquid industrial and household wastes are related to *landscapes of sludge storages, tailing dumps and filtration fields*. All of them have channel-shaped profile. Subkinds of landscapes are divided by their composition both like above mentioned kind, e.g. clayey, saline etc.

Landscapes of open-cast mines are presented by areas occupied by excavation fields where minerals extraction is carrying out by open mode. Subkinds are established on the base of extracted minerals composition.

Landscapes of dams are represented by a number of narrow linear piled up protective installations.

Landscapes of trenches are formed as a result of ground extraction for different (mainly protective and constructive) needs. This kind is usually short-living.

Forestry group is identified on the base of usage mode and transformation degree of forest landscapes. There are following basic kinds of landscapes: lumber, reafforestative, timber plantation and protective forests.

Basic kind of this group is a lumber landscape. It is distinguished by full-scale exploitation of forest resources including timber cutting, turpentine and crud drug provision etc. Subkinds should be defined by timber cutting mode as a main type of forest use. This kind is divided into two subkinds: landscapes of selective cutting and landscapes of complete cutting.

High losses of chemical elements are typical for such landscapes. First of all it caused by timber removal. Biogenic migration of chemical elements is too high and their outflow is higher in comparison with natural forests. Elements removal also occurs with soluble organomineral compounds, which have formed at plant residues decay. This phenomenon has proceeded in natural forest as well, but in case of timber cutting its scale has become much more due to the high amount of crops, branches and underwood, which formed during a cutting. There are many elements received by the landscape during such works. A major part of them are stranger to natural forests. They are part of rubbish, oil products, products of deterioration of machines and mechanisms etc. They are generated at the incineration of branches and other wastes of cutting. Landscapes of glades and sparse grown trees are formed after the timber cutting finishing. Both of them are short-living.

Reafforestative landscapes are differed by large-scale forest renewal works on glades and other sited, which have never been covered by forests. Any industrial timber harvesting doesn't carry out up to the moment of forest maturity. There are following modes of reafforestation: natural, artificial and mixed. Subkinds of landscapes of the same name have corresponded to them. Reafforeatation in naturally-reafforestative landscapes is realized by natural way, i.e. by the means of self-seeding, stool-shoots, root-shoots etc. Seed sowing and planting have practiced as reafforestation method for artificially-reafforestative landscapes. A deal of chemical elements receipt in biogenic form has occurred in both cases. Simultaneously chemical elements introduction with fertilizes, biostimulators, pesticides and insecticides has taken place for the first years after the timber cutting and new forest planting.

Landscapes where forest growing is executed on the territory, which have never been afforested earlier, called timber plantation. A specter of growing species is usually limited by most valuable of them for woodworking industry. Consequently, a number of chemical elements kept in the landscape by biogenic way is limited. Other elements are migrated outside. That is why additional fertilizing and chemical treatment should be carried out regularly.

Protective forests landscapes involve territories occupied by artificial or natural forest plantation, which use for the protection of different economic objects from external unfavorable effects both natural and technogenic. Subkinds are determined by their functional purposes. There are following subkinds may be marked out among them: hygiene and sanitary, resort, slop- protective, water-protective, bank-protective etc. However, the division into subkinds is rather conditional because protective properties of these forests are multifunctional. They are able to carry out water-protective, bank-protective and recreational function simultaneously.

Depending on the executed function and the object of protection there are different ratios of chemical elements, which have formed in it, e.g. if it is a forest of sanitary protective zone around the enterprise then there will be precipitated constituent elements of its gas and dust emissions.

There is no any cutting works besides sanitary and improvement felling. That is why biogenic losses of matter are not insignificant or is absent.

Transport-communication group of landscapes unites territories occupied by communications of all modes of transport and transport infrastructure objects. There are following kinds of technogenic landscapes selected depending on the mode of transport and its kind of communication: road-transport, railway, water-transport, air-transport and pipeline.

Road-transport landscapes include territory occupied by road network and road infrastructure (petrol stations, parking areas, service stations etc.). Subkinds of given landscape are differed by width, pavement and traffic intensity. These features cause a level of technogenic geochemical, geomechanical and noisy load on environment. Landscapes of roads with improved solid pavement, with ordinary solid pavement, with ground pavement and unpaved roads are picked out among landscape subkinds.

Roads with improved solid pavement are usually highways. They have at least more then 2-3 traffic lines for both directions. Pavement materials consist of compositions improving its quality and durability. Traffic intensity is higher then 2500 vehicles for 24 hours.

Roads with ordinary solid pavement are minor motor roads, widths of which usually not exceed two traffic lines for one direction. Pavement of such roads is asphalt with gravel or with macadam. Cube of natural stone is used like pavement but rather rare. Traffic intensity is 500–2500 vehicles for 24 hours.

Roads with ground pavement have usually only one traffic line. Macadam, gravel, sand and different ground compositions are main pavement materials for them. Traffic intensity is not exceed 100–500 vehicles for 24 hours.

Unpaved roads have small length. Their width is equal to same value of previous subkind of landscapes. Traffic intensity is up to 100 vehicles for 24 hours. Much of them are used by cartage.

Railway landscapes unite territories occupied by any rail communications and corresponding infrastructure including tramways, lines of opened metro and monorails. Landscape subkinds are defined by the gauge width and electrification. According to these peculiarities the identification of landscapes of broad gauge railways, narrow gauge railways and monorails as subkinds is obvious. They are divided into electrified and non-electrified excluding monorails, which are electrified totally.

Lands occupied by objects and installations providing waterways functioning are referred to *water-transport landscapes*. There are two kinds, which are differed functionally: port installation landscapes and landscapes of navigation channels. The last kind is not differentiates. The first kind division into subkinds is caused by functional purposes of ports and their operating practice. Thus, according to mentioned criteria there are following types of ports: military, passenger, universal commercial and specialized commercial. Selected kinds of landscapes have corresponded to them with same names.

Military ports have designated for warships deployment and have included into naval bases as their constituent part. Operating practice, which causes a specificity of technogenesis, is organized for servicing of ships and their preparation to military operations.

Passenger ports are differed by minimum technogenic impact on landscapes and water area. Unlike others their processing system is simplest.

Main peculiarity of universal commercial ports is operation with numerous types of cargo. None of the cargo type is prevailing. Technogenic effect is complex and relatively homogenous. It caused by operational specificity for each type of cargo.

Specialized commercial ports are differed by the prevalence of any one type of cargo (oil, ore, coal etc.). The level of technogenic impact is extremely varied depending on the port specialization. It is minimal in ports specialized in container traffic and ports specialized in bulk cargo processing. It is connected with insufficient securing of cargo safety, especially its protection from erosion, atmospheric precipitation and other losses.

Pipeline landscapes include territories occupied by pipelines and pumping stations, which have provided a transfer of liquid, gas and solid (bulk) loads. There is no reason to differentiate pipeline landscapes into subkinds

because mode of pipeline exploitation is not essentially differ. It is not depending on the load type. Geochemical distinction may be occurred in case of leakage and transferring matter spilling.

Territories occupied by apartment blocks including yards, streets, avenues, boulevards and squares are referred to settled landscapes. There are following landscape kinds should be considered according to criteria of built up density and stores number: continuous low-story built up areas, condensed farming built up areas, widely spaced farming built up areas, continuous medium built up areas, condensed medium-story built up areas, widely spaced medium-story built up areas, continuous high-story built up areas, condensed high-story built up areas, widely spaced high-story built up areas (tab. 4).

Table 4. Settled landscapes classification on the base of built up density and number of storey

Landscape kind	Density, %	Number of storeys	Notes
Landscapes of continuous low-storey built up areas	50–80	1–3	
Landscapes of condensed farming built up areas	20–50	1–3	Small farming plot is available. They are common for suburban seasonal and cottage settlements
Landscapes of widely spaced farming built up areas	10–20	1–3	Farming plot availability is obligatory. They are peculiar to farm-steads
Landscapes of continuous medium built up areas	50–80	3-5	Peculiar to historic centers of ancient cities
Landscapes of condensed medium-storey built up areas	20–50	3-5	
Landscapes of widely spaced medium-storey built up areas	15–20	3-5	
Landscapes of continuous high-story built up areas	50–80	> 5	They are common to megapolises
Landscapes of condensed high-storey built up areas	20–50	> 5	
Landscapes of widely spaced high-storey built up areas	15–20	> 5	

Military group has united landscapes formed as a result of technogenesis caused by military activity. There are following kinds may be selected among them: belligerative, military-training and fortification landscapes.

Belligerative landscapes are complexes formed during direct military operations or large-scale militarized actions (maneuvers). Subkind differentiation is depending on military operations mode and degree of breakdowns.

The distinctive peculiarity of *military-training landscapes* where prevailing constituent element is a number of military training objects. Such landscapes kinds as shooting-grounds, target ranges, tank training areas are selected according to their training purposes and technogenic impact degree. Target-ranges differentiation is depending on functional purposes. Among them are artillery, chemical, nuclear etc.

Fortification landscapes are formed by fortified complexes, which assigned to autonomous functioning during a military operation. There are fortresses, castles, scarps, caponiers, redoubts, trenches, blindages, pillboxes etc.

Nature protective group includes landscapes excluded from the economic activity completely or partially with the purpose of their protection or any components of them. There are different landscapes consisted in natural protective areas and objects of natural, historical and cultural heritage.

Thus, we characterized basic groups of technogenic landscapes both like their kinds and subkinds. Nevertheless, some discussion problems, which have been confronted during the classification unit identification, deserve an attention.

Specifically, there are some groups of landscapes, which borders are fuzzy, e.g. recreation. As far as group of landscapes is selected according to the line of economic activity and recreation and tourism as a branch of

economy is really exists then the including of recreation landscapes into one group is well-founded and correct. Their main purpose is satisfaction of needs (wants) of population in different kinds of rest (rehabilitative, medical, sportive, cognitive etc.). This is their identification criterion. However the problem of their spatial binding and frontiers determination is taking place. Object used for the recreation are often included into other groups of landscapes (agricultural, forestry etc.). There are rare cases when we are able to assert that one or another forest fulfills mainly recreation functions. The same we can say about the sanatorium, health centre or hotel where people are staying with the purpose of rest, but area occupied by mentioned objects belongs to settled landscape.

There are some subkinds within the military group related to fortification landscapes, but which are used as a residence at the same time (castles, fortresses etc.). It may be served as a basis for identification of such kind of landscapes as military-settled. At the same time there are such landscapes as military bases and military units areas including territories occupied by objects assigned for staff residence, which are functioning like settled landscape. This fact is an obstacle to the selection of military-settled landscape into the separate kind.

Previous example has demonstrated the inclusion of separate elements from one technogenic landscape into another. Thus, landscapes of military units not exist without elements of settled and transport-communication group. Industrial landscape is impossible without pipelines and brunch lines, which are elements of transport-communication landscape. Any city has areas of regular green plantations or natural forests related to the different kinds of forestry and nature protective group (National Park "Losinyi Ostrov" (Elk Island) in Moscow; landscape and hydrological reserve "Lebiazhyi" in Minsk etc.).

Discussion

Conceptions of technogenic landscapes and approaches to their classification are different. Most principal of them are analyzed.

N.F. Milkov has developed diverse classification criteria. According to his classifications landscapes has differed in contents, in the depth of human impact on environment, in genesis etc (Milkov, 1973). This multicriterial classification and taxonomy of typological units don't raise objections in case of their use at the scale less then 1 : 50 000. Otherwise lowest units like tracts (urochishche) may be lost at larger scales. Moreover, characterizing the class of settled landscapes, a plant type has been referred to urban landscapes despite on its belonging to the class of industrial landscapes.

V.I. Fedotov develops a functional (geotechnic) approach and comprehends a technogenic landscape as a geotechnic system. He divides definitions "anthropogenic landscape" and "technogenic landscape", referring to the last such type of geocomplexes, elements of which have close relation with geotechnic systems with the domination of technical module (Fedotov 1985, 84–85). This is an ideal model, but it is bit far from reality because the forming of all anthropogenic landscapes is a result of the influence of implements (*techne* – Greek) used by a human. A more precise definition of landscape kinds and grade of their technogenic transformation is required. If agricultural, forestry and hydroengineering landscapes are referred to non-technogenic (Fedotov, 1985), then he contradicts himself, because the technical component dominates in their forming and maintaining. Despite on the fact that such system is functioning mainly according to natural regulations, the result will be differed from natural landscapes. The excluding of mentioned types of landscapes from the number of technogenic complexes makes his classification is uncompleted.

Naturetechnosystem approach has been developed by L.I. Mukhina and A.L. Revson at the studying of technogenic landscapes (Mukhina 1985, 61–86; Revson 1992, 9). A geotechnical system consists of few modules of the interaction of technical installations with geospheres. In other words it is a naturetechnosystem comprehended as an aggregate of states of interaction with components of environment and engineering installations under conditions of their dynamic equilibrium at different stages of their functioning. There are following subsystems are included in it: tropotechnical, aquatechnical, biotechnical, geotechnical and historico-architectural. First four of them reflect interaction of a technical installation with troposphere, hydrosphere, biosphere and lithosphere correspondingly. The identification of the fifth subsystem is hardly possible to substantiate. The insertion of appropriate modules into other subsystems is quite enough for the correct classification without damage for the

consideration of the technogenic impact on the historical and architectural heritage.

G.V. Voytkevich et al. proposed to select following taxonomic units for urban landscapes: group, type and kind (Reference Guide 1996, 375–378). A group identifies on the base of natural peculiarities of landscapes; functional purposes of the area is put into the basis of a landscape type identification; dominating landscape use, which makes an influence on the landscape and causes technogenic changes of environment, have been proposed to take as a criterion for the identification of kind.

In addition to the functional classifications considered above there is a number of geochemical classifications. Multilevel geochemical classification of natural and technogenic landscapes (Alexeenko 1999, p. 14–60] should be considered among them. Landscapes have been divided into levels according to peculiarities of the migration of chemical elements. From the point of view of contents this classification is ideal, but it is too cumbersome and laborious for the solution of applied problems.

Classifications of geochemical landscapes (Glazovskaya 1964, 1988, Perelman 1989) are well known and had become classical. They operated by definitions of landscape geochemical system and technobiogeom. Landscape geochemical system have been divided into elementary and cascade systems on the base of organization level and feedbacks density (Glazovskaya 1988, 292–293). Cascade systems have been classified by the relation of different cascade links area and their openness. Landscape geochemical systems are consolidated into tachnobiogeoms on the base of multicriterial approach. A number of criteria have characterized both natural and technogenic factors, which are reduced to the revealing a resemblances in peculiarities putting into the basis of grouping: 1) level of geochemical sustainability to technogenesis and 2) similarity of technogenic geochemical anomalies (Glazovskaya 1988, 294).

A.I. Perelman proposed to select taxonomic units of technogenic landscapes according to criteria used for natural landscapes. Water migration peculiarities he used for a landscape class, a landscape genus identification is based on the water cycle intensity and a landscape kind he selected on the base of geological structures (Perelman 1989, 357–359).

These two classifications are most successive among geochemical classifications. But they have a lack of functional loads of taxonomic units. This disadvantage has been overcome in the geochemical classification of N.K. Chartko, which has been developed for agricultural landscapes.

Conclusion

The natural basis of technogenically transformed landscapes shouldn't be ignored, because they are inscribed into the matrix of natural landscape. That's why both foundations (functional / production and natural) ought to be considered at the classification. For example, if agrilandscape is considered as a particular case of technogenic landscape, then the importance both of mentioned constituent parts becomes obvious especially. For example, mowing land (hayfield) and arable land may be existed within common natural landscape, i.e. having common natural basis. So, land use is lead to irreversible consequences for the natural basis and new complicated landscape system is formed.

Such state is caused by the current practice of consideration of land types out of natural landscape context. It leads to conflict situation between land users and environment protective organizations. The identification of elementary technogenic landscape as well as its definition is considered above, i.e. as a territorial unit differed with its inner natural and technogenic homogeneity, and its comprehension as a uniform elementary unit both for the purposes of land use and environment protection are able to allow us to avoid conflicts in land use and landscape planning. Moreover, such approach helps to do mentioned fields of activity more friendly to environment. Classification is a tool of the determination of such unit position in the landscape hierarchy serving at the same time for the relation with higher landscape levels.

In case of multilateral economic activity within the landscapes they are used diversely and may be considered as multifunctional. But this affirmation is correct for huge and complicated landscape complexes. Consequently the technogenesis inside of those landscapes is polygenetic. In this case researcher should to select derivative classification units, e.g. forestry-recreation landscapes.

References

Chartko N.K., 1990. Geochemistry Of Agrilandscapes Of Belorussia: Thes. Dr. Geogr. Sci. Minsk, 396. (in Russian)

Martsinkevich G.I., Klitsunova N.K., Kharanicheva G.T. et al., 1989. Landscapes of Byelorussia. Minsk, Universitetskoye, 239. (In Russian)

Pomelov A.S. (ed.), 2004. Land Surveyor's Dictionary Guide. Minsk, 271. (In Russian)

Timonin A.S., 2003. Engineering and Ecological Reference Book. Vol. 2. N. Bochkareva Publishing House, Kaluga. 884. (In Russian)

Milkov F.N., 1973. Man and Landscapes: Outlines of Anthropogenic Landscape Studies. –Mysl, Moscow. 223. (In Russian)

Fedotov V.I., 1985. Technogenic Landscapes: the Theory, Regional Structures and the Practice. Voronezh State University Publishing House, Voronezh. 192. (in Russian)

Mukhina L.I., Tolstikhin O.N., 1985. Nature and Technological Revolution. Nedra, Moscow, 111. (in Russian)

Revson F.L., 1992.The Geotechnical Systems States Mapping. Nedra, Moscow, 223. (in Russian)

Voytkevich G.V. et al., 1996. The Reference Book on the Geoenvironment Protection. Phoenix, Rostov-upon-Don, Vol. 1. 448. (in Russian)

Alexeenko V.A., 1990. Landscape Geochemistry and Environment. Nedra, Moscow. 142. (in Russian)

Glazovskaya M.A., 1964. Geochemical Principles of Typology And Methodology of Natural Landscapes Research. Moscow State University Publishing House, Moscow. 230. (in Russian)

Glazovskaya M.A., 1988. Geochemistry of Natural and Technogenic Landscapes of USSR. Vyschaya Shkola. Moscow, 338. (in Russian)

Perelman A.I., 1989. Geochemistry. Vyschaya Shkola, Moscow, 528. (in Russian)