Classification of urban landscapes:
The case study of Mahilew (Belarus)

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Abstract. The world is getting urbanized. Landscape approach is widely used for integrated assessment of urban areas. In this research we understand urban landscapes as natural-anthropogenic spatial complexes (NAL), which defined as a combination of a certain type of morphological urban elements (morphotypes) and natural patterns. Thereby the classification of urban landscape includes three components such as natural background, city-planning structure and existing land use. 15 urban landscapes were defined for the area of Mahilew. We have made typology classification and defined the following classification units of urban landscapes: groups of species, species and variants of urban landscapes. Variants of urban landscapes assemble areas with similar genesis. We defined 9 variants of urban landscapes. Diverse morphological structure of city identifies 12 species of urban landscapes. Species have been combined into 3 groups.
The proposed classification make possible to systematize data about structure of urban environment for optimization of city planning and city management.

Key words: urban landscapes, landscape structure, classification of urban landscapes, city-planning structure

Introduction

Currently landscape approach is widely used for integrated assessment of urban areas. We understand urban landscapes as natural-anthropogenic spatial complexes which have been forming during city-planning development. Thus, it is possible to allocate natural-anthropogenic geosystems which include both natural elements and city-planning patterns.

Data and methods

The classification of urban landscapes has been made for Mahilew – one of the oldest ciiesy and the biggest administrative, industrial and cultural centers of Belarus. The GIS software has been used. The scheme of division urban territory and detecting of urban landscapes embraced three steps: 1) survey and classification of natural landscapes (reconstructed natural landscapes); 2) description and grouping of morphological urban elements; 3) contouring and systematization of urban landscapes.

Survey and classification of natural landscapes (reconstructed natural landscapes)

The five-step classification of natural landscapes has been developed at the scale 1:80 000 (Shkaruba et al.,

2000). Landscape genesis, type of superficial overburden and atrributes of mezo-relief are the main indicators of classification units (Martsinkevich, Klicunova 1989). These attributes describe the inherent features of landscape. They determine mater and energy flows and finally specify landscape stability to anthropogenic impacts. The groups of types, types, sub-types, groups of species and species are the main classification units of natural landscapes (NL). The species (vid) of landscape is the smallest unit of classification of NL. The species assemble areas with similar attributes of mezo-relief. The soil and vegetation cover were used as an additional attributes to allocate species. 27 species of landscapes were defined. Geomorphological data have been used as an additional factors to put species into 14 groups: *flat* (variation of altitudes is less than 1 meter) (I), *flat with sparse hillocks* (II), *flat with remains of holocene natural terraces* (III), *flat with single hillocks* (IV), *flat with small hillocks* (variation of altitudes is less than 1,5 meters) (V), *flat with big hillocks* (variation of altitudes is more than 1,5 meters) (VI), *flat-wavy* (variation of altitudes is less than 2 meters) (VII), *wavy* (variation of altitudes is 2-3 meters) (VIII), *wavy with gullies* (IX), *hilly-wave* (variation of altitudes is 5-10 meters) (X), *eroded hilly-wave* (XI), with small hills (variation of altitudes is 10-15 meters) (XII), *small rivers valleys with slope steepness < 30˚* (XIII), *small rivers valleys with slope steepness > 30˚* (XIV). The superficial overburder is the main attributes for subtypes of NL (tab. 1). 6 types of NL are recognized by the genezis of territory. They are: *secondary moraine plaines, secondary fluvial-glacial plaines, secondary fluvial-glacial plaines with ancient lacustrine depressions, holocene natural and contemporary man-made terraces, flood-lands and small rivers valleys.* We allocated all NL into two groups of types: NL of valleys and NL of watershed.

Description and grouping of morphological urban elements

The large-scale topographic maps together with maps of functional zoning and morphological structure have been analyzed to define the city-planning structure of Mahilew. The classification has been made for every group of building areas, which have been distinguished for study area: inhabited and public, industrial and open spaces.

There are two classification units for building areas: morphological elements of building-up and morphological groups of building-up. The morphological elements define certain functional purpose of area. The morphological groups of building-up are spatial sets of the morphological elements, which characterized by certain morphometrical and sanitary-hygienic indicators, configuration and age of elements.

There were allocated three morphological elements for inhabited and public areas: (1) *multistoried*; (2) *institutional* (administrative and business, scientific and educational, cultural and educational, medical and sport facilities) and (3) *serving building* (trading). 9 morphological groups of building-up are recognized for inhabited and public area: *linear blocks, compact blocks, blocks with sparse structure, blocks with combined linear and compact structure, blocks with combined linear and sparse structure, blocks with ordinary structure, blocks with dot structure, individual rural type* and *individual cottage type.*

Finally, the classification of city space organization has been made. The type of the organisation of city space (TCSO) is understood as a complex of morphological elements of the city-planning environment, which perform certain functions, age, picturesque characteristics and attributes of interaction with natural basis. Different variations of combination of these elements in complex urban structure reflect features of city-planning development and history of the city.

The analysis of structure of the city-planning environment has allowed allocating 14 types of the city space organisation. We used additional criteria to separate morphological elements as uniqueness/ordinary of elements. According to previos mentioned attributes the following two groups of TCSO have been defined:

1. historical (*down-town, building-up of 1930-1950ᵗʰ*);

2. modern (with building-up: *blocks of 4-5-storied building-up of 1960-1970ᵗʰ, modern 5-16-storied building-up of 1980-2000-th, private building-up, institution building-up industrial territories, which have intensive harmful impact on environment, industrial territories, which have moderate harmful impact on environment, transport and storage areas*; open spaces: *city forests, parks and gardens, grassy plant and shrubbery, fields and pastures, special-purpose landscapes* (*cemeteries and burial places*)).

There were defined four categories of TCSO which have special influence on the process of development of

urban environment: I) brand image – TCSO being essential in city-planning structure and defining development of balanced symbolic features; II) background – types of the organisation of space dominating in a city; III) inherited – TCSO has lost their primarily function, possessing considerable social inertia and being relict in the city environment; IV) accompanying – are additional element of city-planning structure, provide consistency of the city environment.

Contouring and systematization of urban landscapes

Urban landscapes can be defined as natural-anthropogenic spatial complexes (NAL). These complexes have both attributes of certain type of morphological urban elements (morphotypes) and natural patterns. Active interactions of two components outline specific social-ecological conditions on the urban area. The border of urban landscape – is a result of interaction of natural landscapes (reconstructed natural landscapes) and

Table 1. The classification of natural landscapes of Mahilew

Groups of types of NL	Types of NL	Sub-types of NL (character of superficial overburden)	Groups of species of NL (geomorphologic differences)													
			I**	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Landscapes of watershed	secondary moraine plaines	with superficial deposition fluvial-glacial clay sands								1*		4	6	8		
		with cover of loess-like loams								2	3	5	7	9		
	secondary fluvial-glacial plaines	with superficial deposition fluvial-glacial clay sands							10	11						
		with cover of loess-like loams											12			
	secondary fluvial-glacial plaines with ancient lacustrine depressions	with superficial deposition of peat							13							
Landscapes of valleys	holocene natural and contemporary man-made terraces	with superficial deposition of holocene alluvial sands, clay sands and loams							14	15						
		with artificial hydraulic fill layer of ground	16						17							
	flood-lands	with superficial deposition of alluvial sands and clay sands	18	20	21	23	22	25	19	24						
	small rivers valleys	with superficial deposition of alluvial sands and clay sands, dealuvial sediments													26	27

* Numbers of species of NL is in accordance with table 1. ** Numbers of groups of species of NL are describes in the text

morphological urban elements. 15 urban landscapes were defined for the territory of Mahilew (fig. 1). The classification of urban landscapes has been made also. There were defined three classification units: groups of species, species and variants of urban landscapes.

Genetic attributes of territory have been used to isolate 9 variants of city landscapes. Species of urban landscapes have been identified according to morphological features of urban-planning components. Species have been combined into 3 groups: «with predominance of…» certain morphological elements (the area mostly occupied by one or two TCSO), «with a complex» (complex combinations of several TCSO without possibility of definition of dominating elements) and «with alternation» (regular distribution and repetition in space of several TCSO).

Results

Description of natural landscapes

The secondary moraine landscapes dominate in the territory of Mahilew. They occupy about 42% of city area. This type of landscape includes 9 species of NL. The secondary fluvial-glacial plains occupy about 19% of study territory and include 3 species of NL. The secondary fluvial-glacial plains with ancient lacustrine depressions are unique landscape for territory of Mahilew, and it is presented by only one specie of NL. The large area of the territory of city belongs to the Dnepr valley. Therefore flood-lands and terraces prevail in the city. The landscape of terraces includes 4 species of NL. The flood-lands extend as a wide zone along the river Dnepr. They are characterized by high level of diversity and include 8 species of NL. Landscapes of the small rivers valleys occupy about 7% of study area. They combine 2 species of NL.

Description of morphological structure of Mahilew

We defined approximately 300 of morphological groups. All these groups of building-up and open spaces perform both structural and environmental functions. The attributes of their combination, spatial distribution and picturesque characteristics reflect distinctive attributes of city-planning structures and also predetermine perception of a city in whole and its separate parts (Gutnov 1990). Thus, the city space is structured not only due to objective factors, but also subjective – through its reflexion in consciousness of inhabitants (Azizyan 1990).

The blocks with combined linear and sparse structure and blocks with sparse structure dominate among morphological groups of inhabited and public areas. The individual building of rural type occupy the considerable areas. It takes more 62% of the area of inhabited and public territories.

Industrial areas include territories of industrial and agricultural enterprises, municipal and storage facilities objects, transport and communications. These areas can also include sanitary-protected zones of the enterprises (City-planning, 1999). Industrial territories occupy about 18% of the area of a city.

Open spaces in the city combine both building, small sites of green vegetation (large areas, parks, foot zones, stadiums and etc.), and recreational landscapes of special purpose (city and suburban, cemeteries).

The industrial territories of intensive and moderate impact on the city environment, historical centres and TCSO with building-up of 1930 – 1950th are brand image areas for Mahilew. They are most stable elements on the contemporary stage of city development. They make the most intensive impact on process of development of the city environment and define ways of future city growth.

TCSO with building-up of middle-storied houses of 1960 - and middle-and multistoried buildings of 1980 – 2000th are background elements of city-planning structure. They define interaction of an anthropogenic and natural basis on the most parts of territory of a city. Thus, this type of TCSO in many respects define living conditions of majority of inhabitants.

The areas of individual building-up of rural type, city woods, forest parks and recreational landscapes belong to inherited territories in Mahilew.

Institutional, transport and storage areas are recognized as a accompanying TCSO. All these types perform service function.

Description of urban landscapes

The structure of urban landscape for Mahilew city is presented on the figure 1.
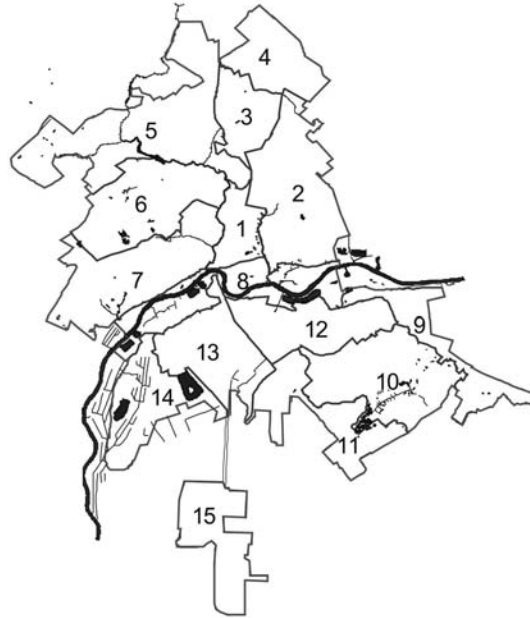

Fig. 1. Urban landscapes of Mohilew

1. Secondary moraine plaines with predominance of building-up of 1930-1950th in combination with down-town, private building-up, parks and gardens; 2. Secondary-moraine plaines with complex middle-storied blocks of buildings of 1960-70th, middle- and multistoried buidings of 1980-2000th, individual rural, industrial terrotories of intensive and middle impact, transport and storage areas, grass and shrubs of urban phytocenosis; 3. Secondary-moraine plaine with prevailence of individual rural houses in combination with middle-storied buildings of 1960-70th and stansport and storage areas; 4. Secondary-moraine plains with prevalence of industrial territories of intensive anthropogenic inpact in combination with middle- and multistoried buildings of 1980-2000th, transport and storage areas, woods and forest parks, grass and grass-shrubs urban phytocenosis; 5. Secondary-moraine and secondary fluvial-glacial plains with prevalence of individual rural houses, woods and forest parks in combination of individual building of cottages, grass and grass-shrubs urban phytocenosis; 6. Secondary fluvial-glacial plains with a complex middle-storage buildings of 1960-70th, individual rural houses, industrial territories, industrial areas of moderate influence, transport and storage territories, wood, grass and grass-shrubs urban phytocenosis; 7. Secondary-moraine plains with prevalence of individual rural houses in combination with middle-sstoried buildings of 1960-70th, industrial territories of the moderate and intensive influence, grass and grass-shrubs urban phytocenosis; 8. Flood-plain with prevailence of grass and grass-shrubs urban phytocenosis in combination of individual rural houses and areas of agricaltural use; 9. Secondary-moraine plains with prevalence of woods and forests parks in combination with middle-storied buildings of 1960-70th, individual of rural houses, grass and grass-shrubs urban phytocenosis; 10. Secondary fluvial-glacial plains and aincient lake hollows with prevailence of wood and forest parks in combination of rural individual houses, grass and grass-shrubs urban phytocenosis; 11. Secondary-moraine and secondary fluvial-glacial plains with complex of individual rural houses, industrial areas of moderate anthropogenic impact, transport and storage areas, woods and forets parks, grass and grass-shrubs urban phytocenosis; 12. Secondary fluvial-glacial plains, holocen and man-made terraces with a complex middle-storied buildings of 1960-70th, middle- and multistoried buildings of 1980-2000th, individual rural houses, industrial territories of moderate impact, transport and storage areas, grass and grass-shrubs urban phytocenosis; 13. Holocen and man-made terraces with prevalence of middle- and multistoried buildings of 1980-2000th with combination of individual rural and cottage buildings, woods, grass and grass-herbs of urban phytocenosis; 14. Holocen terraces and floodplain with alterations of individual building of rural type, grass and grass-herbs urban phytocenosis; 15. Secondary-moraine plains with alterations of industrial territories of intensive impact, grass and grass-herbs of urban phytocenosis.

High complexity of the city-planning environment has reflected in structure of the lowest classification units – variants of urban landscapes defined taking into account subdominant and rare types of the organisation of space. Within group "*with prevalence...*" 9 variants of city landscapes "*in a combination with... and elements*" are allocated; in groups "*with a complex...*" and "*with alternation...*" – accordingly 4 and 2 variants of the urban landscape "*with elements...*" are defined. The landscapes "*with prevalence…*" are typical for Mahilew. They cover about 60 % of city areas.

Discussion and conclusion

There are many classifications of urban landscapes. This research is one of the examples of complex classification of urban landscapes, which includes three components such as natural background, city-planning structure and existing land use.

The proposed classification make possible to systematize data about structure of urban environment for optimization of city planning and city management.

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