Methodological approaches and results of complex and applied subdivision the territory of Belarus

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Abstract: Spatial heterogeneity of geographic sphere is a subject of special scientific direction in geography, which is called "subdivision". The following types of subdivision are defined: integral, complex and sectoral. In relation to practical tasks general subdivision and applied subdivision are defined. However, the later one is not universal and is done for particular problem.

Theoretical and methodological aspects of the complex subdivision, in particular physical-geographical subdivision, are the most developed. Methodology of the complex subdivision includes the system of logically relevant taxonomic units as physical-geographic area - country – zone - region - province – district; list of principles and methods of research, criteria and factors of selection of districts. Based on the methodological concept presented above subdivision of natural landscapes for the whole Belarus has been made. This subdivision could be used for any applied studies.

However, nowadays, researchers have to deal with not only natural landscapes, but with their anthropogenic modification. Understanding of such complexes is possible only in the result of study of the system "natural complex – human use" and analysis of interactions of their components. Therefore, there is a need for applied subdivision, which aims to identify existing spatial differences that are result of economic development of landscapes. Such studies were conducted in Belarus in 2006 and 2010 under the State program of basic research to develop recommendations for optimization of structure of land use in the problem regions of the country – Paazer'e and Palesse provinces.

Under the project data on structure of land use in these regions were collected, analyzed and summarized. These data were used to define main types of anthropogenic impacts on landscapes, to assess intensity of impact, to identify the spatial differences of processes, to develop applied subdivision and to develop recommendations for improvement of land use management in these provinces. Applied subdivision of problem regions in Belarus is based on a methodology, theoretical principles, methods and system of taxonomic units of complex subdivision. However, criteria and indicators used for identification of taxonomic units, methodology for mapping of applied subdivision using GIS are used for the first time.

Paazer'e and Palesse landscape provinces differ significantly between each other not only by natural conditions, but also according to structure of types and species of modern landscapes. Types of anthropogenic landscapes (AL) are defined by direction of economic activity; species (vid) – proportion of structure of different land use within the type of landscape. In Paazer'e landscape province there are 3 types of AL – agricultural, forestry and agro-forestry with the dominance of the last one (51,7% of the area). 11 species of landscapes are defined within this area. In Palesse province there are 4 types of AL – agricultural reclaimed landscapes, agricultural, forestry and agro-forestry landscapes with the dominance of the last one (40%). The province is characterized by high diversity of species of AL with the total number of 16 species.

Defined structure of AL has been used for assessment of spatial distribution of landscapes with different level of anthropogenic transformation (from minimal to maximum). The level of anthropogenic transformation has been used as an indicator for applied subdivision of problem areas of Belarus. As a result, in Paazer'e province 6 districts were allocated and in Palesse – 7 districts. These regions differ between each other by structure of types and species (vid) of AL and level of their anthropogenic transformation.

Key words: landscape subdivision, applied subdivision, approaches, principles, methods of subdivision, results of subdivision

Introduction

Spatial heterogeneity of geographic sphere is a subject of special scientific direction in geography, which is called "subdivision". In physical geography the following types of subdivision are defined as integral (geoecological), complex (physical geography and landscape) and sectoral (geomorphological, soil, geobotanical, and others) subdivision according to complexity of display. The following types of subdivision could be distinguished: general scientific and applied subdivision related to practical problems. Applied subdivision is not universal, but is performed for specific problem or practical task (Landscape conservation, 1998).

The methodological problems of complex subdivision are well- studied, in particular physical-geographical subdivision. Theoretical framework of physical-geographical subdivision includes a number of general scientific approach (systematic, ecological, landscape), the system of logically well grounded taxonomic units as physical-geographical zone- country-region - province - region as well as the principles, methods, criteria and factors of their selection (Gvozdetskyi, 1979). Methods of the leading factor, quantitative characteristics, as well as mathematical, cartometric, remote sensing are tested and widely used for subdivision. The scheme of taxonomic system of subdivision is based on the simultaneous consideration of the zonal and azonal features and differentiation factors of environment.

Despite on progress in addressing some major theoretical problems, some theoretical questions of subdivision still exist. The most problematic and controversial question in the recent decades is interrelation between physical-geographical and landscape subdivision. These two types of subdivision for a long time have been understood as a synonymous. The idea that landscape subdivision is a special type of complex subdivision started to be developed in soviet geography in the last quarter of XX century (Kadilnikov, 1974). This idea is based on the contrast between physical-geographical and landscape subdivision. The first one is based on the particular map of natural conditions and resources instead of the last one, which is based on landscape map. The system of classification units for landscape map could be used as criteria for the selection of taxonomic units of landscape type of subdivision.

Latter the first scheme of landscape subdivision of Belarus has been developed. Previous experience of physical-geographical regionalization of the Republic prof. V.A. Dementiev (Dement'ev 1960) and prof. E. Kondracki (Kondracki, 1992) have been used during the work under the map. At the beginning of the XXI century a group of geographers from Belarusian State University, including the author of this article, made two new maps for Belarus - physical geographic subdivision in the decimal system and landscape subdivision (Martsinkevich, Pirozhnik, 2007; National Atlas of Belarus, 2002).

Principles of complex subdivision

The principles of objectivity, zoning, sector (provincial), azonal, genetic unity, integrity and spatial unity are the basic principles of complex subdivision.

For most of geographers the principle of objectivity is no doubt, however in some geographical schools of USA subdivision is understood as a subjective process. Last point of view has not found wide acceptance. Physical-geographical subdivision is intended to fulfill the diverse needs of the society, but the boundaries of latitudinal or altitudinal zones do not change in the results of it.

The principle of complexity in the physical-geographical subdivision considers jointly regularities and differentiation factors of the geographical environment, which determine intensity of modern geographical processes. In practice, the principle of complexity is understood as an consideration of all components of the landscape, the whole complex of natural conditions (Demek, 1968).

Physical-geographical subdivision is aimed at detecting, identifying, mapping of individual spatial units, each of which occupies a particular territory. Territorial similarity is an essential feature of the physical-geographical units of zoning as opposed to landscape units, which could have spatial differences.

Development of physical-geographical regions is a long process. Therefore there is a need to integrate the genetic principle, which is supported by many geographers (Lipsky, Romportl, 2007, Richling, 1984), but in cases of subdivision has not yet found the full application.

Considering above mentioned methodological guidelines, the landscape subdivision has been made for Belarus,

which is the type of complex subdivision and reflects regional heterogeneity of landscape sphere. Landscape subdivision as well as other types of natural subdivision, has a multi-step approach. This type of subdivision uses generally accepted taxonomic units – district, province, region and country. However, the features of their allocation are not the properties of natural components, but horizontal structure of landscapes. Thus, the landscape region is allocated based on combination of dominant species of landscapes; province – based on combination of genues (rod); zone – subtypes; country – type of landscapes (Martsinkevich, 2009). In general, maps of physical-geographical and landscape subdivision have a fundamental scientific importance and could be used as a basis for applied interpretation aimed to solve certain practical tasks.

Approaches and methods of application of landscape subdivision

The following postulates could be main directions of applied interpretation:

1. Determination of the optimal fractionality of subdivision. Existence of a hierarchy of regions allows selecting the lowest level, which corresponds to the solution of certain practical problem. The level of landscape province could be sufficient for developments on a national scale, and for school geography – landscape zones, sectors and countries.

2. Task-oriented selection of necessary indicators of natural conditions, landscape and resources. Every physical-geographical region is a complex natural system with variety of parameters. Analysis of the natural features of the region can never be exhaustive, it is always more or less selective, and therefore researcher should use this selectivity for special purpose – relating to aim of subdivision.

3. Applied grouping of regions. To solve applied tasks natural regions could be regrouped. This is closely related to applied assessment of landscapes to evaluate exploitation capacit for use for various activities (agriculture, recreation and so on).

Currently, researches have to deal not only with natural landscapes, but with anthropogenic ones. The understanding of such systems could be possible through investigation of the system "natural system – economic production" and analysis of their components (Richter 1981). Therefore there is a need for applied subdivision. The main goal of applied subdivision – to define existing spatial differences resulted in the process of economic development of the territory. Such researches have been made in Republic of Belarus from 2006-2010 within research programme of basic research. During this project data on structure of land use and modern landscapes in problem regions of the country – Paazer'e and Palesse provinces was collected and analyzed. The main results of the projects are the following: identified main types of anthropogenic impact on landscapes; assessment of the level of anthropogenic impact; analysis of spatial distribution of anthropogenic impact; development of the scheme and mapping of applied subdivision and finally, development of recommendations on optimization of land use management.

To define types o anthropogenic transformation we created vector data of land use based on the topographical maps of 200.000 scale. We defined the following land use types as forests, arable areas, peats, forestry peats, water bodies, roads and towns. We made all calculation in ArcView and calculate the structure of land use for Paazere and Palesse provinces. We analyzed land use structure within every landscape. These data were used for allocation of anthropogenic landscapes.

We have received the following results. Paazer'e and Palesse landscape provinces differ significantly between each other not only by natural conditions, but also according to structure of types and species (vid) of modern landscapes. As a result, 3 types of ATL have been defined for Paazer'e province – agricultural, forestry and agricultural-forestry with dominance of the last one, which occupies 51,7% of the area. Within these types of landscapes 11 species (vid) of anthropogenic landscapes were defined (Gagina, Usava, 2008). In Palesse province there are 4 types of AL – agricultural reclaimed, agricultural, forestry and agricultural-forestry landscapes. Agricultural-forestry landscapes dominate and occupy approximately 40% of the territory. The province is characterized by high level of diversity of species of anthropogenic landscapes. The total number of landscapes is 16 (Martsinkevich, Schastnaya, 2010). Maps of types and species (vid) of landscapes were used as a basis for assessment of landscape transformation. Ranking of land use types was made based on the "environmental principle" from nature protected areas to settlements, with assignment of the "weight"

coefficients (ki) from 1 to 5. The coefficient of anthropogenic transformation was calculated according to the following formula (Kochurov, 1999):

$$P = \frac{\sum Si \cdot ki}{Sn}$$

where: P - is the total weighted score of coefficient of anthropogenic transformation for landscape,
  ki - «weight» coefficient for particular land use type;
  Si – the area of land use type within landscape;
  Sn - the total area of landscape.

Assessment maps demonstrate spatial distribution of landscapes with minimum, low, average, high and maximum level of anthropogenic transformation and provide basis to make subdivision of problem areas of Belarus according to the coefficient ofanthropogenic transformation.

Applied subdivision of types of anthropogenic landscapes is based on the methodological background of complex subdivision, theoretical principles, methods and system of taxonomic units of this scientific field. Moreover, criteria and indicators used to select taxonomic units, methods of mapping using GIS technologies have been used for the first time.

We have defined 6 districts in Paazer'e province and 7 districts in Palesse province which have different structure of types and species (vid) of anthropogenic landscapes and various level of anthropogenic transformation.

Results of applied subdivision of the province Paazer'e

Within the Paazer'e province 6 individual districts are defined. Each district has geographical title which corresponds to geographical position and is characterized by strictly defined set of natural and anthropogenic features (fig. 1).
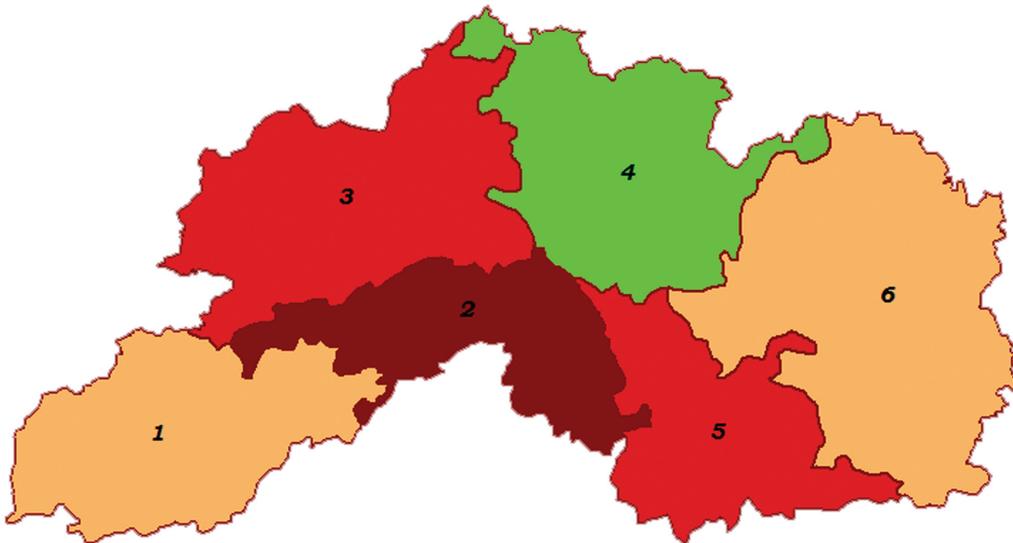

Fig. 1. Applied subdivision of Paazer'e province
Districts: 1- Astravec-Mjadel district of average and high level of transformation; 2 - Glubokae-Lepel district of high and maximum level of transformation; 3 - Braslaw district of high level of transformation; 4 - Rassony dostrict of low and average level of transformation; 5 - Chashniki district of high level of transformation; 6 - Vitebsk district of average and high level of transformation.

1. **Astravec-Mjadel district of average and high level of transformation** locates in the south-western part of the province and occupies 14.2% of its area. The district is characterized by simple structure of the modern landscapes. Among these agricultural landscapes are dominant and agricultural-forestry landscapes – rare. Urban-forestry-agricultural and forestry-agricultural species landscapes are dominant and occupy 57% of the territory of the district. About 22% of the territory is occupied by natural protected areas, including the national park "Narochansky". Landscapes of average and high level of transformation are distributed evenly: 46 and 52 % respectively.

2. **Glubokae-Lepel district of high and maximum level of transformation** locates in the southern part of the province (11.6% of its territory). The region is characterized by fertile soils, which contributes to active agricultural use of the area. Urban-agricultural (35,7%) and forestry-agricultural (38%) landscapes dominate in the structure of landscapes of the region, that explains dominance of land with an average (48%) and maximum level of anthropogenic transformation (about 26%).

3. **Braslaw district of high level of transformation** occupies 19,5% of the province, is located in the north-west with agricultural landscapes. Urban-agricultural and forestry-agricultural species of landscapes are dominant within the district and characterized by high level of anthropogenic transformation of landscapes (62%). National park "Braslau lakes" locates in the region.

4. **Rassony district of low and average level of transformation** locates in the northern part of Paazer'e province and occupies 18.1% of its area. Forestry landscapes are dominant (51,5%) and agricultural-forestry landscapes are less distributed in the district. Rassony region is the only one within Paazer'e province where landscapes with low degree of anthropogenic transformation occupy the same area as landscapes with average level of transformation (44-45% respectively). There are several large landscape natural reserves within this region.

5. **Chashniki district of high level of transformation** locates in the southeastern part of the province (14,2% of the territory) with agricultural and agricultural-forestry landscapes. Forestry-agricultural (53,6%) and urban-agricultural landscapes (15%) dominate. Areas with average (27%), high (73%) level of transformation are distributed within the district.

6. **Vitebsk district of average and high level of transformation** occupies the largest area within the province (22,4%), locates in the eastern part of the region with agricultural landscapes. This explains dominance of urban-agricultural and forestry-agricultural landscapes within the district. Therefore areas with average and high degree of transformation occupy 51% and 46% of the district respectively.

Results of applied subdivision of Palesse province

Within the Palesse province 7 districts were allocated . Distribution of these regions is presented in figure 2.

1. **Brest district of high and maximum level of transformation** locates in the western part of the Palesse province (9,9% area) with agricultural landscapes. Urban-agricultural landscapes (59,7%) and forestry-agricultural landscapes (19,3%) dominate in the structure of species anthropogenic landscapes. Brest district is only one region in Palesse province, where about 40% of landscapes are characterized by maximum and 43% - high level of transformation.

2. **Belazersk-Luninec district of high level of transformation** lies in the western part of the province (8,1% of its territory) with agricultural-forestry landscapes. Urban-forestry-agricultural and forestry-agricultural species of landscapes occupy 51,2 % and 23,6 % respectively. 75% of the area is characterized by high level of transformation and 25% - average level of transformation.

3. **Gancevichy district of average level of transformation** occupies 12,0% of the province. Forest landscapes with peat (44,4%) and swamp-forestry landscapes (29,7%) of forestry type dominate among species of anthropogenic landscapes. Most of landscapes in the district are characterized by average level of anthropogenic transformation (68%), 17,8% - by low level and 14,3% - by high level of anthropogenic transformation.

4. **Saligorsk-Stolin district of average and high level of transformation** occupies 20,4% of the province and is located in the central part of Palesse. The structure of the anthropogenic landscape

is considerably diverse (11 species (vid) of landscapes). Forestry-agricultural landscapes on reclaimed areas (32%) and peat-forestry-agricultural landscapes (19,1%) dominate. Each of the 9 remaining species of landscape takes from 2,6 to 13% of area of the district. However, the distribution of level of anthropogenic transformation is characterized by simple structure: 46,8% of landscapes have high level and 45,5% - average level of anthropogenic transformation.

5. **Prypjat district of low transformation** occupies 6% in the southern part of the Palesse province. Forestry landscapes with peatlands (76,5%) and peatlands with forests (20,1%) dominate in the structure of anthropogenic landscapes. As a result the level of anthropogenic transformation for this region is low: 76% of landscapes of the region are characterized by low level of transformation and 24% - by a minimum level. Location of Pripyat National park and landscape reserve "Olmanskie bolota" with conservation and protection regime contributes to low level of anthropogenic transformation.

6. **Svetlagorsk-Elsk district of average transformation** (26,9% area) locates in the east part of the Palesse province. The region is characterized by high diversity of species (vid) of anthropogenic landscapes. Agricultural-forestry (33.1%) and forestry (27,9%) landscapes dominate. Nevertheless, this district has a very simple structure of the level of anthropogenic transformation: 90% of territory is average level of transformation.

 7. **Homel-Mozyr district of high transformation** stretches along the eastern border of Palesse province, occupies 16,7% of its territory. The structure of anthropogenic landscape is diverse, though forestry-agricultural (42,3%) and urban-forestry-agricultural (15,5%) species of landscapes of agricultural-forestry type are dominant. More than 54% of the region is occupied by landscapes with high level of transformation, 29,7% - average and 16,3% - maximum level of anthropogenic transformation.

Applied landscape subdivision and regional analysis of the results provided the background for development of recommendations for optimization of land use in problem regions of Belarus.
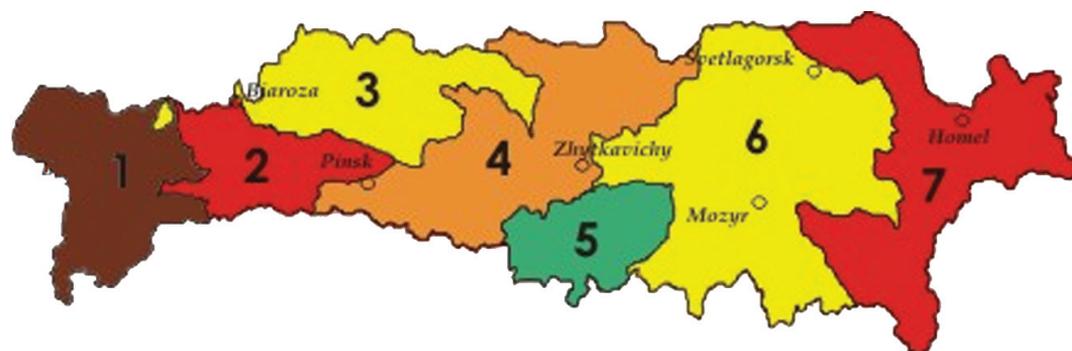
Fig. 2. Applied subdivision of Palesse province
    Districts: 1 – Brest district of high and maximum level of transformation, 2 – Belazersk-Luninec district of high level of transformation, 3 – Gancevichy district of average level of transformation, 4 – Saligorsk-Stolin district of average and high level of transformation, 5 – Prypjat district of low transformation, 6 – Svetlagorsk-Elsk district of average transformation, 7 – Homel-Mozyr district of high transformation.

Discussion and Conclusion

This article devoted to the methodological problems of spatial analysis and optimization of landscape structure of the territory. Proposed methodology for assessment of anthropogenic transformation of landscapes is similar to LANDEP, which is widely used in landscape ecological research in many countries in Western and Central Europe. Such directions of research are named by Kozova as most important areas of landscape ecology (Kozova, Drdosh 2008, Wu, Hobbs, 2007). Relation of landscape metrics with ecological processes, nonlinear dynamics and complexity of the landscape, the role of human activity in the development of landscapes are

the other major research topics of landscape ecology. Landscape-ecological research is actively developed in the largest landscape Russian schools. For example, Russian landscape scientists of Moscow State University research on ecological / geoecological state of landscapes is made in relation to anthropogenic impacts, dynamic processes, and environmental pollution (Annenskaya at al. 1997, Romanova, 2009). Therefore, modern landscape ecological research is characterized by the following tendencies as including of landscape ideas in ecology and environmental perspectives in landscape studies. It is in this direction landscape research in Belarus is developed.

Presented applied landscape subdivision and landscape ecological analysis were used for identification of some general regularity inherent for the problem regions of Belarus. Thus, both in Palesse and Paazer'e provinces urban-agricultural, agricultural and forestry-agricultural landscapes are characterized by high degree of anthropogenic transformation. Forestry-agricultural, forestry-agricultural in drained lands, swamp-forestry-agricultural landscapes are characterized by average level of transformation. Areas of low level of anthropogenic transformation dominate on forestry-swamp, forestry and swamp-forestry landscapes.

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