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GEOSYSTEMS GEOECOLOGICAL ASSESSMENT OF THE BASIN OF RIVERS FOR TOURIST VALORIZATION. CASE STUDY OF ILEK RIVER BASIN

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Nowadays in many regions of Kazakhstan a universal transformation of radical natural geosystems into geosystems natural and technogenic, especially used took place, i.e. directly or indirectly changed by economic activity of people, like e.g. industry, agriculture or development of tourism. In this regard geo-ecological researches are topical, especially for valorization and evaluation of tourism potential. This work contains conceptual and methodological approaches to ensuring geo - ecological assessment of geosystems. The analysis of the interaction of the natural, economic, social subsystems and control systems with modern geosystems, based on the ecosystem services, provided by natural subsystem demanded by society and economy. A model of technogenic geosystem and a series of the indicators reflecting properties, quantitative and qualitative features of each block of subsystems has been developed. Structural variations which arise in geosystem as a result of anthropogenous transformation let you establish quality of technogenic geosystem and to rank them from steadily functioning to the actively degrading.

Keywords: geosystem, geo-ecological assessment, anthropogenesis, technogenesis, GIS-technology, functioning of geosystem, tourism potetial

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INTRODUCTION

In recent years the geosystem - basin approach is actively being developed in the Kazakh, Russian (Zhanalieva, 2010; Ramazanova & Dzhanaleyeva, 2012), as well European geographical science (Wyżga et al. 2012; Pantović & Stamenković, 2013; Obrenić et al., 2015) and involves development of new conceptual and methodological researches in regional geo -ecological researches of geosystems. One of the main features of basin approach is that the considerable part of the globe consists of the river basins of various ranks having properties, characteristic for any natural system: set of structures and functions, hierarchy of a structure, integrity, and ability to self-development. The most important feature of river basins is their dynamic activity defining change of ecological situations; it depends on intensity of an exchange of substance and energy between the adjacent geosystems entering them.

This circumstance allows to consider river basins as *para* dynamic systems which possess typological heterogeneity except landscape heterogeneity. Thus *para* genetic linkages are expressed during transfer of substances and energy from up to down, from radical slopes to the bed of the river, from a source to the mouth. From the given circumstance we come to a methodical conclusion, important for an assessment of geo-ecological situations, that the river mode, inundated alluvia and characteristics of a drain in the closing alignments are indicators of an ecological condition of the basin in general (Korytnyi, 1991; Zhanalieva, 2008), what play important role in tourism development or any other anthropogenic activities (Obrenić et al. 2015).

Nowadays in many regions of Kazakhstan radical natural geosystems transformed into technogenic geosystems, which caused directly and indirectly by economic activities of people, e.g. agriculture, industry and tourism. River valley are green channels with very high biodiversity and habitat for many species. These valleys are also a key element landscape. The changes taking place in their area, even those that apply only to the river, have an impact on the structure of the whole landscape (Wyżga et al. 2012). Evaluation of process of degradation support process of valorization natural values and tourism potential of natural landscape (Nahraoui, 2011; Angelevska-Najdeska, 2014).

According the growing importance of the development of tourism, this activity has increasing importance in the modern economy. The direction, intensity and scale of changes are diagnosed by the natural and anthropogenic processes operating in geosystem and by intra structural changes. In total they define a geo-ecological condition of modern geosystem which depends on intensity and an orientation of streams of substance and energy therefore it is expedient to carry out control and management of an ecological situation within this system on the basis of basin approach. And the ecological condition plays the basic role in evaluation of tourism potential (Ilieş & Wendt, 2015).

The analysis of the geosystem functioning intensity degree of intensive technogenic pollution zones is created at the first stage of geo - ecological assessment. That was done on the example of the Basin of Ilek River. For the realization of this task we had to make a landscape map of the territory of Ilek river basin. That was done on the basis of typological approach, and also the map of modern geosystem (Figure 1).

OBJECTS AND METHODS

As it is known, that the modern geosystem is a formation with complex structure, which fulfill definite functions and provides conditions of human's life activity. The definition and cartographical display of geo-ecological systems on the basis of these key sites recorded during field researches of 2013-2015 has been analyzed in the work.

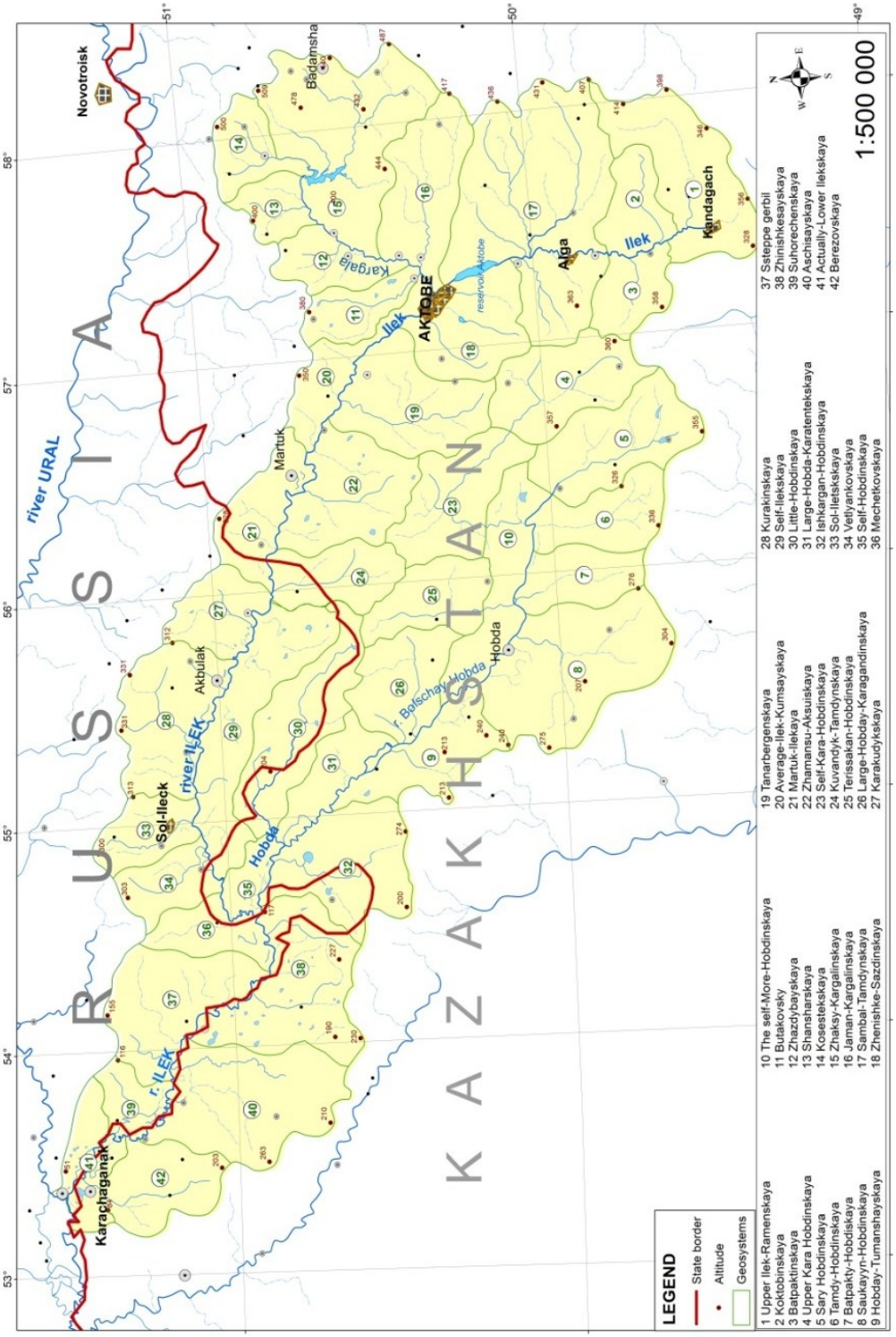

Figure 1. Map of modern geosystems of the basin of Ilek river

The technogenic geosystem consists of several subsystems, and the main of them according to time of formation and importance is – natural one. From the position of geo-ecological analysis natural ecosystem (landscape) is characterized by definite geo-ecological services and resources, which it provides to the society (this terminology is used in the fundamental work prepared according to UN International program "An assessment of ecosystems at a turn of the millennia"). This concept included various natural resources or properties, useful to the person, thanks to which in general there is possible an activity of society and the certain person as a species (Burenkov et al., 1997). Application of model of technogenic geosystem for a geo-ecological assessment of concrete geosystems demands indicators, the describing separate blocks of subgeosystem, their property or processes (Milkov, 1981).

Collection of information, its processing and formalization are necessary procedures for computer systematization of extensive volumes of information and creation of classifications of technogenic geosystems. As a part of natural subgeosystem it is a series of indicators of a lithogenic basis of a landscape (the morphological structure of a surface, the soil-forming material, etc.) the hydro climatic and biogenic indicators. They determine the natural and resource potential (NRP) of geosystem, on a basis by which series of the practical actions necessary for improvement of environment and further use of natural and resource capacity of the region are developed. Natural and resource potential is estimated from positions of various branches and sectors of economy: for industrial and residential development, for the solution of tasks water, recreational and agriculture. In each case specialized indicators are used.

The main objective of the research is solved on the basis of introduction of indicators of the ecological potential of geo-ecosystems, which is poorly used when studying degree of a disturbance of areas under strong techno genesis. The main agents at transformation and violation of interconnections in geosystem are the factors of a production activity: industries, development of minerals, residential systems, development of potential tourism. The results of functioning of production objects, exploration of natural resources can be agents of such types (for example, emissions of waste, volume of the biomass alienated with a crop, density of infrastructure networks) and others. Geo-ecological approach to the analysis of modern geosystem forces to include a social subsystem into the model in addition to natural and economic factors. Indicators of these blocks are usually integrated, each indicator is calculated with use of several indicators, and their values reflect significant impact they have on the state of geosystems.

RESULTS OF RESEARCH AND DISCUSSION

Geo-ecological quality of geosystem is understood as two of its characteristics:

1) a set demanded by society resource-making and the environment forming functions of geosystems;

2) consequences, arising at various technogenic and social influences.

The last quality depends on functions of natural geosystem, from that how successfully the geosystem copes with various anthropogenous processes, not peculiar to technogenic geosystem, but developing in it in response to the made impacts. Thus, consequences define a geo-ecological state of geosystem, degree of its stability under conditions of technogenic impact. These characteristics allow ranking geosystems from steadily functioning to degrading (Table 1). In each case information on indicators and indices is formalized, is entered into the ArcGIS10.1 program and processed according to a scale of assessment of geo-ecological quality.

Table 1. Assessment of geo-environmental quality of some of Ilek river basin geosystems

Geo-system	Type of geosystem	Economic development	Structural changes	Natural and anthropogenic processes	Quality
9, 23, 25, 27, 29, 31	Weak and concave plain with channels of permanent streams with feather- wormwood.	Deposits, pastures, sowing grounds.	90% – pasture, 10% - crops.	Weak erosive processes of plane wash out.	Steady
5, 6, 7, 8, 21, 22	Wavy - sloping plain with fragments of large natural levee trees.	Pastures, recreational areas, crop lands	70 % - pastures, 20 % - crops, 10 % - sat.	Blackness of pastures, deflation.	Moderated the steady
10, 26, 30, 40	Wavy - sloping plain with large beds of temporary and permanent watercourses. Natural and anthropogenic.	Fields of dry farming, pasture.	80% - an arable land, crops, 20% - pastures.	Intensive processes of plane washout, the territory changed by water and erosive processes.	The poorly steady
1, 2, 3, 14, 15	Erosion - denudation plain with hills and hollows in the dark chestnut soils. Natural and man-made.	Industrial blades, heath developed areas, hayfields, recreation.	30% - mining activities, 50% - open cuts, dumps, 15% - pastures, 5% tourism and recreations.	Point bar accumulation of the weighed particles, deflation, degradation goes on.	Not steady (the degrading)
17, 18, 41	diluvial- proluvial plain with dry sais with warmwood - aneurolepidium vegetation on dark chestnut soils calcareous technogenic.	Industrial zones, large settlements, wastelands anthropo-genic, fields of dry farming.	60 % - industrial and residential area, transport, 20% of wasteland, 10 % -dry farming field, 10% pastures.	Heavily degraded modified by erosion.	Not steady (strongly degrading)

Now the territory of the basin is characterized by high degree of industrial and agricultural production. As a result in huge volume various wastes are formed (liquid, firm, and gaseous). In 2013 total of the greenhouse gases which are thrown out in air by the Aktobe large plants (CO – 55,2 thousand tons, SO_2 – 89,4 thousand tons, NH_3 – 148 thousand tons, etc.). To soils and reservoirs of the territory at the same time 250 thousand tons of nitrogen and 50 thousand tons of phosphorus, apart from heavy metals came from different technogenic sources (The information and analytical REPORT, 2013). Annually on the territory of the Aktobe region 52477,72 tons of solid waste are formed, from them about 0,208 tons are processed (Kaz Waste, 2015).

However, the sources of common man- stimulated material flows on the basin sharply differentiated. Most part of emissions of gaseous issues comes to environment from industrial facilities and densely populated centers. Figure 2 shows anthropogenic impact of environment according to our researches. It is known that in large industrial zones practically all natural components – from a lithogenny basis, a relief, and geo-morphological processes to bioclimatic are exposed to radical reorganization. Technogenic geosystems represent natural and anthropogenic form with the most powerful impact on environment.

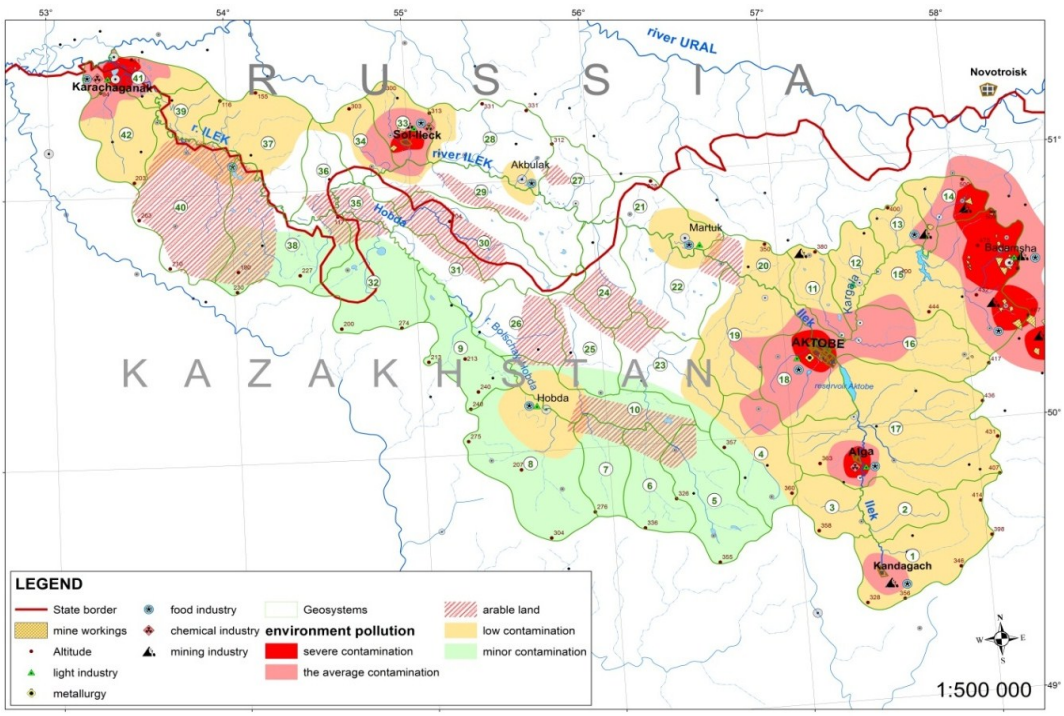

Figure 2. Map of anthropogenic intensity of geosystems of the basin of Ilek river

To assess the degree of anthropogenic impact on the ecosystem into account the parameters of a violation of medium components were evaluated geochemical changes. Finally got the classification model, the parameters of which are linked to certain anthropogenic load, differ in kind and degree of exposure (Table 2).

Table 2. Scale of valuation indicators of anthropogenic pressures on ecosystems

Index	Mark				
	0	1	2	3	4
Area of settlements (%)	not	≤ 10	1,0-2,9	3,0-7,0	≥ 10
Population density (persons / km²)	not	≤ 10	10-20	21-30	≥ 30
Transportation load (km / km²)	not	≤ 0,1	0,1-0,19	0,2-0,3	≥ 0,3
The area of technogenic formations (%)	not	≤ 0,5	0,5-1,0	1,1-3,0	≥ 3,0
The area of arable land (%)	not	≤ 10	10-40	41-60	≥ 60
The area of pastures (%)	not	≤ 20	20-40	41-70	≥ 70

To determine the degree of anthropogenic loading and transformation of all types were introduced ballroom expert assessment showing the relative degree of anthropogenic transformation.

For this purpose, the normalized indicators of anthropogenic pressures on ecosystems (Vaganova & Kovalchuk, 2012; Jasinski, 2000; Ryumin, 1990). The following rules limit the use of environmental Geosystems allow us to rank the territory according to the degree of anthropogenic load on geosystems, and, moreover, reasonably use the results to optimize the structure of nature.

In assessing the degree of anthropogenic impact on the ecosystem of the quantitative indicators for each parameter were translated into scores (0 to 4), which are then summed. The result of the summation is an integral indicator (U), the proposed K.M. Petrov (1998:157), the formula (1):

$$U = \frac{1}{n} \Sigma xi\ ki, \qquad (1)$$

where:

n - the number of factors;
xi - Scoping i factor;
ki - i weighting factor.

The weights are established by experts, based on the ranking of indicators on the extent of human impact on geosystems. Indicators characterizing these factors formed the basis of the zoning (ranking) of the basin on the degree of anthropogenic impact. Upon receipt of the integral indicator (U), the following graduation degrees of anthropogenic impact on geosystems: <0.5 - insignificant in points; 0.5-1 - small; 1-2 - mid; 2-3 - intense, 3-4 –extevely.

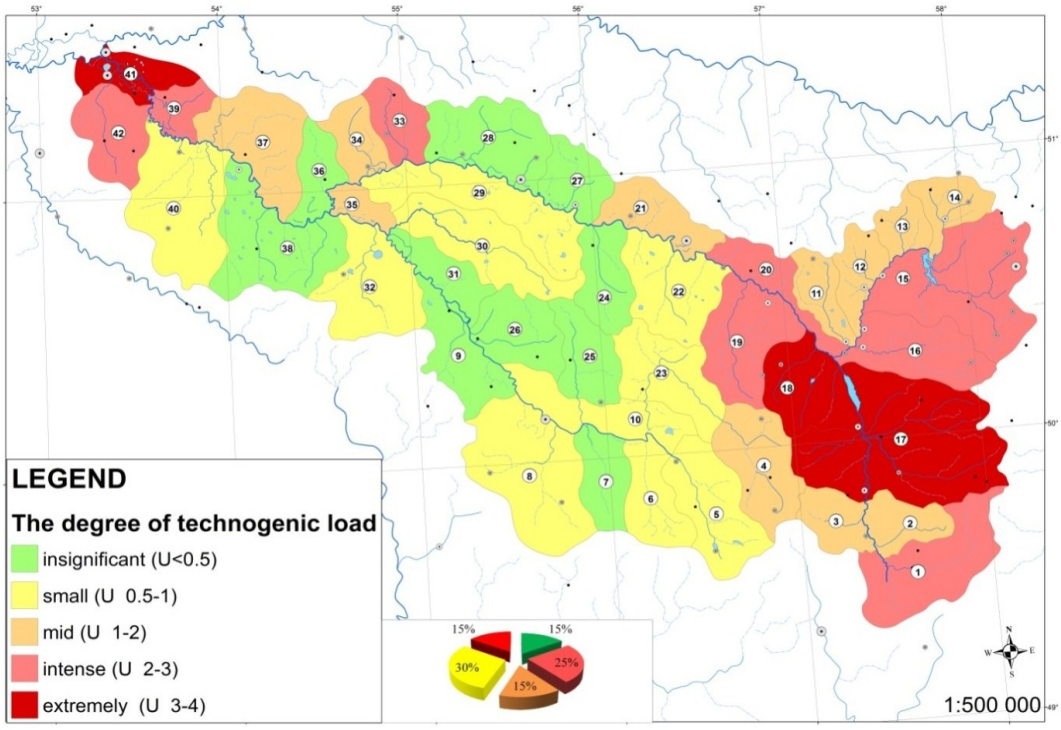

Figure 3. The map of geosystems degree of change under technogenic influence

As a result, spatial modeling of natural and anthropogenic factors produced a set of raster maps in a single coordinate system is a continuous surface distribution of the estimated parameters. Now all component geo-ecological information on 12 indicators of

functioning of ecosystems is entered into database program ArcGIS10.1 on the basis of which integrated characteristics of consequences of economic impact on geosystems by the algorithm described in the book (Tikunov, 1997). According to the materials of a database and calculations a series of cards on the territory of the basin of the river Ilek is created. In this piece of work the technique developed by the grant of the Russian Scientific Foundation was used (Project No. 15-17-30009).

The integral assessment of geo-ecological quality of geo-ecosystems is based on the following assumption: if at least one of ingredients of pollution excess of critical levels was found or intensity of anthropogenic processes became catastrophic, such complex belongs to category of the degrading. To determine the degree of anthropogenic impact on the river basin ecosystem Ilek us areal considered indicators of disturbed land to create a comprehensive assessment of the ecological state of the card geosystems in scale 1: 500 000 (Figure 3).

CONCLUSION

Development and processes of anthropogenic load on the basin clearly illustrated geosystem transformation of the natural environment. Unstable water regime of rivers, annual fluctuations in water availability caused significant changes hydromorphic geosystems. They endure various stages of change under the influence of technological processes and acrogenic changes. Besides the morphology developed on lithological formations, the morphology generated by anthropogenic activities is also a significant recovery with geotouristic potential (Gavrila et al., 2011).

Geosystem approach became the main thing at an assessment of influence of processes of degradation of geosystems in the formation and development of new ecological situations, identifications of the centers of geo-ecological tension. Evaluation of process of degradation support process of valorization natural values and tourism potential of natural landscape. Accumulated in the geo-ecological research, information about the structural organization of geosystems of the basin of the river Ilek allowed to come to a conclusion about the need to consider the fact of their dynamic states on the basis of a temporary system analysis. Carried out the assessment of the tourism potential of river basin Ilek clearly it shows them a small role in the development of tourism. However, studies are a good tool to evaluate any basin river from the point of view of its tourist value and suitability for tourism (Nawieśniak et al., 2015).

The developed model of technogenic geosystem and the cartographical model created on its basis in the ArcGIS10.1 program, allows to analyze one of the most important industrial regions of Western Kazakhstan for identification of the existing geo - ecological systems and their high-quality differentiation. The considerable part of geosystems of the basin of the river Ilek is in a state of strong tension. The most changed geosystems function in techno agro-industrial hubs, created by city agglomerations (Aktobe, Kandagash, Alga, Sol – Iletsk, Khromtau, Nikeltau and others).

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