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LANDSCAPE AND RECREATIONAL ANALYSIS OF YERTIS RIVER UPPER PART ON THE BASIS OF BASIN APPROACH (KAZAKHSTAN)

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Abstract: Structural-functional relationships of geosystems in geosystem classification in the river basin are relied on through systematicity concept. As single geosystem, river basin is supercomplex, exo-regulated, impulsively-dynamic geosystem, limited by two special types of surface: threshold - vertical (for example, glacial area) and contact - horizontal (floodplain). In our opinion, in studies of geosystems of seepage flow it is needed to considerate elements of macro and micro substrate levels of geosystems, not traditional component blocks because surface flow is differentiative factor besides of lithogeneus base. Elements of macro and micro substrate levels of geosystems are parameters of water and heat balance, productivity and yield capacity of phytomass. The purpose of the present article is to study geosystems of the basin of the Yertis river upper part. We regard the geosystems of the unified inter-continental rivers formed by water discharge as paragenetic and paradynamic complexes in the context of the increasing lack of moistening due to natural and anthropogenic factors. These natural complexes develop under the influence of two mutually conditioned leading differentiation factors – a lithogenic base and a river flow. These and other physical-geographical conditions forming the

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river basin enable to define the region as a unified mega-system. The article identifies basic regularities of the transformation of the natural environment of the Yertis river upper part basin. The methodological approach accepted by the authors to the study of modified systems is the theoretical concept of geosystem-basin approach to the study of anthropogenically-transformed systems. Either the following research methods were used: geosystem-basinal, statistical analysis, landscape-structural analysis and maps were compiled with the use of GIS on the ArcGis software.

Key words: research, landscape, river basin, geosystem, landscape, basin approach, macrogeosystem

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INTRODUCTION

According to V.N.Solntsev (Sochava, 1963), supercomplexity and impulsive responsiveness and exo-adjustablity of geosystems of low ranks on all the levels of geosystem organization of the whole macrogeosystem ground on three basic types of geosystem structures: 1) vector, 2) honeycombed, 3) iso-potential types (table 1) of geosystem structures. Such polystructure of geosystems is explained by availability in basins of complex structures of circulatory, radiating features which are fundamental in the system of interrelation - plain-mountain and due to availability of a "barrier effect", greenhouse effect and also other complex geographic processes arising in conditions of one macrogeosystem, with universally-oriented geoflow. The genesis of three types of structures is connected with types of physical-geographical processes occurring in the basin: the first type - structures with external (insolation) processes determined by solar power inflow, vertical flows generally conditioned by the latitude of the region, northern and south facing, the basin and water-dividing positions of geosystems. The second type is with intrashell (circulating) processes. Low-mountain reliefs and subgeosystems of foot hills refer to the second type. The third type is connected with intra-ground (gravitational-tectonic) processes. They include the geosystems of flow forming zones (table 1).

Table 1. Types of landscape structures of geosystems according to V.N. Solntsev, 1948

Forming factors	Types of landscape structures	Physical-geographical processes
Zonal factors	Vector	External (insolation)
Zonal-azonal	Honeycombed	Intrashell (circular)
Azonal	Isopotential	Intra-ground (gravitational- tectonic)

This concept generalizes a range of old-established geosystem statements: independence of zonal and azonal geosystem differentiation A.G. Isachenko (Isachenko, 1981), genetic relation of altitudinal latitudinal zonality A.D. Armand (Armand, 1975) availability of catchment-based forms of geosystem orderliness F.N. Milkov (1967). Theoretical concept of relations of these three types of geosystem structures is well clarified by Solntsev books etc. Macrogeosystem of river catchment is considered by us as geosystem with territorial stability due to lithogenous frame with high biota plasticity which is connected with dynamics surface flow (Berdenov et al, 2016). In conditions of rivers basins of Upper part of Yertis river, simple lithologic and petrographic characteristics of mine rocks is not enough for clarifying of their systemically important role. It is needed to get compositional analysis and modes of occurrence of territorial composite of mine rocks Perelman, (1964) suggested idea on single and heterogeneous geosystems, the second one means geosystems, formed on different mine rocks; "geomorphological complexes"

(Isachenko, 1990). According to N.A. Solntsev (1975) these perceptions are unavoidably joined to famous definition of geosystem. All these factors, as in the case of other regions, affect the possibilities of tourism development, as is the case in the lake regions (Wendt, 2016; Atasoy et al., 2017; Mazhitova et al., 2018a; Nazarova et al., 2019).

AIMS AND BACKGROUND

Analysis of field expedition studies (July-August 2018), generalization of stock materials, excursion method, as well as methods of landscape mapping, interpretation of satellite images of key areas and route survey, geochemical and geophysical methods, paleogeographic ones, etc. (Mazhitova et al., 2018b; Kabiyev et al., 2018; Ramazanova et al, 2019). All cartographic materials and models were made by ArcGIS 10 software. The territory of East Kazakhstan has passed a very long and complex way of geological development. In this regard it is characterized by structural-tectonic heterogeneity.

In view of that modern hydrogeological processes are determined by the nature of Paleozoic and pre-Paleozoic structures and ancient relief and the manifestation of young tectonics (Chlachula, 2011, 2017). The territory under study in the Alpine cycle of tectogenesis developed in isolation against the background of a larger geostructure which received the name of the Alpine geotectonic system of Altai. Within the latter three major tectonic structures of the first order are distinguished: the Altai arch uplift (Altai arch), the pre-Altai trough and the outer chain of the Altai uplifts (Nekhoroshev, 1914).

The described tectonic zones of Altai are at the same time its main orographic systems which play the role of watersheds of the largest Altai rivers. From the North, North-West, South-West and South the Altai arched uplift shares borders with an equally large young negative structure called the pre-Altai trough, which has a horseshoe shape facing the West with the convex (outer) side. Its foundation in the greater part of the area is composed mainly by Hercynides. As the structures of the second order within the Pre-Altai trough the following ones are found: the Kulundi depression, Semei-Scharsk structural closure, Zhaisan depression (Figure 1). Yertis macrogeosystem which is a constituent part of the Kara-Ob megageosystem on the territory of the Republic of Kazakhstan is represented by four subgeosystems which unite the basins of many tributaries of this river the permanent or temporary flow of which is directed to the river Ob. They include native Yertis, Yertis-Shulba, Yertis-Buktyrma, Yertis-Zhaisan subgeosystems. The North-Eastern watersheds of the Yertis-Buktyrma subgeosystem are represented by the Koksu ridge and Listvyaga whose morpho-structure is close to Alpine features. The tributaries Ertis, Uba, Ulba have their rise from the southern slopes of the Koksu ridge forming the native Yertis sub-geosystem. Along the southern slopes of the Listvyaga ridge and the Ulba ridge the rivers Buktyrma and Naryn flow whose basins form the Yertis-Buktyrma subgeosystem. The river Kurshym, a tributary, flows from the southern slopes of the Naryn ridge (abs. h. 3375 m). The Kaldzhir river, the right tributary of the Kara Yertis, the flow of which is regulated, has its rise from the high-mountain lake Markakol. The basins of these three rivers form Buktyrma, Uba and Kurchym subgeosystems, the functioning of which has an effect on physical-geographical processes of the whole Yertis macrogeosystem. The watersheds of the southern edges of the Yertis macrogeosystem are occupied by the mountain ridges of the Tarbagatai ridge having insignificant amplitudes of neotectonic movements. The south-west watersheds are represented by the low mountains Shyngyztau (Yedrei, Arkat, Murdzhick, etc.).

The north-east part of the subgeosystem is occupied by the edges of the West Siberian lowland - the Kulunda plain. Tectonically the southern part of the Yertis macrogeosystem presents an arch-like Neogene-lower Quaternary uplift formed on the location of Hercynian structures. In the Pleistocene these areas underwent glacial period (Djanalieva, 2010). The Northern edge of the macrogeosystem's region refers to the West Siberian plate.

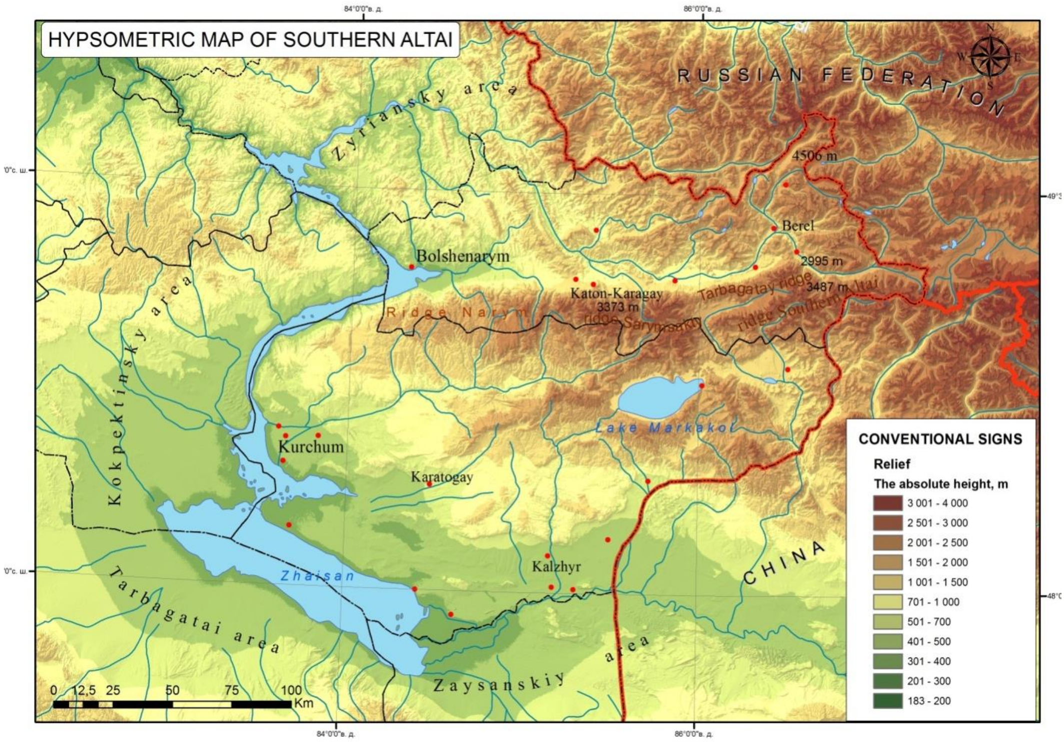

Figure 1. Hypsometric map of South Altai

The high-altitude strongly dissected relief of the southern edges of the region gradually passes into the rolling-undulating plains of the middle reach of the Yertis. Absolute marks vary from 235 (the mouth of the Uba river and the Alei river valley) to 2000 m (at the tops of the "whites"). The surface of Yertis macrogeosystem with gentle incline to the North is characterized with rather compound form of the terrain. Often flat crests alternate with gentle slopes, small closed depressions, sometimes arranged in chains. The largest basins are associated with tectonic movements (the Teniz lake). Neogene deposits are represented by two suites - lower Miocene (Aral Suite) and middle Miocene (Pavlodar Suite) (Djanalieva, 2010). The first one is of lake origin – saline green clay with gypsum, the second one consists of lake-marsh and alluvial sediments of red color with gypsum. Quaternary deposits are widely represented, their thickness depending on local conditions of accumulation and destruction varies from 0 to 100 m. The most common deposits are sandy, alluvial, lake-marsh accumulations of different mechanical composition and cover yellow-brown carbonate clay loams of loesslike appearance.

EXPERIMENTAL

Groundwater, soil and climatic conditions, rivers, lakes and biodiversity play an important role in the structural analysis of the landscapes of the upper part of the Yertis river basin. The aim is to study the nature and dynamics of geoecosystems of landscapes of the upper part of the Yertis river basin impacted by modern anthropogenic factors (technogenesis and agrogenesis) on the basis of geosystem-basin approach. Groundwaters are non-saline. The most aquiferous are the Cambrian-Sulirian limestones where the water is of the fissure-karst type, hard. Clastic glacial and alluvial deposits are also aquiferous. Alluvial strata of ancient river valleys are characterized with formation waters. The waters have a weak chloride-sodium salinity. The Yertis macrogeosystem is characterized with great variety of soil and climatic conditions.

In the Yertis-Zhaisan subgeosystems with very dry North winds and the dominance of ephemeral desert vegetation the appraising points of soil and climatic conditions are less than 40. Mountain areas of subgeosystems of the Eastern edges of the macrogeosystems refer to the humid mountain agro-climatic zone and are estimated at 100-130 points. Further to the North, they drop to 60-80 points. In addition to these tributaries the Shar, Shagan, Aschisu, Kyzylsu rivers flowing into the Yertis are of importance in the physical and geographical situation of subgeosystems. Some of them have outlined above-flood terraces, but the flow in them is unstable (Shagan, Aschisu, etc.).

According to the regime the rivers refer to the Altai type. The rivers' feeding is mixed, due to the melting of seasonal snow and summer rains, with exception of the Buktyrma river which has a glacier-derived feeding. The rivers Kurshym, Buktyrma function as timber-rafting rivers. All the rivers (with exception of the Yertis) have a hydrocarbonate composition of water during the flood and a chloride composition during the water-low season. In the said period there is an increase in mineralization in 2-5 times. Modern glaciation is developed in the Katun ridge, in the sources of the Bereli and Sarymsakty rivers. The average annual runoff depth fluctuates from 1000-1500 mm (in the zone of macrogeosystems runoff formation) and decreases to 2-5 mm in the transit zone (Burlibaev, 2014). The average long-term water consumption makes up 895 m3 / s with a catchment area of 179 thousand km2. The average annual water supply of the Irtysh macrogeosystem, which is formed within the Republic of Kazakhstan, is 200 thousand km3 per 1 square km in the zone of flow formation (Zhakupov et al., 2014).

The average dates of the flood on rivers with average catchment heights up to 1000 m comes on April 1, with a height of up to 2000 m-on April 20, and with a catchment height of more than 2200-2500 m. The flood starts in May. The rise of the flood on the rivers and temporary streams on the flat, hilly-low-mountainous regions of the Upper Yertis basin is rapid. After 10-15 days the maximum is reached and after 15-20 days the flood is over. On the rivers of the second type the flood is less high, stretched in time. The maximum of its height the flood reaches in the period from April 25 to May 5, and ends in late June-early July. The type of flood is spring-summer. The floods commence in the period from April 10-March 31 in the zone of flow formation and April 5-10 in the transit zone. The flood is over on July 31 and May 15 respectively (Galperin, 2012).

The Kara Yertis River, which has well-developed valley, is the main water way of Kalguty-Takyr and Shorga-Kosty sub-geosystems. This river forms waterlogged estuary when flowing into the Zhaisan lake. The Zhaisan lake takes ancient valley of Yertis. Lake waters are nonsaline, flowing. After construction of Buktyrma hydro-electric power station and the reservoir, backwater effect in upper part expanded along the Yertis valley to Zhaisan, so the level of the lake rose up to 388m resulting in the flooding of low lands and the Kara Yertis delta. Kaldghyr, Kurshym, Kendyrlik and other rivers flow from slopes of the nearest mountains. Many of them dry up in low water season (Zhensikbayeva et al., 2017, 2018). Ghaysan big lake forms Yertis-Ghaysanskaya sub-geosystem, also Ghaysan is young geological feature. Tourist resources such as landscape, climate, hydrographic characteristics, biological diversity, are very important for tourism development (Ilieş & Wendt, 2015).

The lake Markakol is located at an altitude of 1449.3 m. above sea level. Markakol-Karakaba subgeosystems function in a strongly dissected topography. The slopes of the middle height mountains facing the lake are occupied by mountain-tundra, mountain-forest and mountain-meadow-steppe natural complexes. Geosystems function in conditions of increased humidity. Geosystems formed by 27 small rivers (Topolevka, Karabulak, Matabay, etc.) have a stable character. Ultra-fresh, slightly acidic water of lake areas forms geosystems of calcium group. To protect the biota, the Markakol natural reserve (Nekhoroshev, 1914) was organized in 1976 [12].

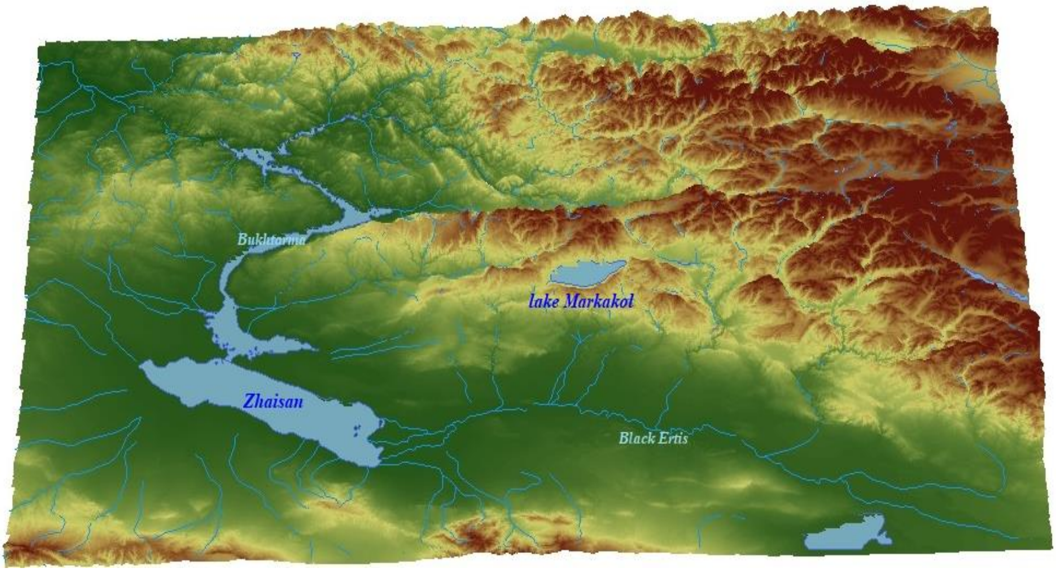

Figure 2. Devisualization in ArcScene 10 program
of the Markakol lake area of the Southern Altai region

Geosystems at an altitude of 1760 m above sea level are formed by lake geosystems of the lake Rakhmanovskoe, surrounded by forests of larch, cedar and spruce. The lake is flowing, has the depth of 30 m. the Average annual fluctuation of the water level is 1.5 m.

Geosystems of the lowest rank are formed in the zone of flow formation in the conditions of mountain-tundra, mountain-meadow, mountain-forest, mountain-steppe high-altitude zones. The northern mountain ridges of the macrogeosystem are characterized with forests of Siberian fir and larch.

Geosystems, linked to the transit zone of the flow, develop in conditions of the steppe zone. Geosystems of flat plains dominate, with numerous suffosion and relict thermokarst depressions and runoff hollows that causes weak drainage and a complex combination of swamping and salinization processes. The instability of watering, its intra-annual fluctuations result in an alternate strengthening of these or the other processes.

Markakol natural-recreational area. The allocation of this province is based on the location of the lake Markakol in it. In Kazakhstan, this is the largest high mountain lake. To the north of the lake is the high mountain ridge Sarym-Sakty, whose maximum height is 3373 m. Along the northern coast of the lake there is the mid-altitude Kurchum ridge, in its middle part an array of 2645 m high rises. Along the southern shore of the lake is the Azutau ridge with an absolute height of 1800-2300 m. The lake is of tectonic origin. The southern shore is steep, formed by the edges of the ridge that fall directly into the lake. The northern coast is low, formed by the newest deposits. The length of the lake is 38 km, the width is 18 km, the maximum depth is 27 m. The catchment area is 1180 km2. The mirror of the lake is at an altitude of 1485 m. The landscapes of the area are picturesque. Larch forests predominate, on the northern slopes there are cedar-fir-aspen taiga, and on the southern slopes there are many rocks, between which are steppe lawns.

Tourism here should be of an ecological nature (Zhensikbayeva et al., 2017; Saparov et al., 2016). Nonsaline soils dominate in the Yertis-Buktyrma subgeosystem. Salt marshes are found on the shores of salt lakes, and meadow species - in the valleys of some rivers. The general direction of geochemical flow in this subgeosystem is from South to North, and the amount of saline soils in this direction gradually decreases. This situation is explained by a change in the precipitation-evaporation ratio, primarily due to a decrease in evaporation. This phenomenon is called inversion of salt belts. The main type of soil salinization is sodium sulfate. The tendency of increasing the area of saline soils does not cross the toxic threshold. The biological cycle and productional processes in the biota of the Yertis macrogeosystem are characterized by a high contrast associated with the diversity of habitat areas of communities. According to long-term stationary researches in Barabinsk forest-steppe, stocks of live phytomass of a meadow steppe on ordinary chernozems (tops and the top slopes of crests) make up 16,4 C/ha (including 2,2 C / ha above-ground part), annual productivity-19,0 C / ha (including 4,0 C / ha of the above-ground weight). The maximum productivity was noted for floodplain reedgrass swamps (63.7 C / ha), the minimum - for grass thickets on meadow salt marshes (3.1 C/ha). Birch outliers on crests produce 9 C / ha (7 C/ha of above-ground parts) of the phytomass, and in inter-crest depressions-13.8 C / ha. Reserves of ash constituents and nitrogen in the live and dead organic mass of the Yertis macrogeosystem make up 570 kg / ha in meadow-salt marsh communities, 1600 kg / ha in meadow steppes, 9200 kg/ha in reedgrass swamps. Up to 80% of mineral elements are concentrated in underground organs. 1013 kg/ha of ash constituents (CA, Na, K, Si), 175 kg/ha of nitrogen are consumed for the creation of annual production in the meadow steppe, in the birch outliers of the inter-crest depression it is much less (up to 454 kg/ha).

The meadow steppe is marked by a high intensity of metabolism, the biological cycle is almost closed (Dghanalyeyeva & Bayandinova, 2003). The soil cover in the hollows and lowlands is mottled. In the North of the Yertis macrogeosystem leached chernozems predominate in the watersheds under the settled meadows; in the South semi-hydromorphic meadow-chernozem soils are common under the meadow steppes. Various halophytic variants of meadow steppes are common along riverbeds, on floodplain terraces.

Grey forest solodic soils are developed under birch outliers on crests, soloth soils are developed on kettles. Floodplain terraces of all subgeosystems are represented by low-land alluvial clay and loamy plains, as well as ancient lake-alluvial plains with flow hollows. Low terraces, hollows, the lake basins of Markakol-Karakaba subgeosystems and Yertis-Zhaisan subgeosystems are featured with widely distributed halophytic types of the steppe - feather grass-fescue steppe with halophytic motley grasses and fescue goldilocks steppes on salt marshes. The Bugaz-Tebesty subgeosystem is characterized by low-land alluvial and Aeolian sandy plains along sandy flood-plain terraces and ancient estuaries, often with dune-bumpy and bumpy-ridge sands, semi-fixed groupings of sandy feather grass, fescue, meadow oat grass and psammophytic mixed grasses on underdeveloped dark chestnut and chestnut soils (Bayandinova, 2003). Yertis-Shulba, Yertis-Buktyrma, Yertis-Zhaisan subgeosystems cover geosystems linked to the Kara Yertis valley, the lake Zhaisan and Buktyrma reservoir. They have features typical to Central Asian semi-desert. Areas with the lowest elevations are presented with a hillside plain with tasbiyurgun-wormwood vegetation on brown soils. Valley geosystems of the Kara Yertis: Kalgaty-Takyr, Shagan-Ob-Zharmy, Shorga-Kosty, Bugaz-Tebesty, Zhuzagash have saltwort-wormwood plant communities, and lakeland winnowed sand massifs have erkek-takyr communities.

The high terraces of the Kalgaty-Takyr subgeosystem are occupied by sagebrush-grass associations formed on light chestnut soils. Higher according to the high-altitude zones of Shorga-Kosty subgeosystems they change their look from mountain-tundra, mountain-meadow to mountain-forest and mountain-steppe ones.

CONCLUSION

Previously geographical works on the study of the structure, dynamics and development of landscapes of the upper part of the Yertis river basin were as a rule through the example of long-evolving and at the moment relatively stable landscapes. The assessment of the landscape formation process and landscape functioning process of the upper part of the Yertis river basin is based on the features of their morphological structure. Having considered physical and geographical features of landscapes of the basin of the upper part of the river Yertis it is possible to draw the following conclusions:

- The natural complexes of the Yertis-Zhaisan subgeosystems differ sharply from each other by modern physical and geographical processes owing to different conditions of formation of the entire geographical flow which is based on surface and underground flow;
- Technogenesis factors modified the natural potential of the region and its ecological situation to different degrees. Buktyrma, Kurchym, Kalguty-Takyr subgeosystems develop impacted by toxic substances, which are decay products of emissions from the enterprises of nonferrous metallurgy.
- Water and land resources, air basin of urban agglomerations of Ust-Kamenogorsk, Zyryanovsk, Ridder, Serebryansk are contaminated with zinc, lead, mercury, beryllium salts. Of particular note is the high rate of lead pollution (3.3 MPC); the Huge rate of industrial and agricultural production of the Yertis macrogeosystem intensifies the negative environmental situation;
- Irregularity of modern technical equipment in the context of market economy, widespread destructive, irrational use of natural resources have caused the development of adverse natural and anthropogenic processes on large areas. All that resulted in the phenomenon, which received the name "ecological crisis" in the scientific literature;
- The problem of protection of geosystems from negative processes of technogenesis has become one of the most important practical and natural - scientific issues in the Republic of Kazakhstan. However, there is a certain contradiction between the social nature of environment protection and private activities of many enterprises of non-ferrous metallurgy, which makes it difficult to solve the environmental problems of the region. Further research on the territory of the upper Yertis river basin with practical results will provide opportunities to improve the sustainable development of recreational activities in this unique Ecoregion.

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