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Article

Analysis of impact of anthropogenic factors on the landscape-geochemical state of the Nura river basin

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Abstract. The study examines the formation of anthropogenic landscapes under the influence of multiple factors, including pollutants, radioactive substances, radiation, noise, and the extraction of natural resources. Society's transformation of natural landscapes into anthropogenic ones has become a global phenomenon, acquiring new characteristics due to scientific and technological advancements in mining, industrial chemistry, and agriculture. The Nura River basin, dominated by the metallurgical complex of Qarmet, serves as a key area for this investigation. This enterprise is the largest mining and metallurgical facility in Kazakhstan, producing a range of materials, including coated metals and raw industrial products. Geochemical analyses were conducted within the Nura River basin to assess the environmental impact of industrial activities. Water and soil samples were collected systematically, and pollutant concentrations were determined using accredited laboratory methods. Data were processed through statistical analysis to identify patterns and causal relationships.

The research revealed significant pollution in the Nura River basin, predominantly caused by industrial discharges containing heavy metals and other contaminants. Elevated concentrations of pollutants were linked to the metallurgical activities of Qarmet and other industrial enterprises. The transformation of natural landscapes into anthropogenic ones was found to be closely associated with the intensity of these activities.

The study highlights the critical influence of industrial processes on the geochemical composition of landscapes within the Nura River basin. The findings underline the need for improved environmental management, including the modernization of industrial processes and waste treatment systems, to mitigate anthropogenic impacts and ensure sustainable development in the region.

Keywords: landscape, anthropogenic landscapes, environmental degradation, pollution, environment.

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Introduction

Increasing influence of technogenic factors on the natural environment creates a different background of reverse reactions of landscapes in the processes of their self-regulation. Consequently, the "typification" of geo-ecological situations on a landscape basis will lead to even more unreliability of scientific research. In this regard, most physical geographers [1] recognize the prospects of a functional-holistic approach ("the third way") towards differentiation of the natural environment and the geosystem-basin approach as its leading component.

Classics of the theory of techno genesis [1, 2] consider the basin as the main unit for calculating the balances of pollutants, self-cleaning of natural environments, migration of toxic elements, etc. This circumstance is one of the main reasons for applying the geosystem-basin concept in nature management. The origins of ideas about the basin as an integrated natural object found in the middle of the XX century in the works of representatives of the branch of sciences physical-geographical cycle. R. Horton and A.A. Virsky substantiated the idea of the pool as erosion complex, I.A. Titov as theoretically system, P. Balovich - a special complex of "functional aggregates", created as a result of migration of the substance. The result was summed up by the hydrologist S.D. Muraveysky, who, emphasizing the importance of integrating processes, and first of all, the flow process, stressed that without transport, without movement, there can be no mutual relations, interactions. Atalay in his work linked the boundaries of natural complexes with the boundaries of flows, areas of removal and introduction of matter [3,4] considered river basins as cascading systems, coupled with flows of matter and energy so that the output of one of them forms the input of the other.

The main focus was on finding out balance ratios, equilibrium conditions, development and management trends. Approximately in the same years, a synthesis of positions concerning the basin was undertaken by both representatives of complex and branch physical geography and hydrologists, as well as the main provisions of the doctrine of geosystems [5]. Noting the advantages of this approach, L.M. Korytny assesses the catchment area as "a special spatial unit of the biosphere, the most promising for the multidimensional study of nature and Economics and for environmental management".

The main industries that determine market specialization within the territory of the Nura River Basin are the metallurgical complex. Arcelor Mittal Temirtau Joint Stock Company is the largest enterprise in the mining and metallurgical sector of the Republic of Kazakhstan and is an integrated mining and metallurgical complex with its own coal, iron ore and energy base. Qarmet JSC specializes in the production of flat and rolled section steel, including those with polymer, zinc and aluminum coatings, and also produces agglomerate, iron ore and coal concentrate, coke, cast iron, steel, including continuously cast slabs, strips, and side members, electric-welded pipes and related products of blast furnace and coke-chemical production.

Materials and methods

Many scientists have developed a methodology for assessing the nature and depth of anthropogenic transformation. To assess the performance criteria, modern land use is used, but the state of the geosystem is the result of intense impacts. According to Glazovskaya, in order to see the picture of anthropogenic variability of geosystems, one must bear in mind the anthropogenic influences in areas where processes of technogenesis are active at which geochemical change happens [6]. The study of the impact of anthropogenic factors on the landscape-geochemical state of the Nura River basin involved a systematic and interdisciplinary approach. The Nura River basin was selected as the study area due to its ecological significance and proximity to major industrial facilities, including the Qarmet metallurgical complex. The region is characterized by significant anthropogenic pressure from industrial, agricultural, and urban activities.

Water and soil samples were collected from key points along the Nura river and its tributaries. Sampling sites were strategically chosen to capture variability in pollution levels, both upstream and downstream of industrial discharge points. Surface soil samples (horizon A1) were gathered from locations identified as hotspots for industrial and agricultural activity, following a grid-based approach with additional targeted sampling near identified pollutant sources. Sampling was conducted in multiple seasons (spring, summer, and autumn) to account for seasonal variations in pollutant levels.

Water sample analysis focused on measuring pollutant concentrations, including heavy metals such as Cu^{2+}, Zn^{2+}, Pb^{2+}, and Hg, using atomic absorption spectrometry (AAS) at the accredited Kazhydromet laboratory in Karaganda. Additional chemical parameters, such as pH, sulfate ion content, and total dissolved solids (TDS), were also determined to assess the geochemical characteristics of water samples. Soil samples were analyzed for heavy metal content using X-ray fluorescence spectrometry (XRF) at the accredited EcoNUS laboratory in Karaganda. To evaluate soil contamination, the cumulative soil pollution index (Zc) was calculated to identify deviations from background concentrations of trace elements.

Geographic Information System (GIS) tools were utilized to integrate sample data into a unified cartographic framework, with spatial interpolation methods applied to create pollution maps of the study area. Experimental data were processed using variation statistical methods based on N.A. Plokhinsky's approach, calculating key indicators such as mean, standard deviation, range, and coefficient of variation. Microsoft Excel was employed for statistical analysis and data visualization. Comparative analysis was conducted by comparing the results with baseline values and established environmental standards to assess the extent of pollution.

Causal analysis correlated pollutant levels with anthropogenic factors such as industrial discharge data, land-use patterns, and agricultural activity. Historical data and previous studies were also reviewed to provide context for current findings. Quality control measures, including calibration of analytical instruments, duplicate sampling, and cross-validation of results with independent datasets, were implemented at every stage to ensure the reliability of findings.

This comprehensive methodology enabled an in-depth evaluation of the landscape-geochemical state of the Nura River basin, identifying key factors contributing to environmental degradation and informing strategies for mitigation and sustainable management.

The territory of the Nura River basin is located in the central part of Kazakhstan in the Karaganda and Akmola regions. The Nura River springs from the western spurs of the Kyzyltas Karkaraly-Aktau low-mountain massif at an altitude of 1000-1200 m BS. The total length of the river is 978 km.

Within the Nura River basin, fragments of individual landscapes were identified and shown on the map, which, as a result of their typological grouping, and then structural genetic classification, were ordered into hierarchical systematics. The following classification categories are distinguished by headings and subheadings in the legend: classes (plain and mountain landscapes), types (steppe and semi-desert landscapes), subtypes (north-desert landscapes).

Our medium-scale (1:500,000) landscape map of the Nura Basin was structured according to the structural-dynamic principle of community typification and reflects the genetic origin and classification hierarchy (Figure 1). Its main task was to demonstrate the spatio-temporal patterns operating in geosystems. The classification of geosystems and the creation of a landscape-based legend are based on a system-hierarchical approach to identifying the subordination of landscape taxons. The idea of geochemical research is the consideration of various natural substances and energies as a whole on the earth's surface. These flows are formed according to various degrees of complexity and stability and according to the types of functioning. The first task of geochemical research is the interaction between landscape components and the cycle of elements.

The territory of the Nura River Basin refers to steppe and semi-desert landscapes with biological information, water connections, and with intense direct air links. The average annual precipitation is 265 - 322 mm. Within the basins about 71 - 81% of the annual precipitation falls in the warm season. Winter precipitation is 19 - 29% of the annual amount. The maximum precipitation in the basin is most often observed in June-July, and the minimum falls in September.

Results and discussion

The basin territory is characterized by a large heterogeneity of soil formation conditions (climate, relief, vegetation, etc.). In the northern part of the massif, on the high plains, the southern rich black soils are formed, with preserved relict solonetzicity. Dark chestnut, chestnut and light-chestnut soils are widespread. Soil salinity is noted, participation of solonetzes in soil complexes, readily soluble salts appear in the second meter of soils. In the region of the Kazakh small hills, short-developed, underdeveloped crushed soils are widespread, and in the northeast region of low mountains, the mountain chestnut soils were formed, and the mountain rich black soils are in the north.

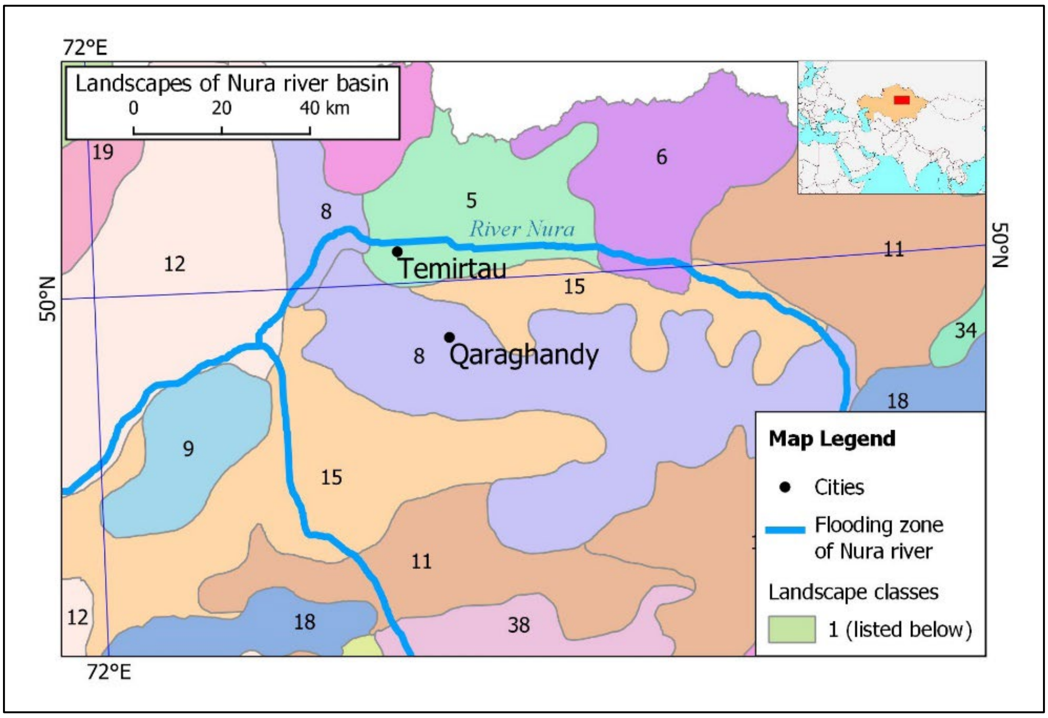

Figure 1. A fragment of the landscape map of the Nura River Basin

Table 1. Keywords to fragments of Nura basin's lanscape map (№ by map Figure 1). Geosystems Fragment description

Geosystems	Fragment description
Steppe zone Peneplains	5 - Riverine melkosopochnik, composed of effusive sedimentary rocks, with Austrianpole-tipchak-krasnokovylnaya vegetation with tavolzhniki on dark-shtane soils with steppe salt flats. 6 - Melkosopochnik is cone-shaped and dome-shaped, composed of effusive sedimentary rocks with tipchak-krasnokovylnaya, Austrian wormwood-tyrsovy-fescue, cold-wormy-fescue vegetation with shrubs, on normal chestnut with steppe solonetzes and underdeveloped soils.
Accumulative plains	8 - Lacustrine - alluvial plain with lacustrine hollows, composed of loam, sandy loam, loamy gravel, pebble-fescue vegetation with the couch-grass, bonfire, spicy, small reed grass communities with mixed herbs on dark chestnut solonetzic soil with steppe solonetzic and grass land solonetzes. 9 - Deluvially - proluvial plain composed of intrusive rocks with holopetrophytic wormwood - fescue with perennial glasswort and cocpec vegetation on underdeveloped light chestnut and short developed gravelly soils. 11 - Melkosopochnik is ridge-domed, composed of effusive sedimentary rocks, with shrub - petrophytous herbaceous and shrub - turf - grass vegetation on chestnut normal with steppe salt pans and underdeveloped soils. 12 - The melkosopochnik is hilly-withered, composed of effusive-sedimentary rocks, with Austrian-wormwood-type vegetation on dark-brown and partially chestnut soils. 15- Alluvial-proluvial plain, composed of effusive sedimentary rocks, with feathery-wormwood-fescue and mixed-feathering vegetation on underdeveloped light chestnut soils with steppe solonetzes. 18- Deluvial-proluvial dissected plain, composed of gravelly loams, clays, with holopetrophytic wormwood - fescue and cocpec vegetation on light chestnut, underdeveloped and short developed gravelly soils. 19 - Lacustrine-alluvial slightly undulating plain with feathery-wormwood-fescue, mixed-wormwood-feather-grass of mesoxerophilic grasses, on dark-brown saline soils with saline. 34 - Low mountains are heaped, composed of granites, granodiorites, porphyrites, with tipchak-kovyl-ovsets vegetation with the participation of kragana and meadowsweet on mountain dark-shtane and dark-shtane undeveloped soils. 38 - Low mountains composed of clays, loams with karagan-cold-wormwood- tyrsian vegetation on dark-chestnut, underdeveloped and short developed gravelly soils.

For the main dominant families, the following biogeochemical formulas are characteristic, compiled from the values of the concentration clarks of the most accumulating elements: cereals-Mo (Zn, Ag), Compositae-Mo (Ag.Cu), mallow-Ag (Mo, Sr), meadow steppe and marsh grasses (without legumes) –Sr, Mn (Zn, Mo), multi-colored –Sr (Mn, Ba, Zn, Ag), willow –Sr (Zn, Mn), birch Sr (Zn, Mo).

On the map of geochemical landscapes of the USSR by (Perelman, 1989), where landscapes of various classes of water migration of chemical elements and typomorphic elements characteristic of these classes, which determine the geochemical situation, are shown, the territory of the Nura River Basin, the most of the basin territory in the upstream belongs to the landscape of calcium-sodium (Ca - Na) class.

This class is characterized by low mountains and small hills, which belongs to the III genus. Wormwood communities are spreading here, water exchange is quite intense, with the predominance of mineralized fractured-ground waters of hydro-carbonate-calcium and sodium composition.

Under motley grass-grained petrophytic communities where biogeochemical and soil-geochemical mobilization of substances occurs in autonomous and traneluvial positions, thin gravelly black soils are formed. They are characterized by a neutral and slightly alkaline reaction, the fulvate composition of humus, the contrast distribution of the silt fraction in the profile with a sharp maximum in the humus horizon, and carbonless upper soil [7].

The main geochemical feature of soil formation on silicate rocks is the creation of a soda medium, where anionic elements and complexing agents acquire mobility. Calcium and calcium-sodium classes are characteristic of autonomous and transit-accumulative landscapes with a deep groundwater level. The main mechanism for the selective differentiation of anionic elements is the mobilization of soils of autonomous landscapes in the alkaline soil environment. The main mechanism for the selective differentiation of anionic elements in the soils of subordinate landscapes of the small hills is the mobilization of autonomous landscapes in alkaline soil environment.

Hard rocks are found on the steep slopes of the hills, and the functions of weathering and primary soil creating fine earth are performed by lichens. Between gravelly-fine-earth soils due to the mineralization of plant residues, brown humus-rich fine earth lies. Petrophyte vegetation was presented in the study area, along with herbs, shrubs are widespread [8].

On the territory with gentle slopes, wormwood and grass vegetation are characteristic. There is more percent of fine earth, often contains an illuvial solonetzic horizon.

Vegetation plays an important role in the migration and accumulation of chemical elements. The plant of the calcium-sodium class is characterized by high ash content (10-40%) and, after mineralization, enrich the surface horizons of soils with alkaline (primarily Na) and alkaline-earth (Ca, Mg) elements that increase salinity and soil carbonation. In low mountains and small hills, the lateral migration of trace elements is weakly expressed. In superaqually-accumulative landscapes of intermountain salt marshes, the microelements participating in the evaporation concentration (Sr, B, Mo) can accumulate. Many geochemical features of salt accumulation are determined in the process of regional groundwater migratio [9].

Solonetzic (Na - OH) landscapes on the territory of the Nura River Basin occupy eluvial-accumulative positions, where brown-solonetzic, gray-brown solonetzic soils and solonetzs, often saline soils, are formed under wormwood-saltwort communities. Soil salinization, residual or subaerial, biogenic salinization is important, especially with sodium salts, as in the ash of litter of shrubs (wormwood, saltwort), the sodium content reaches 7-10%.

The contrast of the radial geochemical differentiation of soils determines the alkalinity. Many chemical elements concentrate on sorption barriers (G3-G4), which are texture solonetzic horizons. Relict evaporation barriers (F3-F4) are typical in the lower part of the soil profile. The landscapes of the Nura River Basin are characterized by the following main types of geochemical barriers: evaporation - F-barrier, typical for the zonal type of soil and causes powerful secondary salinization, Na, K, Cs salts accumulate here, etc.; sorption - G - is formed at the contact points of aqueous solutions with natural sorbents, which are humic substances, hydroxides of iron and manganese [10].

From the moment of liquid atmospheric precipitation and from the intense flow of melt water, the chemical composition formation of the river water begins. It is enriched with soluble salts and organic substances in the process of water runoff along the surface of slopes and by contact with different soils and terrain over time. But the anthropogenic factor is currently the main factor in the formation of the chemical composition of surface waters. The most sensitive indicator of anthropogenic changes in the environment is natural water. Discharge of sewage and storm water from urban areas, flushing of fertilizers and pesticides from agricultural areas, dry and wet atmospheric precipitation to the surface of catchment areas are the main pollutants of natural waters. Water quality in the Nura River has seasonal dynamics: it sharply worsens during spring floods and in late autumn, after heavy rains, as a result of intensive washing out of humus from fields, residues of fertilizers and pesticides, as well as suspended solids. The main contribution to pollution and deterioration of water quality is made by discharges of insufficiently treated wastewater discharged from objects of various categories of water use -

industrial enterprises, utilities, etc. In addition to the above listed external factors, processes occurring directly in river waters have a significant impact on the hydrochemical parameters of the river (sedimentation, complex formation, oxidation or reduction of elements, etc.) [11].

Based on generally accepted methods, physico-chemical analysis of water samples (25 samples) for the content of individual pollutant ingredients in them was carried out in an accredited laboratory "KAZHYDROMET" in Karaganda. Physical and chemical analyzes of soil samples for the content of individual pollutant ingredients are made by the accredited testing laboratory "EcoNUS" in Karaganda.

A comparison of the results with the background values was carried out to assess the pollution of surface waters of the geosystems of the study area. When choosing key areas within the Karaganda-Temirtau industrial region to determine the extent of dispersion of the tested ingredients, water samples were taken at a frequency of 500 m before and after the point of sewage discharge.

Table 2. Variational and statistical indicators of distribution of heavy metals in soils of Nura basin

Parameters	$\bar{X} \pm \bar{S}x$	lim	*p*	σ	CV, %
	mg/kg				
Cu	884,44±8,8635	8,50-246,18	237,67	44,31	125,27
Zn	547,59±1,1699	9,02-41,35	32,33	5,84	26,70
Cd	8,91±0,0329	0,14-0,82	0,69	0,16	46,16
Pb	1550,10±8,9155	15,64-259,63	243,99	44,57	71,89

The average zinc content in the soils of the basin was 547,59±1,1699 mg/kg, with the limits range of 9,02-41,35 mg/kg. The minimum average content of gross zinc of 15,64 mg/kg is typical for chestnut soils in Taldyssay. Table 2 shows The deep penetration of humus is associated with the soil fracturing and, obviously, with its irrigation. The maximum zinc concentrations are characteristic of loamy soils in Karaganda. The average Cd content in the soils of the basin was 8,91±0,0329 mg/kg, the coefficient of variation was 46,16%. A correlation between the cadmium content and the pH of different soil types in most cases is absent. The effect of carbonates on the total cadmium content is clearly manifested in light chestnut solonetzic loamy soils (r = 0,60). In the remaining types of soils, the relationship is low and often the opposite.

Studies have established that an excess of the MPC of gross lead concentration is characteristic for clay soils in Karaganda, an excess of MPC of gross copper content is also in Karaganda. For most soils, a significant high correlation was revealed between humus and gross forms of heavy metals. The content and distribution of gross lead in soils and the correlation dependence on the silt fraction, carbonates, and pH of the media in most cases are absent or have a weak strength relationship.

Thus, a significant heterogeneity in the content of chemical elements in the basin soils was revealed, which is due to the contrast of soil-forming rocks, the physicochemical properties of soils, landscape and geochemical conditions of migration and accumulation of elements.

Near the Karaganda-Temirtau industrial region, where the detected distribution of heavy metals is performed on the basis of a detailed landscape-geochemical analysis of the territories located in the zone of its influence. The industrial unit led to the transformation and complete destruction of natural geosystems and the emergence of specific artificially created territories. The natural components of such geosystems are in a state of constant dynamic change. The territory of industrial sites at the local level is the core of the concentration of technogenic geochemical anomalies, which creates favorable conditions for the interpenetration of polluting ingredients of natural environments. Migration cycles of the substances transformation depend on the nature of the anomalies, ultimately, on the specifics of technogenesis. One of the main pollutants of the basin's water resources is industry. Its needs are met through the intake of fresh surface water (70,2% of the total intake) and underground sources (29,8%).

The industry of water complex is represented by enterprises of ferrous and non-ferrous metallurgy, coal industry, mechanical engineering and food processing industries, chemical industries.

The analysis of the current sectoral industrial structure of the Karaganda region shows that the main industrial potential is concentrated in the manufacturing sector, which accounts for almost 85% of the total output. The metallurgical industry is absolutely prevailing in the structure of the manufacturing industry of the region - almost 86% ("Mittal Steel Temirtau" and "Kazakhmys"). The indicated growth rates of the manufacturing industry of the region are directly related to the industrial and innovative development programs of these companies.

The area of the Karaganda-Temirtau industrial site occupies the most elevated part of the Kazakh small hills - Saryarka, which is a peculiar, very heterogeneous in geomorphological terms, highly elevated territory (absolute height 400-1000 m). The relief is complicated by shallow depressions, river valleys, dry channels of watercourses, hollows with coming up of groundwater to the surface, drainless hollows, lacustrine basins and steppe saucers. A characteristic feature of the territory is the outcrops of dense rocks in the form of rocks, rocky piles and placers, strongly dissected and chaotic in relief. The small hills were formed in the process of long continental development, which lasted from the middle of the Paleozoic to the present, due to the intense destruction and denudation of Precambrian, Paleozoic and later tectonic formations. Denudation processes turned mountains into low mountains, into vast ancient peneplains by insular mountain ranges composed of rocks most resistant to destruction. The Cenozoic-Mesozoic peneplain experienced repeated weak epeirogenic movements. Peneplain processes and, in part, neotectonic uplifts caused the emergence, as well as the revival of wide, aligned main watersheds of the region with low mountain massifs and small hills. The annual rainfall in the region varies from 130 mm or less to 310 mm or more. The climate of the region is sharply continental, dry. A high degree of continent is manifested in large annual and daily temperature amplitudes and in the instability of climatic indicators over time (from year to year). The average annual air temperature fluctuates throughout the region in the range of 1,4-7,3°C, and its highest values are typical for the most southern regions - deserts. Summer in this region is very hot, and it is sultry and long in the south. In the summer the air temperature sometimes rises to 40-48 ° C; the winter, on the contrary, is cold, frosts sometimes reach -40-45°C and even 50 °C. One of the main meteorological factors affecting the concentration and distribution of atmospheric pollution is the wind regime. The conditions of the relief determine the formation of an active wind regime in combination with synoptic conditions. The vastness of the region's territory and the complex relief cause significant differences in wind speed and direction.

When considering the influence of the main meteorological values on the level of atmospheric pollution, it was noted that the general atmospheric circulation regimes play an important role, and together with it the wind regime, solar radiation, temperature regime, air humidity and precipitation. The circulation conditions of the region atmosphere are formed under the influence of cyclonic activity, the dynamics of which are due to western transfer. Transformed three types of air masses, such as arctic, polar and tropical, enter the territory of the region under the study. All of them have their own characteristics of h air pollution level formation. In cyclonic weather, cloudy weather is formed, often with winds and precipitation [12]. This contributes to the dispersion, leaching of harmful substances from the atmosphere, respectively, reducing the concentration of atmospheric pollution. In the cold period, the western spur of the Asian anticyclone plays a significant role. Inversions are formed as a result of cooling the earth's surface, with the merger of warm and cold fronts, that is, on the fronts of occlusion. The probability of their repetition in the cold period is 18%. Inversions form a kind of "ceiling" that prevents the rise and dispersion of relatively heated emissions from production sources. Surface inversions are more often formed at night, so at night there is an increase in impurity concentration by 0,5-0,7 times. In the afternoon, their dispersion occurs. The most powerful inversions occur during anticyclone weather in the winter, combined with strong night-time cooling. According to aerological observations, the thickness of such inversions is from 250 to 350 m, and the altitude varies in most cases from 500 to 1200 m. In light winds, emissions of low and fugitive emissions tend to accumulate in the surface layer. With significant winds (7-10 m/s) and the absence of inversion in the surface layer, impurities dissipate and reach the earth's surface a little. With strong winds at a speed of 12-15m/s and more, impurities are transported to considerable distances from sources.

According to the Department of Ecology, in the first six months of 2018, 305 thousand tons of harmful substances were already released into the atmosphere of the region. Last year, this indicator amounted to 598,7 thousand tons, which amounted to a quarter of all emissions (2357 thousand tons). The most significant contribution to air pollution is made by such large enterprises as "Kazakhmys Corporation" LLP, "Qarmed" JSC, "Central Asia Cement" JSC, "Carcement" JSC, "Orken Atasu" LLP, "Orken Kentobe" LLP, Kine Group "Kazmarganets", TNC "Kazchrome" JSC, "Karaganda Energy Center" LLP, "BapyMining" LLP, "TEMK" JSC.

In the city of Karaganda (landscape № 8), the level of air pollution was estimated as high and was determined by the values of SI = 10, NP = 38%. According to an automatic post on the 3rd stoker street, on October 25 a case of high pollution with suspended particles of RM 2,5 was recorded. The content of the harmful substance was 10,4 times higher than the MPC, which is associated with the mass kindling of furnaces at a low wind speed.

The average monthly concentrations of suspended particles of PM 2,5 were 2,8 MPC, phenol –2,0 MPC, suspended particles PM 10 –1,6 MPC, formaldehyde –1,3 MPC, nitrogen dioxide – 1,1 MPC, and concentrations of other pollutants did not exceed MPC. The maximum one-time concentrations of suspended particles of PM 2,5 amounted to 10,4 MPC, suspended particles of PM 10 – 5,8 MPC, hydrogen sulfide –3,9 MPC, carbon monoxide –2,7 MPC, ammonia – 2,0 MPC, suspended particles (dust) – 1,4 MPC, concentrations of other pollutants did not exceed MPC.

And in the town of Temirtau (landscape № 5), the level of air pollution was estimated as very high and was determined by the value of SI = 12. The average monthly concentrations of suspended particles (dust) amounted to 1,4 MPC, phenol – 2,4 MPC, ammonia – 1,5 MPC, the concentrations of other pollutants did not exceed MPC. The maximum single concentration of suspended particles (dust) was 3,0 MPC, sulfur dioxide – 5,7 MPC, carbon monoxide – 1,5 MPC, nitrogen dioxide – 1,6 MPC, nitric oxide – 1,6 MPC, hydrogen sulfide - 11,6 MPC, phenol – 2,3 MPC, ammonia – 1,2 MPC, concentrations of other polluting substances did not exceed maximum concentration limits. According to the study we conducted, we can distinguish the following facts:

1. The territory of the Nura River Basin refers to steppe and semi-desert landscapes with little biological information, weakened by water links, but with intense direct air links. Due to the combination of natural complexes, the territory of the Nura River Basin is characterized by a variety of geosystems types. The territory of the Nura River Basin belongs to the steppe and semi-desert landscapes. The zonal and subzonal differentiation of the main geosystems when moving from north to south occurs primarily due to climate changes (heat and moisture balance). The distribution of the basin geosystems is subject to the law of latitudinal zonality, which leads to a consistent change of landscapes. The water availability of geosystems confined to elevated plains depends solely on the mode of precipitation, that is, the automorphic conditions of humidification. Geosystems of the lowered plains sometimes have additional moisture, due to flooding or close occurrence of groundwater (hemi hydromorphic). Basin

geosystems have a combination of natural factors that enhance the pollution of geosystems. All this reduces centralization, orderliness and self-organization, stability of the landscape.

2. Economic activities carried out within the study basin, and, therefore, the key factors of anthropogenic modification of geosystems are industrial and agricultural activities: mining, hydro construction, grazing, as well as the expansion of residential areas and transport construction.

3. An assessment of the degree of the geosystem pollution was carried out, which allowed identifying the areas with a high degree of geosystems pollution, because of outrageous impact. The geosystems, where the metal processing complex (Karaganda-Temirtau industrial unit) dominates in the nature management structure, are characterized by a strong and very severe degree of pollution, where all its components are severely damaged.

Conclusion

The proposed methodology for the degree assessment of anthropogenic stress on natural complexes most fully reflects the main factors of influence. Assessing the degree of anthropogenic load on geosystems is not the result of our research. The information obtained during the assessment of anthropogenic load on geosystems will be interpreted from the standpoint of applied geography to develop an optimal nature management structure taking into account indicators of the anthropogenic load degree on geosystems, the resistance of geosystems to anthropogenic impacts and the predicted trends in the dynamics of geosystems under conditions of anthropogenic influences. Moreover, it is believed that the optimal structure of nature management does not lead to negative consequences, does not reduce the environmental and resource-forming properties of geosystems, and, conversely, an imperfect nature management structure, formed without taking into account the landscape features of the territory, leads to disruption and degradation.

The results obtained can be used not only in determining measures of environmental rehabilitation of the study area, but also can serve as a model for improving geo-ecological research of geosystems oriented to solving problems of environmental management practice.

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References

1. Glazovskaya M.A. Geohimiya prirodnyh i tekhnogennyh landshaftov SSSR [Geochemistry of natural and technogenic landscapes of the USSR]. (Moscow: High School, 1988, 312 p.) [in Russian].

2. Yang T., Chen W., Chen L., Liu W., Zhang D. CH_4 Reforming by CO_2 and O_2 Using Ni-M (M= Cu, Fe, Co, Mn, Zn, Cr) Bimetallic Aerogel Catalysts//Energy Technology, Springer, Cham. - 2016.-P. 173-180. *https://doi.org/10.1007/978-3-319-48182-1_20*

3. Atalay I., Efe R., Öztürk M. Ecology and Classification of Forests in Turkey// Procedia - Social and Behavioral Sciences.-2014.-Vol.120.-P.788-805. *https://doi.org/10.1016/j.sbspro.2014.02.163*

4. Atalay I., Efe R. Ecological attributes and distribution of Anatolian black pine [Pinus nigra Arnold. subsp. pallasiana Lamb. Holmboe] in Turkey//Journal of Environmental Biology.-2010.-№33(2).-P.272-285.

5. Herman G.V., Ilieş D., Gaceu O., Ilieş A., Mester C., Ilieş M., Wendt J.A., Josan I., Baias S., Dumitru M. Some consideration concerning the quality of groundwater in the NATURA 2000 Lunca Barcaului

(Barcaului Meadow) site// Journal of Environmental Protection and Ecology. - 2019. - №20(3). - P. 1102-1109.

6. Mendybayev E.H., Atayeva G., Berdenov Z., Atasoy E. Geochemical researches of region soil with technogenic influence in terms of Borlinskiy region, West Kazakhstan//Oxid Commun.-2015.- №38(4).- P.1933-1941.

7. Borisenko I. Analiz dinamiki nakopleniya metallov v pochvah urbanizirovannoj territorii [Analysis of the metals accumulation dynamics in the soils of an urbanized area] Ekologo-geohimicheskij analiz tekhnicheskogo zagryazneniya, Moskva [Ecological and geochemical analysis of technical pollution, Moscow]. 104-115 (1997), [in Russian]

8. Berdenov Z.G., Mendybayev E.H., Atayeva G.M., Dzhanaleeva G.M. Landscape and geochemical features of man-made pollution zones of Aktobe agglomerations // Oxid Commun. - 2015. - № 38(2). - P.852-859. DOI:10.26577/JGEM.2015.2.251

9. Berdenov Z.G., Atasoy E,. Mendybayev E.H., Ataeva G., Wendt J.A. Geosystems geological assessment of the basin of rivers for tourists valorization. Case study of Ilek river basin // GeoJournal of Tourism and Geosites. - 2016.- №2(18). - P. 187-195.

10. Ozgeldinova Z.,Mukayev Z., Ramazanova N., Zhanguzhina A., Ulykpanova M. Spatial distribution of potentially toxic elements in soils and water bodies of the Kostanay region in Kazakhstan // Scottish Geographical Journal.-2024. - №140(1-2). - P.277-290.

11. Ramazanova N., Toksanbaeva S., Berdenov Z., Tursynova T., Zhakupov A. Analysis of the current state of recreational resources of the Nura River Basin, the republic of Kazakhstan // Geojournal of Tourism and Geosites. - 2020.- №31(3). -P.1043–1048(2020). doi:10.30892/gtg.31316-539

12. Toksanbaeva S.T., Ramazanova, N.E., Tusupbekov, Z.A. Current state and prospects for the development of agricultural land in the Nura River basin// IOP Conference Series: Earth and Environmental Science. - 2022. - №954(1). -doi:10.1088/1755-1315/954/1/012087

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Нұра өзені алабының ландшафтық-геохимиялық жағдайына антропогендік факторлардың әсерін талдау

Аңдатпа: Мақалада антропогендік ландшафттардың қалыптасуын әртүрлі факторлардың, соның ішінде ластаушы заттар, радиоактивті заттар, сәулелену, шу және табиғи ресурстарды өндірудің әсерімен байланыстырып қарастырады. Табиғи ландшафттардың антропогендік ландшафттарға айналуы ғаламдық құбылысқа айналып, тау-кен өнеркәсібі, химия өнеркәсібі және ауыл шаруашылығы салаларындағы ғылыми-техникалық прогрестің арқасында жаңа сипатқа ие болуда. Зерттеу үшін негізгі аумақ ретінде Нұра өзенінің алабы таңдалды, мұнда Qarmet металлургиялық кешені орналасқан. Бұл кәсіпорын Қазақстандағы ең ірі тау-кен металлургиялық нысаны және полимерлі жабындысы бар металлдар мен өнеркәсіпке арналған шикізаттың кең ауқымын өндіреді.

Нұра өзенінің алабында өнеркәсіптік қызметтің геоэкологиялық әсерін бағалау мақсатында геохимиялық талдау жүргізілді. Су мен топырақ үлгілері жүйелі тәсілмен алынып, ластаушы заттардың мөлшері аккредиттелген зертханалардың сертификатталған әдістерімен анықталды. Алынған тәжірибелік деректер статистикалық әдістерді қолдану арқылы өңделіп, заңдылықтар анықталды.

Зерттеу барысында Нұра өзенінің алабы едәуір ластанғаны анықталды, бұл негізінен ауыр металдар мен басқа да ластаушы заттардан тұратын өнеркәсіптік қалдықтардың қалдықтарымен байланысты. Ластаушы заттардың жоғары концентрациясы «Qarmet» металлургиялық кәсіпорны және басқа да өнеркәсіптік нысандардың қызметімен байланысты екені анықталды. Табиғи ландшафттардың антропогендікке айналуы бұл процестердің қарқындылығымен тығыз байланысты екені анықталды.

Зерттеу нәтижелері Нұра өзені алабы ландшафттарының геохимиялық құрамына өнеркәсіптік процестердің елеулі әсер ететінін көрсетті. Алынған мәліметтер антропогендік әсерлерді азайту және аймақтың тұрақты дамуын қамтамасыз ету үшін өнеркәсіптік процестер мен қалдықтарды тазарту жүйелерін жаңғырту арқылы экологиялық басқаруды жетілдіру қажеттілігін көрсетеді.

Түйін сөздер: ландшафт, антропогендік ландшафттар, қоршаған ортаның деградациясы, ластану, қоршаған орта.

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Анализ влияния антропогенных факторов на ландшафтно-геохимическое состояние бассейна реки Нура

Аннотация: Данное исследование рассматривает формирование антропогенных ландшафтов под влиянием множества факторов, включая загрязняющие вещества, радиоактивные вещества, излучение, шум и добычу природных ресурсов. Превращение природных ландшафтов в антропогенные стало глобальным явлением, приобретая новые черты благодаря научно-техническому прогрессу в горнодобывающей промышленности, химической индустрии и сельском хозяйстве. В качестве ключевой территории для исследования выбран бассейн реки Нура, где доминирует металлургический комплекс Qarmet. Это предприятие является крупнейшим горно-металлургическим объектом Казахстана, производящим широкий ассортимент продукции, включая металлы с покрытием и сырье для промышленности.

В бассейне реки Нура был выполнен геохимический анализ с целью оценки геоэкологического влияния промышленной деятельности. Отбор проб воды и почвы осуществлялся по систематическому подходу, а содержание загрязняющих веществ определялось с применением методов, сертифицированных аккредитованными лабораториями. Полученные экспериментальные данные были обработаны с использованием статистических методов для выявления закономерностей и установления причинно-следственных связей.

Исследование выявило значительное загрязнение бассейна реки Нура, в основном обусловленное промышленными сбросами, содержащими тяжёлые металлы и другие загрязняющие вещества. Повышенные концентрации загрязнителей связаны с металлургической деятельностью «Qarmet» и других промышленных предприятий. Установлено, что трансформация природных ландшафтов в антропогенные тесно связана с интенсивностью данных процессов.

В исследовании подчёркивается критическое влияние промышленных процессов на геохимический состав ландшафтов бассейна реки Нура. Полученные результаты акцентируют необходимость улучшения экологического управления, включая модернизацию промышленных процессов и систем очистки отходов, для снижения антропогенных воздействий и обеспечения устойчивого развития региона.

Ключевые слова: ландшафт, антропогенные ландшафты, деградация окружающей среды, загрязнение, окружающая среда.

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