IRSTI 39.19.27

[1]Ye. Keukenov, [2]K. Dzhanaleeva, [3]G. Baryshnikov,
[4]K. Orazymbetova

L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
(E-mail:, [2] dzhanaleeva_km@enu.kz, [3] bgj@geo.asu.ru,[4]orazymbetova62@mail.ru)
Corresponding author: [1]komorymoroni@mail.ru

Landscape forming factors of the Karkaraly low mountains

Abstract. The territory of geosystems of the Karkaraly low mountains is mainly forest landscapes and dark-chestnut soil cover. The paper reflects the state of the soil and vegetation cover of the forest landscapes of the Karkaraly low mountains in the Karaganda region. The paper provides the results of chemical soil tests, describes the vegetation cover samples using geoinformation technologies based on the standard quantitative index NDVI (Normalized Difference Vegetation Index), confirmed in field studies in the summer of 2020. The work performed aims at a comprehensive assessment of the physical, chemical, and biological characteristics of the components of geosystems.

In course of the field study, a brief description of phytodiversity was compiled, indicating the geomorphological attributes of key areas. To study the vegetation, sample plots of the underlying soil and vegetation cover were set. Overview and thematic maps of the object under study were created. At the final stage of the study, the interpretation of the results is presented with the identification of cause-and-effect relationships of the state and fluctuations of geoecosystems. Data sources include satellite images of Landsat-8 (US Geological Survey) and field studies along the routes and four key areas. The results of the work allow defining the object under study, determining the distinctive properties in key areas, as well as possible reasons for the difference in the studied territory of geosystems.

Keywords: forest landscapes, phytodiversity, ecosystem, chemical analysis, biodiversity.

DOI: **https://doi.org/10.32523/2616-6771-2023-142-1-85-95**

Introduction

Soil and vegetation cover plays a special part among the landscape-forming factors and performs various functions, where one of them is ecological. In addition to natural factors that influence the formation and development of the soil and vegetation cover, anthropogenic impact, both indirect and direct, is of particular importance. The level of anthropogenic impact can be assessed by the degree of pollution of the object under study, by changes in biochemical processes in geoecosystems. The object under study in this paper is the landscapes of the Karkaraly low mountains; therefore, identifying the degree of anthropogenic impact on the study area is of particular interest. The intensity of anthropogenic impact on the environment reduces the stability of geosystems, which requires a periodic monitoring of the territory to determine positive or negative changes.

The study of the composition and properties of the soil of the area is an important problem. After all, in order to have a well-kept and environmentally properly set plot, it is essential to understand the chemical composition and type of the soil. In current times, it is important to find out what is the pollution intensity in a given area, how it affects the phytodiversity and soil cover of the object under study. Considering that plants have an attached mode of life, the state of their organism reflects the state of the particular local habitat. It is the chemical analysis will identify the signs, the causes of soil contamination. Identification of the features of composition and properties of particular soils will determine the methods of soil maintenance so that the percentage of fertility remains high enough. The importance of assessing the state of natural plant populations lies in the fact that plants are the main producers, where their role in the ecosystem can hardly be overestimated. Plants are a sensitive objects that allows assessing the entire complex of impacts specific to a given territory as a whole, since they assimilate substances and are directly affected simultaneously from two environments: from the soil and from the air.

Territory under study

The geosystems of the Karkaraly low mountains are located in the eastern part of the Kazakh Uplands in the Karkaraly district of the Karaganda region. They represent a low-hill terrain with isolated massifs of low mountains extending from the north-northwest to the southeast for 30–35 km with a width of 20–25 km. The mountains are ones of the highest in Central Kazakhstan and consist of individual ridge mountains (Zhirensakal, Akterek, Myrzashoky, Karkaraly, Buguly, Koktobe, Shankoz). The highest point is Komsomolsky Peak with a height of 1403 m above sea level, which is part of the southern ridge of Zhirensakal. To the south-east of this ridge are the Akterek mountains, 1230 m above sea level, and Myrzashoky, 1170 m above sea level. To the north are located: the Karkaraly jagged ridge, up to 1115 m above sea level (which gave the name to the entire mountain-forest massif), the Bugula ridge (1323 m above sea level), and the Shankoz ridge, up to 1360 m above sea level. In the west, there is the seven-peak Koktobe (1254 m above sea level) [1]. The Karkaraly mountain-forest massif is divided by the wide intermountain valleys of Kendara, Kurozek, Karatoka and others, and is endowed with fresh groundwater.

The diversity of terrain and soil cover determined the phytodiversity development.

The area under study is almost completely located in the dry steppe subzone of the steppe landscape-climatic zone. In the Karkaraly low mountains, mainly pine forests grow with undergrowth of *Rosa spinosissima, Rosa majalis, Juniperus communis, Lonicera tatarica, Padus avium, Crataegus sanguinea*. They account for 71.3% of the total area of mountain forests. Birch forests (*Betula pendula, B. pubescens*) are located on the slopes of northern and north-eastern exposure, in valleys between hills, along rivers and streams. They occupy 10% of the forested territory, and about 2% of the forested territory is occupied by aspen forests (*Populus tremula*) confined to relief depressions, valleys of rivers and streams, and the toes of round slopes [2, 3, 4, 5].

The first geobotanical studies of the geosystems of the Karkaraly Mountains were carried out by A.Ya. Gordyagin, a professor at Kazan University. It was then that the assumption was put forward that the forests located in the islands inherit the former single forest massif, which had a connection with the taiga forests in the north. Then, the same assumption was put forward by I.M. Krashennikov, who believed that the island forests of the Karkaraly low mountains were the remnants of the forest-steppe belt stretching from the Southern Urals to Altai. A large number of boreal relics were discovered by V.N. Sukachev in the Kokshetau forests. Botanical studies of this territory were also carried out by B.A. Bykov, who in his book described in detail the vegetation cover of Central Kazakhstan, as well as its development in the Cenozoic era.

At the end of the 19th century, the West Siberian branch of the Geographical Society of Russia was established. The expeditions arranged by the branch made a significant contribution to the knowledge of not only the flora, but also the vegetation of the region. After 1917, botanical study was carried out in connection with the solution of practical problems. Geobotanical work in the region acquired a special scope during the development of virgin and fallow lands. In 1954-1955, botanists studied the northern part of this region as members of the Special Complex Expedition for the lands of new agricultural development. As a result of these works, the Natural Zoning of the Territory was completed (1960), a map of the vegetation of Northern Kazakhstan was compiled (which included the northern part of the region), and a description of the main types of steppes was given. A map of the vegetation of the Karaganda region was compiled.

In 1957 and 1959, the Biocomplex Expedition of the BIS and ZIS of the USSR Academy of Sciences carried out research mainly in the western part of the Uplands, partly they also included the geosystems of the Karkaraly low mountains.

In 1964-1966 and 1968, the work of the East Kazakhstan Expedition of the BIS of the USSR Academy of Sciences was arranged, as a result of which the territory of Eastern Saryarka was also studied in detail. As a result, a map of the vegetation of the Kazakh Uplands was published, and Z.V. Karamysheva and N.I. Rachkovskaya published a monograph "Botanical Geography of the Steppe Part of Central Kazakhstan". The monograph presents a list of flora with analysis, general characteristics of vegetation, botanical and geographical zoning, and a detailed description of the regions. In the eastern part of the Uplands, much attention was paid to the study of the forest vegetation of the low mountains.

Later on, local floristic and geobotanical studies were conducted in this area. In recent years, important resource studies have appeared in connection with the search for medicinal plant species.

However, the ratio of anthropogenic and natural factors that affect the functioning of the geosystems of forest areas is not fully covered in the scientific literature. There is no analysis of the multiway relationships of phytodiversity with the lithogenic base, topography, hydrological regime, and other factors.

Regarding the geosystems of the Karkaraly low mountains, work on expanding the network of specially protected natural areas (SPNA) is being carried out very slowly. Among the existing specially protected natural areas (SPNA), only the Karkaraly State National Natural Park and Buiratau receive funding, and even then, to an insufficient extent. On the territory of Karkaraly, not enough attention is paid to biotechnical measures to preserve and improve bioresources, despite the fact that their numbers are decreasing due to poaching and deterioration of habitat conditions. Now one of the most important tasks of conservation of nature and bioresources is to protect the gene pool of flora and fauna, as the loss of each species can cause significant harm to the social-economic and ecological-geographical interests of society. The depletion of flora and fauna is observed in all regions of Central Kazakhstan. For rare and endangered species of flora and fauna, excessive fishing, poaching and destruction of their natural habitats threatens with complete extinction. Broad and systematic inventory studies of flora and fauna are lacking or clearly insufficient [6].

The soils of the mountain-forest massifs of Karkaraly and Kent develop under the influence of two factors, which are vertical zonality and geological features of the area. Like all other mountain soils, dark chestnut soils are very heterogeneous in terms of their physical-chemical and genetic production traits and differ from each other in the thickness and severity of the humus horizon, the thickness of the fine-earth strata, the nature of the underlying rocks, the degree of alkalinity and carbonate content.

Methodological framework and study methods

General geographical methods [7] were used in the work. To preliminary introduce the object under study, as well as to identify the degree of compliance with the cartographic material of the territory, to develop a unified methodology of observation and fixation of components for the entire route, a reconnaissance survey of the area was carried out. Soil cover studies in key areas were carried out using the methodology of V.M. Fridland. [8] The soil pits were set with consideration to the terrain.

Analysis and discussion

According to the forms of the surface structure, the described area is divided into latitudinal-northeast-trending bands, coinciding with the zones of anticlinal uplifts and synclinores described above. It is common to the entire area that ancient pre-Upper Palaeozoic rocks form a low levelled terrain, while igneous formations of the Middle-Upper Carboniferous and Permian age form belts of mountainous relief or island mountain ranges, like the Karkaraly or Kent mountains. The latter represent the result of long-term continental denudation as early as the Carboniferous, as a result of which Upper Palaeozoic igneous formations accumulated on a flattened surface. Comparison of the Middle Palaeozoic surface elevations in the Synclinorian basement and in the anticlinal uplifts shows that this surface is partly undulating and partly broken into blocks.

In any case, the Middle Palaeozoic does not rise above the established or restored basal surface of the Upper Palaeozoic, the latter being incompletely manifested in the modern surface relief in a somewhat distorted form. Of course, it is difficult to say whether it is separated from the Permo-Carboniferous deposits or directly inherited from the Upper Palaeozoic, but the undoubted levelling of the Middle Palaeozoic relief follows from the whole essence of the geological development of the Karkaraly region. The active relief-forming nature of the Upper Palaeozoic magmatism becomes more obvious.

Not only lava accumulations, volcanic cones, and extrusive laccoliths, but also uplifted massifs of granular granites solidified at a shallow depth rise above the level of the Middle Palaeozoic surface. It can be assumed that the formation of the main positive landforms is associated with the active magmatism processes. In particular, there is a direct evidence that the granite and granodiorite massifs of the region were formed in the groundmass not by metasomatic means, but by the active intrusion of magmatic melt, which raised the roof to a height of up to 2 km from its original position.

In relation to the magmatic forms of the Upper Palaeozoic, the modern terrain is directly inherited. Simple forms are sometimes inversed. For example, in some cases synclinally built lava fields got a higher position than the zone of volcanic cones that formed these covers, which was explained by the armouring of the surface by gently lying covers of acidic hard tuff lavas.

At the same time, the foregoing, apparently, gives reason to reject the idea that in Central Kazakhstan, in the Mesozoic or at a later time, any single levelling surface developed, from which all the now existing landforms occurred. In the Mesozoic, there was a period of descending development of the terrain, but apparently, it was associated not so much with the levelling as with the conservation of the ancient Upper Palaeozoic forms.

The modern terrain of the area is a typical combination of sharply defined mountain ranges and wide branched intermountain plains, with river valleys locating along them. The plains are located almost entirely on the Middle Palaeozoic rocks of the anticlinal zones, despite the fact that these rocks are often more resistant and harder than the nearby igneous rocks of the Upper Palaeozoic massifs.

The Upper Palaeozoic volcanic relief is cut by narrow rectilinearly oriented valleys dependent on faults. Intermountain valleys and plains are filled with Neogene and higher Quaternary deposits. It is known that Paleogene and partly Upper Cretaceous loose rocks appear in the valley deposits along the periphery of Central Kazakhstan. In connection with this, the age of these valleys is determined on the interval from the Upper Cretaceous to the Neogene. The Quaternary period is characterized by a noticeable revival of erosion, the cutting of river valleys into the Neogene and Palaeozoic deposits, which causes the regeneration of the pre-Quaternary terrain, strengthening its general dissection, sharpness and contrast of forms.

Mountain groups and individual island mountains are of a tectonic nature. Almost everywhere they are morphologically well expressed, have a distinct sole, sharp forms, more often than exposed tors.

The latest tectonic movements, which are widely manifested in the eastern part of Saryarka, are established by a number of signs:

- wide ancient valleys separating mountain ranges, partly developed within tectonic troughs or faults;
- stable contrasting appearance of some mountain structures, despite the relatively easily destroyed constituent rocks (granitoids);
- distinct rectilinear tectonic ledges, antecedent sections of river valleys, deformations of levelling surfaces, confinement of springs and lakes to sharp inflections of the topographic profile, wide development of cracks, slickensides, etc.

The shape of the mountains is developed mainly by erosion, although gravitational slope processes, combined with physical and chemical weathering, are also widespread. Usually the slopes of the mountains are steep, especially in the upper part, often more than 30°, where sharp ridges are combined with gorges. Various bizarre forms of weathering, talus, stone streams are noted here. In the lower part, the steepness of the slopes decreases to 15-20°, they acquire soft convex and concave outlines. Erosive incisions take on smoother transverse and longitudinal profiles, but the direction of the ravines coincides with the strike of the cracks.

According to the morphometry, the mountains of the Karkaraly district, as well as the entire Saryarka, belong to the low-mountain type with a relative elevation above the framing surfaces of 200-600 m. Since, in most cases, mountain ranges are framed by small hills, the measurement reference is the surface of intramountain and intermountain depressions and valleys.

Watershed peaks have levelling surfaces. The north-western (Shyngys-Khantau) direction of morphostructures changes to the east-northeast (Tekturmas) direction here, and therefore both of these directions are noted on the main watershed, depending on the stability of the structures, as well as the orientation of mountain ranges along widespread tectonic faults.

Low-mountain massifs are usually confined to the cores of Palaeozoic anticlines and are mostly composed of stable rocks, often jaspers, quartzites, porphyries, and tuffites. More rarely, Late Hercynian granitoids, which determines their appearance. The mountain peaks are pointed, the slopes are rocky.

In this case, mainly the highest (eluvial landscapes) and the lowest (accumulative-eluvial or superaqueous landscapes) places were selected [8]. Four key areas were set on the territory of the study object (Table 1, Figure 1.)

The organization of field studies of the phytodiversity of geosystems of the Karkaraly low mountains included the following stages:

1) Collection of herbarium material of vegetation cover of different systematic groups. At this stage, a herbarium was collected, plant species were identified;

2) Characteristics of the vertical structure of the vegetation cover. In this case, a morphological approach was used, implying the allocation of tiers according to the height of the crowns;

3) Determination by species – the abundance of woody and large herbaceous forms was determined by the methods of Drude and Shennikov, Yaroshenko.

The cartographic research method included the modelling of a single natural territorial complex with consideration to the preservation of its geometric image. The key areas were selected based on the geographical and indicative localization of the mapped ecosystems. The analysis of spatial images was carried out with the relationship between the geometric and genetic aspects of the object under study. Each key area is characterized by an individual genetic process and the structure of spatial forms.

Table 1. Coordinates of key areas

Key area	Geographical coordinates	
	North latitude	East longitude
1	2	3
No.1	49°28′11″	75°31′45″
No.2	49°12′54″	75°13′43″
No.3	49°41′18″	75°34′50″
No.4	49°34′27″	75°04′07″

Key area No. 1 is located near the middle reaches of the Karkaralinka River, northeast of the town of Karkaraly. The phytodiversity of this area is represented by forbs, predominantly wormwood vegetation. There are trees (elms, birches) in combination with shrubs (rose hips, currants) at the foot of the hills. The main representatives of vegetation: wormwood, fescue, feather grass. The study area is in some places affected by pastureland, which is why the vegetation is partially thinned out.

Key area No. 2 is located on the territory of the lower reaches of the Zharly River and its tributary (the Taishchek River), which is represented by steppe shrub-sagebrush-fescue associations with rare occurrence of Pinus sylvestris pine and Betula pendula birch. Shrubs are mainly presented by steppe species (Rosa spinisissima, Spiraea crenata, S. Hypericifolia, Caragana frutex). Key area No. 3 is located at the source of the Karkaralinka River, southwest of Akzhol village.

Key area No. 4 is located on the territory of the middle reaches of the Zharly River near Karbushevka village. The location map of key areas is shown in Figure 2. Soil pits were set in the indicated key areas and soil samples were taken in accordance with the standards – GOST 17.4.4.02-84 "Nature Protection. Soils. Methods of sampling and sample preparation for chemical, bacteriological, helminthological analysis". For the chemical analysis of the soil of key areas, the results of laboratory studies of EcoExpert LLP of the Republic of Kazakhstan were used

Earth remote probing (ERP) is in great demand in scientific geography and is used in numerous studies. Vietnamese researchers Duong Thi Loi, TienYin Chou, and Yao-Min Fang used ERP methods and

FCD index to study the forests of Thai Nguyen province [12]. Long-time satellite images help to generalize information about the forest cover of the Earth [13, 14]. The study area is located in the Karkaraly district of the Karaganda region. The source of data for the study of the territory was multispectral space images of the Earth from the Internet resource of the US Geological Survey (https:// earthexplorer.usgs.gov/) Landsat 8. These channels were used to calculate the NDVI index (Figure 3).

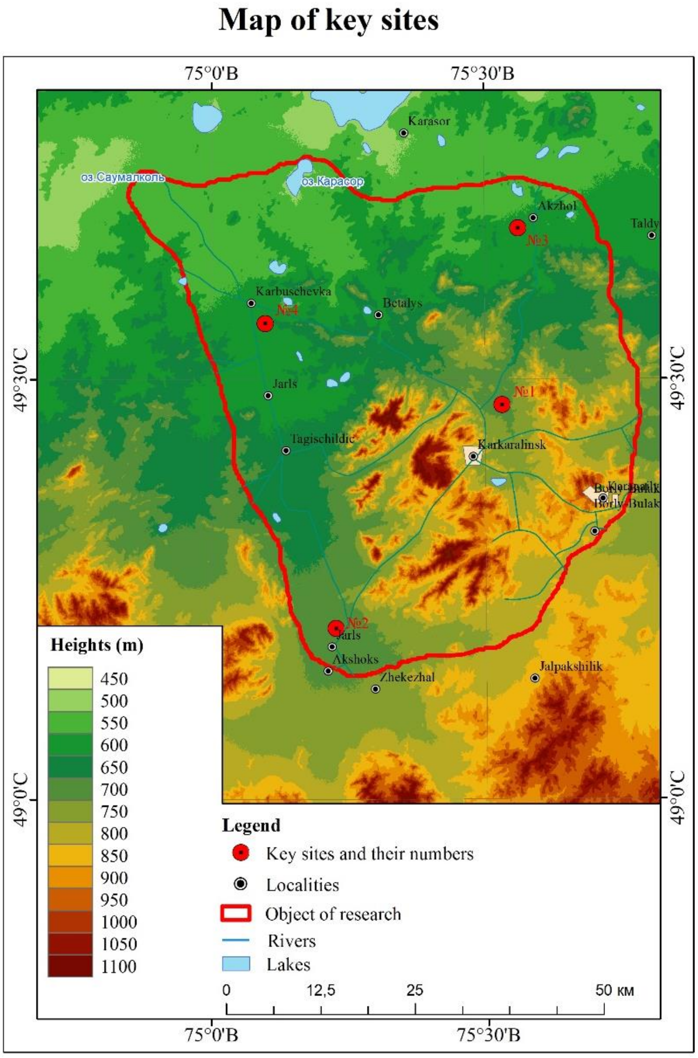

Figure 1. Map of the key areas of the geosystems of the Karkaraly low mountains. Scale 1:500,000

Results

According to the results of NDVI calculation for Key Area No. 1 (Figure 2), the value is 0.20. [9, 10, 11]. This indicator allows for attributing the vegetation of this territory closer to sparse. Plant community consists of fescue-red feather grass, meadowsweet-fescue-red feather grass vegetation on chestnut soils. For Area No. 2, the value is 0.45, which characterizes it as an area with dense vegetation. It is represented by fescue-red feather-grass, Austrian wormwood-cattail-fescue vegetation with forb-quackgrass meadows on dark chestnut and normal meadow soils. Areas No. 3 and No. 4 show a value of 0.17-0.18, which means that the vegetation of these areas is sparser. According to our assumptions, the reason for this is the ploughing of the steppes, cattle grazing. Meadowsweet-fescue and oat grass, meadowsweet-forb and fescue-red feather-grass vegetation grows in these areas on chestnut soils. In accordance with the NDVI indicators, the areas were visited to assess the forest stand in terms of species and quality composition

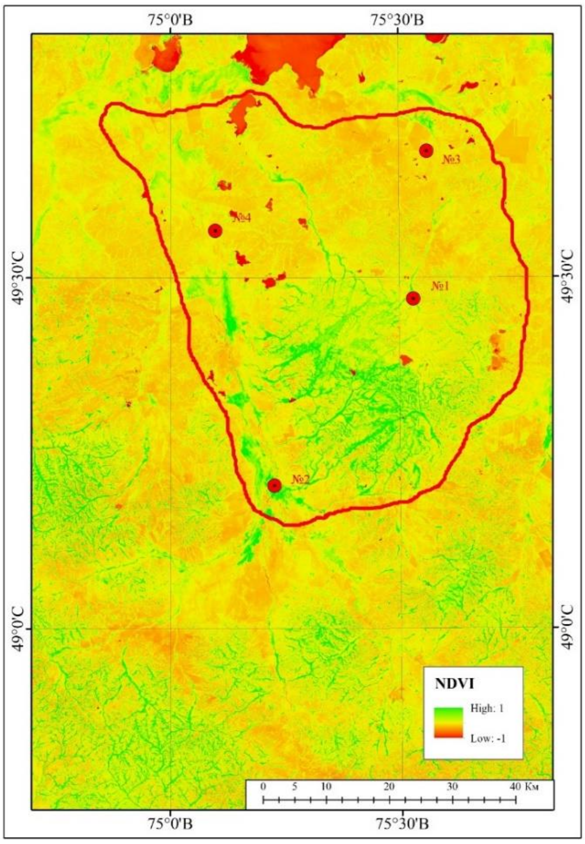

Figure 2. Map of NDVI indicator of the study area as of June 2021. Scale 1:500,000

The main accumulator of nutrients in the soil in the key areas (Table 2) is humus, which contains 95-99% of all soil nitrogen reserves, 60% of phosphorus, up to 80% of sulphur, and a significant part of microelements. The content of humus in the soil cover varies from 3.31 to 7.25%, which for the steppe and forest-steppe zones determines Key Areas No. 1-4 as a fertile layer (over 2%). [15].

The pH values of the soil of all key areas can be correlated as alkaline.

According to the table, in all four key areas, the index of chromium, arsenic and copper exceeds the maximum allowable concentration (MAC) by more than 10 times. The concentration of zinc, nickel and cobalt exceeds this indicator too. According to our assumption, the Karagaily Mining and Processing Plant (MPP), located in the south-eastern part of the study area, has a depressing effect on the ecosystem introducing imbalance in the results of soil surveys (Figure 3). The rest of the values in the areas are deemed standard.

Table 2. Results of chemical analysis of soils from key areas

No.	Sampling point	Area 1	Area 2	Area 3	Area 4	MAC
1	Total humus, %	3.31	7.25	5.77	6.96	
2	pH	9.03	8.88	7.68	7.80	
3	Nitrates (mg/100 g)	14.9	31.7	2.3	1.3	13
4	Manganese(mg/kg)	800	708	655	1312	1500
5	Vanadium (mg/kg)	76	62	82	71	150
6	Chromium (mg/kg)	83	75	69	66	6.0
7	Lead (mg/kg)	<30	<30	<30	<30	32
8	Arsenic (mg/kg)	<30	<30	<30	<30	2
9	Zinc (mg/kg)	56	49	39	70	23
10	Copper (mg/kg)	42	37	31	49	3
11	Nickel (mg/kg)	28	20	20	25	4
12	Cobalt (mg/kg)	<10	<10	<10	13	5

According to the draft regulations for maximum allowable emissions (MAE) of pollutants into the atmosphere of the Karagaily Mining and Processing Plant for 2022-2031 (10), the total number of sources polluting the environment is 48 (29 stationary sources, and 19 fugitive sources). The previous Draft MAE considered sources in the amount of 46. The increase in the number of pollution sources is associated with the merger of two approved projects – DP "Reconstruction of the Karagaily Mining and Processing Plant for processing ores from the Akbastau, Abyz, Kosmurun deposits". The reconstruction of the Karagaily Mining and Processing Plant considered emissions from 46 pollution sources (the main operations of the concentrator). The Glavniy Pit operation project considered emissions from 2 pollution sources (dusts from the pit walls and beaches). Thus, when combining the above approved projects, 48 sources are obtained, which are regulated by this Draft MAE for 2022-2031. Other additional sources of pollutant emissions are not considered in the developed Draft MAE.

Figure 3. Karagaily Mining and Processing Plant of "Karagandatsvetmet" PA, a branch of Kazakhmys Corporation LLP (photo by the author)

Conclusions

The results of the studies allow noting that there is a significant change observed in landscape components in these systems in terms of their qualitative composition. The vegetation index at the key area located near the anthropogenic system reflects the sparseness of the vegetation cover in relation to others. In the upper soil layer, some chemical elements significantly exceed the MAC. The important factor for this deviation is the close location to the Karagaily Mining and Processing Plant, which reflects the qualitative and species composition of the forest stand and the chemical analysis of the soil cover. Obviously, the reason for the change should be considered the involvement of more spaces in the anthropogenic landscape. The results obtained, statistical data and geoinformation models can be used in geoinformation mapping at the district level and in generating more detailed maps for a comprehensive atlas of the region, namely maps of vegetation, forest land, undergrowth, herbaceous vegetation in forest lands. The derived materials can be used as a cartographic basis for management in the field of forestry and forest management, monitoring; and also as a basis for solving the problems of optimizing regional nature management.

References

1. Keukenov Y., Dzhanaleeva K., Ataeva G., Ozgeldinova Zh, Orazymbetova K. Prospects of ecotourism development in Central Kazakhstan// GeoJournal of Tourism and Geosites.- 2022.-№42(2spl).-P. 664–670. https://doi.org/10.30892/gtg.422spl04-875

2. Keukenov Y.B., Dzhanaleeva G.M. Use of biological resources of the Karkaraly Mountains// Vestnik KazNRTU.-2021.- №5 (143).-P.10- 17

3. Dikareva T.V., Leonova N.B. Phytodiversity of the Karkaraly National Park (the Republic of Kazakhstan). Arid ecosystems.-2014.- №4 (61).-P.105-114

4. Keukenov Y., Dzhanaleeva K., Orazymbetova K. Recreational potential of the Karkaraly mountains.-2022.

5. Shomanova Z., Safarov R., Shomanov A., Tleulessov A., Berdenov Z., Lorant D. Aspects of assessment of Ecological impact of an Ash-Sludge collector of Pavlodar aluminum plant (Kazakhstan)//Journal of Landscape Ecology.-2020.-№17 (1).-P. 47-62.

6. Gabov U., Kist V., Hamzin B., Obuhov U., Smagulov B. Central Kazakhstan: problems and decisions. – Almaty: Evero, 2020. – 268 p.

7. Beruchashvili N.L., ZHuchkova V.K. Metody kompleksnyh fiziko-geograficheskih issledovanij [Methods of complex physical and geographical research] Uchebnik – M.: MGU, 2007. –p. 75-117, 203-218

8. Fridland V.M. Struktura pochvennogo pokrova.[The structure of the soil cover.] –M.: My`sl`, 1972.-423p.

9. Stamford John D., Vialet-Chabrand, Silvere, Cameron, Iain, Lawson, Tracy. Development of an accurate low cost NDVI imaging system for assessing plant health.// Plant Methods.- 2023.-№19(1).-P 2. https://doi.org/10.1186/s13007-023-00981-8

10. Wang L, Duan Y, Zhang L, Rehman TU, Ma D, Jin J. Precise estimation of NDVI with a simple NIR sensitive RGB camera and machine learning methods for corn plants// Sensors.-2020.-№20(11).-P.3208

11. Gu Y, Wylie BK, Howard DM, Phuyal KP, Ji L. NDVI saturation adjustment: a new approach for improving cropland performance estimates in the Greater Platte River Basin, USA. Ecol Ind.- 2013.- №30.-P. 1–6. https://doi.org/10. 1016/j.ecolind.2013.01.041.

12. Duong Thi Loi, Tien-Yin Chou, и Yao-Min Fang. Integration of GIS and Remote Sensing for Evaluating Forest Canopy Density Index in Thai Nguyen Province, Vietnam. International Journal of Environmental Science and Development.-2017.- 8(8).-P. 539-542

13. Saei jamalabad M. and A.A. Abkar. Forest Canopy Density Monitoring Using Satellite Images, Proc. of The International Society for Photogrammetry and Remote Sensing Congress, Istanbul, Turkey.-2004.-5 p.

14. Azizia Z., A. Najafi, and H. Sohrabia, Forest Canopy Density Estimating Using Satellite Images, Proc. of The Interna-tional Society for Photogrammetry and Remote Sensing Congress Commission VIII, Beijing, China, July 3-11.-2008.- XXXVII. Part B8.- 1130 p.

15. Vozna L. Humus and its role in creating and maintaining soil fertility. Available at: https://garden.wikireading.ru/10598 (Accessed 20/02/23)

Е. Кеукенов, К. Джаналеева, Г. Барышников, К. Оразымбетова

Л. Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан

Қарқаралы аласа тауларының ландшафт түзуші факторлары

Аннотация.Қарқаралы аласа таулары геожүйелерінің аумағы негізінен орман ландшафттарын және жер жамылғысының күңгірт-күрең топырақ түрін қамтиды. Еңбекте Қарағанды облысының Қарқаралы аласа тауларының орманды ландшафттарының топырақ және өсімдік жамылғысының жай-күйі көрсетілген. Мақалада топырақтың химиялық талдауының нәтижелері берілген, NDVI (Normalized Difference Vegetation Index – бұдан әрі мәтін бойынша ВИ) стандартты сандық индексі негізінде геоақпараттық технологияларды пайдалана отырып, өсімдік жамылғысы үлгілерінің 2020 жылғы жазғы кезеңде далалық зерттеулерде расталған сипаттамасы келтірілген. Жүргізіліп жатқан жұмыстар геожүйелер компоненттерінің физикалық-химиялық және биологиялық сипаттамаларын кешенді бағалауға бағытталған.

Далалық зерттеулер барысында негізгі учаскелердің геоморфологиялық құрамдарын көрсету арқылы фитоалуантүрлілік бойынша қысқаша сипаттама жасалды. Өсімдіктерді зерттеу үшін төсеме топырақ-өсімдік жамылғысының сынақ алаңдары салынды. Зерттеу объектісінің шолу және тақырыптық карталары жасалды. Зерттеудің соңғы сатысында геоэкожүйелердің жай-күйі мен ауытқуларының себеп-салдарлық байланыстарын анықтай отырып, нәтижелерді түсіндіру ұсынылған. Деректер көздері Landsat-8 (АҚШ Геологиялық қызметі) ғарыштық суреттері, маршруттар мен 4 негізгі учаске жөніндегі далалық зерттеулер болып табылады. Жұмыстардың нәтижелері зерделенетін зерттеу объектісінің сипаттамасын беруге, негізгі учаскелердегі айрықша қасиеттерді, сондай-ақ зерттеліп отырған геожүйелер аумағы айырмашылығының ықтимал себептерін айқындауға мүмкіндік береді.

Түйінді сөздер: *орман ландшафттары, фитоалуантүрлілік, экожүйе, химиялық талдау, биоалуантүрлілік.*

Е. Кеукенов, К. Джаналеева, Г. Барышников, К. Оразымбетова

ЕНУ им. Л.Н.Гумилева, Астана, Казахстан

Ландшафтообразующие факторы Каркаралинских низкогорий

Аннотация. Территория геосистем Каркаралинских низкогорий имеет, главным образом, лесные ландшафты и темно-каштановый тип почвенного покрова. В работе отражено состояние почвенного и растительного покрова лесных ландшафтов Каркаралинских низкогорий Карагандинской области. В статье даны результаты химического анализа почв, приведено описание образцов растительного покрова с использованием геоинформационных технологий на основе стандартного количественного индекса NDVI (Normalized Difference Vegetation Index – далее по тексту ВИ), с подтверждением на полевых исследованиях в летний период 2020 года. Проводимые работы направлены на комплексную оценку физико-химических и биологических характеристик компонентов геосистем.

В ходе полевых исследований была составлена краткая характеристика по фиторазнообразию с указанием геоморфологических принадлежностей ключевых участков. Для исследования растительности были заложены пробные площади подстилающего почвенно-растительного покрова. Были созданы обзорная и тематическая карты объекта исследования. На завершающей стадии исследования представлена интерпретация результатов с выявлением причинно-следственных связей состояния и флуктуаций геоэкосистем. Источниками данных являются космические снимки Landsat-8 (Геологической службы США), полевые исследования по маршрутам и 4-м ключевым участкам. Результаты работ позволяют дать характеристику изучаемому объекту исследования, определить отличительные свойства на ключевых участках, а также возможные причины различия изучаемой территории геосистем.

Ключевые слова: *лесные ландшафты, фиторазнообразие, экосистема, химический анализ, биоразнообразие.*

Сведения об авторах:

Кеукенов Е. – докторант 3 курса по образовательной программе 8D05213 – География-География, ЕНУ им. Л.Н.Гумилева, Сатпаева 2, Астана, Казахстан

Джаналеева К.М. – доктор географических наук, профессор кафедры физической и экономической географии, ЕНУ им. Л.Н.Гумилева, Сатпаева 2, Астана, Казахстан

Оразымбетова К.Ш. – кандидат географических наук, старший преполаватель кафедры географии, землеустройства и кадастра КазНу им. Аль-Фараби, Аль-Фараби 71, Алматы, Казахстан

Барышников Г.Я. – доктор географических наук, профессор кафедры природопользования и геоэкологии Алтайского государственного университета, просп. Ленина, 61А, Барнаул, РФ

Keukenov E. - 3rd year PhD student in the educational program 8D05213 - Geography, L.N.Gumilyov Eurasian National University, Satpaev str., 2, Astana, Kazakhstan

Dzhanaleeva K.M. - Doctor of Geography, Professor of the Department of Physical and Economic Geography, L.N.Gumilyov Eurasian National University, Satpaev str., 2, Astana, Kazakhstan

Orazymbetova K.Sh. - Candidate of Geographical Sciences, Senior Lecturer of the Department of Geography, Land Management and Cadastre of Al-Farabi KazNu, Al-Farabi 71, Almaty, Kazakhstan

Baryshnikov G.Ya. – Doctor of Geographical Sciences, Professor of the Department of Nature Management and Geoecology, Altai State University, prosp. Lenina, 61A, Barnaul, RF