NEWS OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224–5278
Volume 1.
Number 475 (2026), 286–302

https://doi.org/10.32014/2026.2518-170X.604

UDC 911.5
IRSTI 39.19.31: 34.35.33

©Salikhov T.K.[1*], Issayeva Zh.B.[2], Onal H.[3], Akhmetzhanov Zh.B.[4], Atasoy E.[5], 2026.

[1]L.N. Gumilyov Eurasian National University, Astana, Kazakhstan;
[2]Innovative University of Eurasia, Pavlodar, Kazakhstan;
[3]Balikesir University, Balikesir, Turkey;
[4]al-Farabi Kazakh National University, Almaty, Kazakhstan;
[5]Bursa Uludag University, Bursa, Turkey.
*E-mail: tuatai_76@mail.ru

USING GIS TECHNOLOGIES AND TRADITIONAL GROUND-BASED METHODS TO ANALYZE THE VEGETATION COVER OF ECOSYSTEMS IN THE WEST KAZAKHSTAN REGION

Salikhov Talgat — Candidate of Agricultural Sciences, Acting Professor of L.N. Gumilyov Eurasian National University, Astana, Kazakhstan,
E-mail: tuatai_76@mail.ru; https://orcid.org/0000-0002-8720-0931;
Issayeva Zhanetta — PhD, Associate Professor of the Innovative University of Eurasia, Pavlodar, Kazakhstan,
E-mail: zhanetta.aysha@mail.ru, https://orcid.org/0000-0002-4182- 3041;
Hakan Onal — PhD, professor of Balikesir University, Balikesir, Turkey,
E-mail: onal@balikesir.edu.tr; https://orcid.org/0000-0001-8434-9880;
Akhmetzhanov Zhanbolat — doctoral student Educational Program 8D01503 – Geography of al-Farabi Kazakh National University, Almaty, Kazakhstan,
E-mail: Akhmetzhanov.zhanbolat@mail.ru; https://orcid.org/0009-0001-1893-4659;
Atasoy Emin — PhD, Professor of Bursa Uludag University, Bursa, Turkey,
E-mail: eatasoy@uludag.edu.tr; https://orcid.org/0000-0002-1473-7420.

Abstract. In the context of the country's accelerated economic development and increasing use of natural resources, further improvement of environmental protection systems is becoming increasingly important. Therefore, the preservation of the biological diversity of ecosystems requires the appropriate application of new scientific and methodological approaches. One such approach is the combination of traditional ground-based methods with geoinformation system technologies. The purpose of this study was to investigate the vegetation cover in the ecosystems of the West Kazakhstan region using a combination of traditional ground-based methods and geoinformation system technologies. The theoretical and methodological basis of the study includes general scientific methods, including descriptive, comparative, statistical, and system analysis, as well as cartographic analysis. The research methodology is based on a system of general principles and approaches. The general scientific methods include comprehensive, integral, systemic, environmental, and geographical methods. The study resulted in the creation of thematic maps and GIS attribute databases for plants. As a result of the research, a digital map was developed, which is practically accessible to a wide audience of GIS users. The method of creating a soil map using the ArcGIS software product was also developed. The use of GIS technologies expands the possibilities of analyzing the current state of vegetation during mapping. The availability of a basic thematic inventory map significantly reduces the time required to obtain new layers, as well as to refine and edit computer maps and their legends. As a result, it becomes much more efficient than using paper maps to analyze the current state and dynamics of vegetation, assess biodiversity and the relationships between plant communities and landscape components, and obtain new information about the ecological potential of the territory. In addition, studying such an informative and physiognomic component of the landscape as vegetation allows us to assess the current ecological situation in the region.

Key words: vegetation cover, ecosystem, territory, digital maps, GIS technologies

For citations: *Salikhov T.K., Issayeva Zh.B., Onal H., Akhmetzhanov Zh.B., Atasoy E. Using GIS Technologies and Traditional Ground-Based Methods to Analyze the Vegetation Cover of Ecosystems in the West Kazakhstan Region. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences. 2026. No.1. Pp. 286–302. DOI: https://doi.org/10.32014/2026.2518-170X.604*

©Салихов Т.Қ.[1*], Исаева Ж.Б.[2], Онал Х.[3], Ахметжанов Ж.Б.[4], Атасой Э.[5], 2026.

[1]Л.Н. Гумилев атындағы Евразия ұлттық университеті, Астана, Қазақстан;
[2]Инновациялық Еуразия университеті, Павлодар, Қазақстан;
[3]Балыкесир университеті, Балыкесир, Түркия;
[4]әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан;
[5]Бурса Улудаг университеті, Бурса, Түркия.
*E-mail: tuatai_76@mail.ru

БАТЫС ҚАЗАҚСТАН ОБЛЫСЫНДАҒЫ ЭКОЖҮЙЕЛЕРДІҢ ӨСІМДІК ЖАМЫЛҒЫСЫН ТАЛДАУ ҮШІН ГАЖ ТЕХНОЛОГИЯЛАРЫН ЖӘНЕ ДӘСТҮРЛІ ЖЕРДЕГІ ӘДІСТЕРДІ ПАЙДАЛАНУ

Салихов Талғат — ауыл шаруашылығы ғылымдарының кандидаты, Л.Н. Гумилев атындағы Еуразия ұлттық университетінің профессор м.а., Астана, Қазақстан,

E-mail: tuatai_76@mail.ru; https://orcid.org/0000-0002-8720-0931;
Исаева Жанетта — PhD, Инновациялық Еуразия университетінің доценті, Павлодар, Қазақстан,
E-mail: zhanetta.aysha@mail.ru; https://orcid.org/0000-0002-4182-3041;
Онал Хакан – PhD докторы, профессор Университета Балыкесир, Балыкесир, Түркия,
E-mail: onal@balikesir.edu.tr; https://orcid.org/0000-0001-8434-9880;
Ахметжанов Жанболат — әл-Фараби атындағы Қазақ ұлттық университетінің 8D01503 – География ОБ докторанты, Алматы, Қазақстан,
E-mail: Akhmetzhanov.zhanbolat@mail.ru; https://orcid.org/0009-0001-1893-4659;
Атасой Эмин — PhD докторы, Бурса Улудаг университетінің профессоры, Бурса, Түркия,
E-mail: eatasoy@uludag.edu.tr; https://orcid.org/0000-0002-1473-7420.

Аннотация. Елдің жедел экономикалық дамуымен және табиғи ресурстарды пайдаланудың артуымен қоршаған ортаны қорғау жүйелерін одан әрі жетілдіру маңызды болып келеді. Сондықтан экожүйелердің биологиялық әртүрлілігін сақтау жаңа ғылыми және әдіснамалық тәсілдерді тиісті түрде қолдануды талап етеді. Осындай тәсілдердің бірі - дәстүрлі жер үсті әдістерін географиялық ақпараттық жүйе технологияларымен біріктіру. Бұл зерттеудің мақсаты Батыс Қазақстан облысының экожүйелеріндегі өсімдік жамылғысын дәстүрлі жер үсті әдістерін географиялық ақпараттық жүйе технологияларымен біріктіру арқылы зерттеу болды. Зерттеудің теориялық және әдіснамалық негізіне сипаттамалық, салыстырмалы, статистикалық, жүйелік талдау және картографиялық талдауды қоса алғанда, жалпы ғылыми әдістер кіреді. Зерттеу әдіснамасы жалпы қағидаттар мен тәсілдер жүйесіне негізделген. Жалпы ғылыми әдістерге мыналар жатады: кешенді, интегралды, жүйелік, экологиялық және географиялық. Зерттеу нәтижесінде тақырыптық карталар мен ГАЖ атрибуттарының дерекқорлары: өсімдіктер пайда болды. Зерттеу нәтижесінде ArcGIS бағдарламалық жасақтамасын пайдаланып топырақ карталарын құрастыру әдіснамасын ГАЖ пайдаланушыларының кең аудиториясы үшін іс жүзінде қолжетімді ететін сандық карта жасалды. ГАЖ технологияларын пайдалану картаға түсіру кезінде өсімдіктердің ағымдағы жағдайын талдау мүмкіндіктерін кеңейтеді. Негізгі тақырыптық түгендеу картасының болуы жаңа қабаттарды алуға, сондай-ақ компьютерлік карталар мен олардың аңыздарын жетілдіруге және редакциялауға кететін уақытты айтарлықтай қысқартады. Нәтижесінде өсімдіктердің қазіргі жағдайы мен динамикасын талдау, биоәртүрлілікті және өсімдік қауымдастықтары мен ландшафт компоненттері арасындағы байланысты бағалау, сондай-ақ аумақтың экологиялық әлеуеті туралы жаңа ақпарат алу қағаз карталарға қарағанда әлдеқайда тиімдірек болады. Сонымен қатар, ландшафттың ақпараттық және физиогномикалық компоненті болып табылатын өсімдіктерді зерттеу аймақтағы қазіргі экологиялық жағдайды бағалауға мүмкіндік береді.

Түйін сөздер: өсімдік жамылғысы, экожүйе, аумақ, цифрлық карталар, ГАЖ технологиялары

©Салихов Т.К.[1*], Исаева Ж.Б.[2], Онал Х.[3], Ахметжанов Ж.Б.[4], Атасой Э.[5], 2026.
[1]Евразийский национальный университет имени Л.Н. Гумилева, Астана, Казахстан;
[2]Инновационный Евразийский университет, Павлодар, Казахстан;
[3]Университет Балыкесир, Балыкесир, Турция;
[4]Казахский национальный университета имени аль Фараби, Алматы, Казахстан;
[5]Университет Бурса Улудаг, Бурса, Турция.
*E-mail: tuatai_76@mail.ru

ИСПОЛЬЗОВАНИЕ ГИС-ТЕХНОЛОГИЙ И ТРАДИЦИОННЫХ НАЗЕМНЫХ МЕТОДОВ ДЛЯ АНАЛИЗА РАСТИТЕЛЬНОГО ПОКРОВА ЭКОСИСТЕМ ЗАПАДНО-КАЗАХСТАНСКОЙ ОБЛАСТИ

Салихов Талгат — кандидат сельскохозяйственных наук, и.о.профессора Евразийского национального университета имени Л.Н. Гумилева, Астана, Казахстан.
E-mail: tuatai_76@mail.ru; https://orcid.org/0000-0002-8720-0931;
Исаева Жанетта — PhD, доцент Инновационного Евразийского университета, Павлодар, Казахстан,
E-mail: zhanetta.aysha@mail.ru; https://orcid.org/0000-0002-4182-3041;
Онал Хакан — доктор PhD, профессор Университета Балыкесир, Балыкесир, Турция,
E-mail: onal@balikesir.edu.tr; https://orcid.org/0000-0001-8434-9880;
Ахметжанов Жанболат — докторант ОП 8D01503 – География Казахского Национального Университета имени аль Фараби, Алматы, Казахстан,
E-mail: Akhmetzhanov.zhanbolat@mail.ru; https://orcid.org/0009-0001-1893-4659;
Атасой Эмин — доктор PhD, профессор Университета Бурса Улудаг, Бурса, Турция,
E-mail: eatasoy@uludag.edu.tr; https://orcid.org/0000-0002-1473-7420.

Аннотация. В условиях ускоренного экономического развития страны и возрастающего использования природных ресурсов дальнейшее совершенствование систем охраны окружающей среды приобретает всё большее значение. В связи с этим сохранение биологического разнообразия экосистем требует адекватного применения современных научно-методических подходов. Одним из таких подходов является сочетание традиционных наземных методов с технологиями геоинформационных систем (ГИС). Целью данного исследования стало изучение растительного покрова в экосистемах Западно-Казахстанской области на основе интеграции традиционных наземных методов и ГИС-технологий. Теоретико-методологическая основа исследования включает общенаучные методы, в том числе описательный, сравнительный и статистический, а также системный и картографический анализ. Методология исследования базируется на комплексном, интегральном, системном, экологическом и географическом подходах. Результатом исследования стали тематические карты и база атрибутивных данных ГИС по растительности. Разработана цифровая карта, доступная для широкого круга пользователей. Показано, что использование ГИС-технологий расширяет возможности анализа текущего состояния растительности при картографировании. Наличие базовой тематической инвентаризационной карты существенно сокращает время, необходимое для получения новых слоёв, а также для уточнения и редактирования цифровых карт и их легенд. В результате становится возможным значительно эффективнее, чем при использовании бумажных карт, анализировать текущее состояние и динамику растительности, оценивать биоразнообразие и взаимосвязи между растительными сообществами и компонентами ландшафта, а также получать новую информацию об экологическом потенциале территории. Кроме того, изучение такого информативного и физиономического компонента ландшафта, как растительность, позволяет оценить текущую экологическую ситуацию в регионе.

Ключевые слова: растительный покров, экосистема, территория, цифровые карты, ГИС-технологии

Introduction. Preservation of biological diversity of ecological systems, unique natural complexes, objects of natural reserve fund, cultural and natural heritage of the Republic of Kazakhstan is one of the important tasks of the state at the present stage (Salikhov et al., 2024).

The territory of Kazakhstan has a unique set of landscape complexes: from deserts to highlands and ecosystems of inland seas. In the context of the increasing pace of economic development of the country and the increased use of natural resources, the issue of further improvement of the system of territorial nature protection is becoming relevant (Salikhov et al., 2023).

A significant part of the natural steppe spaces on Earth is located in Kazakhstan, which make up over 120 million hectares. In turn, the steppe ecosystems of Kazakhstan are the sites of distribution of unique steppe flora, globally endangered species of steppe fauna. Steppe ecosystems of Kazakhstan are a platform for about 2000 species of flora, including approximately 30 endemic species, unique floristic compositions. The steppes of Kazakhstan are also home to globally endangered species of steppe fauna, including 9 out of 24 species of endangered mammals living in the country (Petrenko et al., 1998).

Natural areas must be protected from various risks, such as pollution, plant poisoning, the presence of dangerous, wild animals, etc. All natural resources, being carriers of energy and information, act as a natural resource potential of a wide range (Salikhov, 2017).

Today, the use of modern computer modeling and visualization methods of GIS in monitoring has become a trend (Shomanova et al., 2019; Kushnyr, 2014; Makarov et al., 2002). Such methods allow determining the spatial location of ecological zones, population density, distribution by city microdistricts, development of social infrastructure in microdistricts, and other important tasks.

Human settlements depend on the resources, benefits, and services of ecosystems, but they also degrade ecosystem health. A new approach to urban planning and design is emerging to address this situation. Drawing on theories of regenerative design, ecosystem-level biomimicry, and ecosystem services, it proposes designing projects that reconnect urban spaces with natural ecosystems and restore the entire socio-ecosystem, contributing to ecosystem health and the production of ecosystem services (Blanco et al., 2021; Kambo et al., 2019).

The presence of natural resources is the first condition for the placement of productive forces in the region. The quantity, quality and combination of resources determine the natural resource potential of the territory, which is an important factor in the placement of population and economic activity.

However, technogenic civilization brings not only benefits to humanity. If the laws of interaction between society and nature, man and the environment are not sufficiently taken into account, its development can lead to catastrophic consequences for the biosphere and humanity itself. Therefore, the most urgent problem facing humanity today is the creation of conditions for environmentally safe (sustainable) development in the economy in order to achieve and maintain the necessary level of quality of life for current and future generations.

The purpose of the study: to study the current state of vegetation in the West Kazakhstan region using traditional terrestrial methods with GIS technologies.

Materials and methods of research. The full research cycle was divided into three stages: preparatory, expeditionary-field and office. When conducting geobotanical studies, the relevant methodological recommendations for generally accepted techniques were used (Alekhin, 1938; Andryushchenko, 1958; Darbaeva et al., 2003; Darbaeva, 2006; Debelo et al., 2000; Petrenko et al., 2001; Salikhov, 2017; Ivanov, 1958). For topographic and geodetic works, paper geobotanical maps of different scales were used - from 1:2,000,000 to 1:25,000 (to search for and highlight reference areas). The development of phytomaps using GIS technologies was carried out on the basis of ArcGIS software using scanned paper maps and aerial photographs. The theoretical and methodological basis of the study was formed by general scientific methods: geobotanical, floristic, ecosystem, descriptive, comparative, statistical, systems analysis, and cartographic. The research methodology is based on a system of general principles and approaches. The general scientific methods used are comprehensive, integral, systems, ecological, and geographical.

The object of the study is the vegetation cover of the West Kazakhstan region, where monitoring sites have been established with data plotted on a topographic base and GPS-recorded. Habitats of key plant species were mapped. The underlying principle for identifying valuable areas in the article is an ecosystem approach based on a comprehensive assessment of the ecological state of the territory's natural components and an analysis of the dominant biocenoses of the steppe environment using remote sensing data and GIS technologies. During the expeditionary survey of the study area, material was collected for an inventory of the higher plant flora, in the form of preliminary lists for all surveyed points and selected contours of the preliminary map. Herbarium material was also collected to clarify the taxonomic affiliation of groups difficult to determine in the field. During the office work, the herbarium was compiled using the most comprehensive published botanical summaries. The nomenclature of species, genera, and families is presented in accordance with the latest summaries. For brevity, only Russian names are used in some places in the article. It should be emphasized that the higher plant flora of the study area in the West Kazakhstan region has not been specifically studied. Therefore, in preparation for the expedition and during the office work, disparate data from various sources was used, primarily data from the Department of Botany at Makhambet Utemisov West Kazakhstan State University and our own fieldwork over the years. The study focused on land cover in the West Kazakhstan region, where monitoring sites were identified, their data plotted on a topographic base, and GPS coordinates recorded.

Mapping was conducted using Earth remote sensing data and GIS technologies. The initial stage of digital map creation can be considered the processing of high-resolution satellite data. ENVI 4.0, a specialized software product, is successfully used for this purpose, enabling a number of necessary adjustments and subsequent classification, identifying different classes for export to a GIS. Paper topographic bases at a scale of 1:100,000 also undergo appropriate processing, from scanning and georeferencing to vectorization and database creation.

Results. The territory of the West Kazakhstan region is located in the northwest of the Republic of Kazakhstan (Akimat of the West Kazakhstan region, 2024). It borders on two regions of Kazakhstan and five regions of Russia: in the north with the Orenburg region of the Russian Federation, in the east with the Aktobe region of the Republic of Kazakhstan, in the south with the Atyrau region of the Republic of Kazakhstan and the Astrakhan region of the Russian Federation, in the west with the Volgograd and Saratov regions of the Russian Federation, in the northwest with the Samara region of the Russian Federation. Administrative center: the city of Uralsk.

The relief of the territory is flat. Moreover, the height above sea level decreases from the northeast to the southwest of the region.

Several areas are distinguished in the region by relief features, including - General Syrt, Emba Plateau, Caspian Lowland. In the north and northeast of the region are the spurs of General Syrt and the Pre-Ural Plateau. In the south, within the Caspian Lowland, there are sand massifs of Narynkum: Kokuzenkum, Akkum, Karagandykum and others. The highest point of the region, an elevation in the area of the former settlement of Mirgorodka, its height above sea level is 262 meters.

The surface is composed of marls, Paleogene sandstones and limestones, covered by Quaternary deposits of the Caspian lowland. River valleys consist of alluvial deposits (Andryushchenko, 1958).

The climate is sharply continental. Strong winds blow throughout the year, dry winds are frequent in summer. The average temperature in January is up to - 14°C, in July up to +25°C. The absolute minimum temperature is - 40°C, the absolute maximum is 40°C. Snow cover lasts 70 days in the south of the region and 140 days in the north. The annual amount of precipitation in the south of the region is from 250 mm, and in the north up to 400 mm.

The soils are dark chestnut, chestnut, light chestnut clay and solonetz. Cereal-forb, cereal-wormwood, wormwood-wheatgrass vegetation predominates. In the southern regions there are brown soils, solonetz and solonetz soils, there are sand massifs (Salikhov, 2017; Salikhov et al., 2024).

The flora of the West Kazakhstan region, in the herbarium of the V.V. Ivanov Department of Botany at West Kazakhstan State University, comprises 1,256 wild plant species. Species from 117 families, represented by 487 genera, are found here. Among these, 10 rare and endangered plant species are included in the Red Data Book of the Commonwealth of Independent States, and another 14 species are listed in the Red Data Book of Kazakhstan.

The territory of the West Kazakhstan region is located in two natural zones: steppe (subzone of semi-shrub-tussock-grass desert steppes on chestnut soils) and desert (northern subzone of wormwood and perennial saltwort deserts on brown soils). The northern part of the territory is in the steppe zone, and the southern part is in the semi-desert zone.

In the system of botanical and geographical zoning, the territory is represented by the Eurasian steppe and Afro-Asian desert regions. The steppe is represented by the most arid subzone – the Trans-Volga-Kazakhstan semi-shrub-tussock-grass desertified steppe, which includes the northern part of the territories, and the semi-desert is the least arid northwestern edge of the Caspian province of the North Turan steppe desert, which includes most of the Caspian lowland.

The territory is widely represented by 7 types of vegetation: steppe, desert, forest, shrub, meadow, marsh, submerged-aquatic (Salikhov, 2017).

In the flora of the territory, we identified 537 species of vascular plants belonging to 66 families and 265 genera. However, this number does not exhaust the final species composition of flora (Salikhov et al., 2023).

In terms of vegetation, the West Kazakhstan Region contains elements of three zones. In the north lies a true steppe zone, a significant portion of the region's central part falls within the desert steppe (or semi-desert) zone, and the southern regions are marked by the northern boundary of the deserts (Figure 1).

The region's vegetation is predominantly steppe-like, but unsustainable land management has led to increased desertification. The true steppe zone occupies the northern part of the West Kazakhstan Region and includes feather-grass and fescue steppes.

Feather-grass steppes. The southern boundary of the feather-grass steppes runs from the headwaters of the Yeruslan River through Bolshoy and Maly Uzen, 20-25 km south of the village of Yershov, then slightly north of the village of Chizha to the Shipovo railway station, along the spurs of the Obshchy Syrt to the village of Krasny. From there, through Novyenky and Dar'insk, on the left bank of the Ural, to Lake Shalkar and then east, cutting through the watershed of the Ilek and Khobda rivers in the central part. The entire belt of feather-grass steppes is connected to the most elevated syrty part of the region.

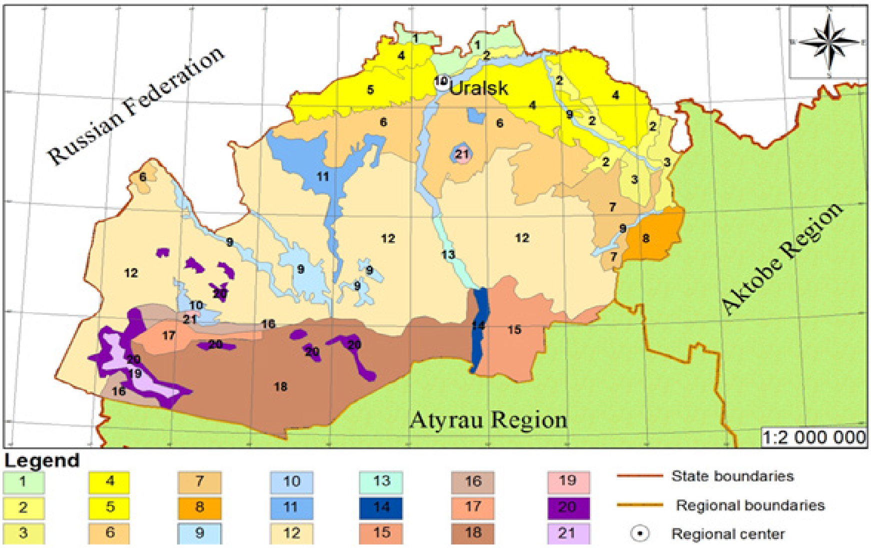

Figure 1 - Geobotanical map of the West Kazakhstan region

Legend of the geobotanical map of the West Kazakhstan region

1 — Steppe. Plain. Forb-feather grass (arid): arable lands in place of feather grass-red feather grass and red feather grass-feather grass steppes;

2 — Fescue-feather grass (moderately arid). Sandy-feather grass: psammophytic-forb-fescue-sandy-feather;

3 — Fescue-fescue with psammophytes: fescue-fescue;

4 — Arable lands in place of fescue-feather grass, fescue-fescue-feather grass, fescue-feather grass, fescue-fescue grass;

5 — Complex fescue-feather grass, feather grass-fescue, fescue-chestnut;

6 — Fescue-feather grass (dry steppe). Complex bunchgrass-grasses and wormwoods: bunchgrass-grasses in combination with wormwood and black wormwood;

7 — Oat grass-sand feather grass and sand wormwood-sand feather grass;

8 — Arable lands in place of xerophytic forb-fescue-feather grass steppes Arable lands in place of xerophytic forb-fescue-feather grass steppes;

9 — Vegetation of river valleys, sea coasts, lakes and reservoirs in the steppe. Plain. Willow thickets, true and halophytic meadows, celandines and perennial saltwort communities: riverine willow thickets with forb-grass true and halophytic species meadows with celandine and grass-wormwood in combination with perennial saltwort communities;

10 — Shrub-willow and poplar forests and meadows: shrub-willow riverine, willow and poplar floodplain forests with rich forb-grass true and sedge-forb-grass

marshy meadows with wormwood-forb-grass steppe meadows in combination with shrub thickets with oak groves and elm sparse forests on the Ural River (Zhaiyk);

11 — Cattail, reed, halophytic-grass, halophytic-wormwood and perennial saltwort communities with a predominance of halophytes a complex of perennial saltwort communities along the margins of salt lakes;

12 — Wormwood-feather grass: complexes of wormwood-bunchgrass-cereal, wormwood and perennial-saltwort communities: complexes of wormwood-wheatgrass-bunchgrass-cereal, black wormwood and in places kokpek communities;

13 — Riverine willow thickets with forb-grass true and halophytic species meadows with chee and grass-wormwood in combination with perennial saltwort communities in in combination with poplar groves, shrub thickets and licorice meadows on the Ural River (Zhaiyk) and along the river valleys of West Kazakhstan;

14 — Vegetation of river valleys, lakes and reservoirs in deserts. Plain. Shrub and meadow communities: shrub thickets with saltwort-reed, marshy, halophytic grass true meadows with perennial saltwort communities on salt marshes in combination with willow and oleaster groups and licorice-brunets meadows on the Ural River (Zhaiyk);

15 — Northern deserts. Plain. Grass-wormwood: grass-wormwood and itsigeko-wormwood;

16 — Complex grass-wormwood wormwood and saltwort: complex bluegrass-lerchowort black wormwood,;

17 — Psammophytic-grass-wormwood: psammophytic-grass-wormwood;

18 — Grass-sand wormwood and psammophytic shrubs;

19 — Avandelta and lakeside. Bre salt marshes of depressions;

20 — Halophytic vegetation. Obionaceae and halophytic-succulent saltwort communities: obionaceae, annual saltwort-sarsazan and kokpek;

21 — Vegetation of river valleys, lakes and reservoirs in deserts. Plain. Reed floodplains, halophytic meadows and succulent saltwort halophytic communities: cattail-reed floodplains combined with hydrophyte thickets in lagoons with club-reed and alkali grass meadows with kermek-sarsazan communities on salt marshes.

But as the intersyrt valley begins, you feel transported to the northern steppes. Here, the feather grass is almost lost among the awnless, thin-stemmed brome grass and the abundant, colorful forbs, represented by bedstraw, clovers, night violets, steppe cherry, broom, and other species. These are mostly plowed lands, but on the sands of the Yanvartsevo-Rubezhinsky, Karaagashi Kok-Uzekumy, and in areas adjacent to cliffs, ravines, and ravines.

Fescue steppes. South of the feather-grass steppe zone, the fescue steppe zone is quite clearly visible. Fescue dominates here, with various feather grasses mixed in, but all occupy a clearly subordinate position. Mesophilic forbs are significantly reduced in these steppes, but steppe shrubs are common: laburnum, meadowsweet, and serrated meadowsweet, as well as chiliga (caragana). Along with shrubs, feathery northern feather grasses persist in places in the hollows. Large hollows, depending on depth, form wheatgrass, bromegrass, and foxtail meadow communities.

White wormwood-wheatgrass steppes are found on sandy soils. Their origin is also associated with moderate grazing. Desert steppes cover most of the region. In the north, bordering the fescue steppe zone, they almost directly approach the spurs of the General Syrt, and in the south they adjoin the vast Ryn-sands massifs and equally vast white and black wormwood deserts on brown soils. Depending on the constituent groups, they are divided into two-member, three-member, and four-member complexes. The first, found primarily in the western part of the region (the Gorkaya River basin, Chizhinskie Razlivy), is formed by black wormwood solonetz soils interspersed with grass communities. The three-member complex, the most widespread, includes black wormwood solonetz soils, grass or wormwood-grass associations on light chestnut soils, and grass communities with an admixture of shrubs on chernozem-like depressions. In the four-member complex, occupying smaller areas, these members are joined by chamomile-white wormwood communities on solonetz soils. In terms of forage, all complex steppes are more conveniently divided by the amount of wormwood (black wormwood) they contain. Year-round pastures provide a turnover of 6-8 centners per hectare. Steppes with the lowest wormwood content (up to 20%), under adequate moisture conditions, are the most productive pastures.

Desert steppes include white wormwood steppes on solonetzic chestnut and light chestnut soils, dominated by white wormwood and its companions: chasteberry, sagebrush, and pyrethrum, with a small amount of grass. They are found in varying sizes throughout the region. A smaller portion is associated with solonetzic soils and is the result of the gradual desalination of our steppes.

Deserts. In the southern part of the region (Zhanybek, Zhangalinsky, and Akzhayik districts), significant areas of true wormwood deserts associated with severe solonetzic conditions are found along the edges of sandy massifs. In addition to wormwood, anabasis (itsigek) and stag bee (ebelek) are common here, and in the spring, a considerable number of ephemerals appear.

Large black wormwood deserts on solonetz soils are also found in the southern parts of the region: south of Zhalpaktal, near Aral-Sor, west of Taipak, near Itmurunkul, and elsewhere. In addition to black wormwood, camphorosma and anabasis are common here, and very rarely, saxifrage and burdock. In early spring, bulbous bluegrass and martyr grass are quite abundant.

Deserts on solonchak soils sometimes occupy vast areas in the southern part of the Shagansky Razlivs, in the south of the Kaztalovsky, Karatobinsky, and Akzhayiksky districts. In addition to wormwood, these plant communities include wormwood, camphorosma, and saltwort; among the grasses, alkali grass, burdock, burdock, and martyr grass.

Black wormwood-kokhrek deserts occur alongside the previous type, also occupying large areas. With black wormwood, the abundance of grasses and ephemerals increases.

Along with the zonal vegetation described above, our region also has estuaries, floodplain meadows, and even forests. On the gray solodized soils of the Chizhinsky and Darinsky spills, in the lower reaches of the Uzeni, Kushum, Zhaksybai, Buldurta, and several other rivers, significant areas are covered by couch grass, brome grass, and bekman estuary meadows. On the saline soils of the steppe floodplains, along with the previous types, alkali grass (Akmamyk) and wormwood-alkali grass estuary meadows are widespread. Under favorable conditions, Akmamyk meadows are a continuous carpet of alkali grass. Large areas in the floodplain areas are occupied by groups of azhrek (small sedge) and succulent saltworts, dominated by orach.

In large areas of the steppe floodplains, estuary marshy rush and rush meadows are found. In such meadows, it is necessary to reduce the duration of flooding.

In the Kamysh-Samara Lake basins, in the Zhaksybay floodplains, and other areas, reed and reed thickets are found.

Floodplain meadows. Wheatgrass and wormwood-wheatgrass meadows are common on high ridges that are flooded for short periods. In addition to crested wheatgrass, sea wormwood and steppe forbs are also present. The relatively sticky alluvial soils of these meadows are often used for vegetable gardens and melon fields. The largest areas of these meadows are concentrated in the Ural floodplain, with significant tracts in the Shagan, Derkul, and Buldurta valleys.

The lowest areas of the floodplain are occupied by marshy meadows of sedge, rush, and mayman. These meadows often occupy large depressions where water stagnates after floods. These meadows are common in the Ural floodplain in the Burlin and Baiterek districts. Overgrazing in such meadows results in hummocks and thickets of wormwood.

Forests. A study of the region's forest vegetation revealed that the size of the steppe groves is uneven, with groups along the valleys tending to be concentrated in moist areas. Depending on habitat conditions, the vegetation of the West Kazakhstan Region comprises the following forest types and habitat associations: forest stands, floodplain or estuary forests, and ravine forests. A characteristic feature of the forest vegetation is the heterogeneity of tree and shrub species, their mixture and grouping based on the hydrothermal conditions of the habitats, latitude, and proximity to large bodies of water. Poplars and various willows predominate here, with oaks, ash, and maples being less common. These forests receive additional moisture from precipitation runoff from the surrounding area and are fed by groundwater. Depending on the drought tolerance of the species, various formations are distinguished: willow, black poplar, white poplar, elm, birch, and black maple-oak.

The following formations are found in willow-willow forests in the Ural and Ilek valleys: willow-poplar forests and willow-poplar forests with poplars of various leaves, oriental poplars, willows, tamarisks, malt, and sedges. Elm-poplar forests are confined to more humid conditions, on alluvial soils. Birch-white poplar forests occupy fairly large areas. They are widespread in the Ural Valley, along its middle and lower tributaries: the Berezovka, Derkul, Uzeni, Chingirlau, and others. They are especially abundant in the Ural and Derkul river basins. The stands are represented by downy and silver birch, white poplar, and black poplar. Birch-white poplar forests are confined to old delta areas, oxbow lakes, and high terraces above the floodplains. The herbage is dominated by reed grass, bentgrass, and sedges. Buckthorn, rose hips, currants, and raspberries are found in the understory.

The aspen-birch formation is represented by two forest types: birch-aspen and oak. Their main habitats are confined to river valleys. These forests can be either primary or secondary in origin. Aspen-birch thickets are found in the Ural and Kushum River valleys. Aspen alone is rare in the tree layer. Birch forests occupy large areas between the Ural and Kushum Rivers.

Coniferous birch forests, unlike aspen-birch forests, are common in the wetter areas of floodplains and the Kushum River. In addition to birch (hanging and downy), poplar (white and black poplar), willow, European elm, and English oak (on terraces and in river valleys) are found in the tree layer.

Large forest stands located on floodplain estuaries receive additional moisture from floodwater runoff from the surrounding area. This is interrupted quickly due to the sandy soil, but due to the abundance of moisture and its ability to retain it for a long time.

Floodplain birch forests extend southward across the steppes, reaching as far as 49° N. Depending on habitat conditions, four forest types can be distinguished within the floodplain forests: typical birch forests, forb-sedge birch forests, aspen-birch forests, and forb-grass forests.

Fern birch forests have been described in the Kara-Agach, Kotantal, and Kindykty tracts. They grow in vast floodplain depressions where spring floods flow and precipitation filters from adjacent sandy areas. Two species of birch (bearded and downy) are found in the tree layer.

Sedge-sedge birch forests grow on saline soils and replace fern birch forests. Birch of this type has been described in the Karaagash tract.

Sedge birch forests are ecologically located higher than the previous two types. Found in areas with significantly moist and peaty-boggy soils, this forest type is well developed in the floodplain of the Karaagash forest piles and depressions. Aspen, reed grass, and horsetail dominate the herbage. The understory includes willow triandra and honeysuckle (black). The tree layer includes aspen, white birch, and black poplar.

The ravine forests of Western Kazakhstan are widespread within the Ural, Chingirlau, and Elek river basins, and the Chagan and Derkul tributaries.

Aspen forests with mixed grasses and shrubs are confined to the northern slopes of the Common Syrt and the CIS-Ural plateau. In these areas, the forests are represented by small-leaved aspen stands and develop on slopes with sufficient moisture, on the slopes of hillocks, depressions, and floodplains.

Discussion. In our research, we conducted geobotanical mapping to assess the current state of soil and vegetation in the West Kazakhstan region and determine the degree of desertification risk. We produced a 1:2,000,000 scale geobotanical map of the region with a detailed vegetation and soil cover legend.

Ecosystem service analysis can provide quantitative targets for urban ecological regeneration, which are determined by the specific ecology and climate of the urban area (Zari, 2019).

In addition to the features of the soil cover and relief, moisture conditions, the anthropogenic factor also influences the patterns of vegetation distribution.

Intensive grazing, which usually begins in early spring and ends in late autumn, has had a major impact on the formation of the modern vegetation cover in the study area. As a result of intensive and unsystematic grazing, large areas of the region's ecosystems have been destroyed and littered with poisonous (itsegek, deskurenia), and poorly edible (Austrian wormwood) plants.

Today, the real vegetation is therefore the result of both the presence of various mire habitats and various types of agricultural use. The current state of spring-fed fens in the Chociel River valley points to the urgent need for the implementation of various active protection measures (Osadowski et al., 2019).

In our research, we used the primary taxonomic unit of classification, the most appropriate for mapping purposes being the association (an association in the sense adopted by the International Botanical Congress in Amsterdam in 1936). Our geobotanical map of the West Kazakhstan region identifies higher-ranking taxonomic units of vegetation (association groups), primarily their complexes. The identified vegetation and soil cover contours are generally of varying ages and have undergone very different degrees of anthropogenic impact (overgrazing, anthropogenic impacts, etc.). In this regard, the emerging ecological relationships between ecosystem components (biogeocenoses) primarily impact the nature of the vegetation cover.

Throughout the study area on the plain there are scattered lopatina (depressions) with soils of the meadow row. Depressions are rounded, saucer-shaped depressions of various sizes. Accumulating melt water, in early spring, such depressions turn into lakes. It is therefore not surprising that in dry steppes, where the moisture factor is decisive, the vegetation of depressions differs sharply in composition and growth pattern, clearly standing out with its lush greenery among semi-desert communities. Wheatgrass communities predominate there.

The authors conducted an assessment using the vitality index and proposed measures to improve the condition of tree and shrub species (Smirnov et al., 2020).

On meadow-chestnut soils, crested wheatgrass, Welsh fescue, and feather grass are present in smaller depressions. They differ from the surrounding cereal communities on chestnut soils by their brighter greenery. Despite their small size, such depressions clearly stand out against the background of black wormwood communities.

The acquired data on the recovery of vegetation on lahar contribute to the study of succession processes, for the first time, the rates of restoration of the vegetation cover following its destruction as a result of burial by lahar products, are estimated (Romanyuk et al., 2021).

Vegetation on chestnut clay and heavy loamy solonetzic zonal soils is represented by white wormwood-chamomile-bulbous-bluegrass-feather grass-fescue communities. However, there are very few such areas - no more than 1%. Three-membered desert-steppe complexes with solonetz on micro-elevations dominate.

Since urban areas are advanced man-made complex ecosystems consisting of nature, society, and economy, the key to assessing the health of urban ecosystems is to establish a suitable model to address the uncertainties of urban ecosystems (Yu et al., 2009; Semeraro et al., 2022).

Our combined vegetation display enhances the information content and value of the geobotanical map. This specialized map is of great practical importance, as it provides information on the state of vegetation and the productivity of forage lands (pastures and hayfields). The geobotanical map can be used to demonstrate the ecological situation of a region.

Within the micro-elevations, facies of rather diverse vegetation are formed: from camphor-wormwood with the participation of cypress and ephemerals on crusty solonetz to sedge-black wormwood and solonchak-wormwood with feather grass, kermek and ephemerals on solonetz. In micro-depressions, there are forb-couch grass-fescue-thin-legged associations on meadow-chestnut soils. In depressions, there are rich forb-narrow-leaved bluegrass-feather grass associations on powerful meadow-chestnut soils, sometimes in a complex with solonetz. On estuaries, wormwood-couch grass complexes with the participation of licorice on meadow and meadow-chestnut soils predominate.

The unsystematic selection of pasture areas for summer pens and camps contributed to the widespread distribution of weeds. Their locations changed almost every year, as a result of which the currently usable area of pastures has significantly decreased (Chibilev, 1999). Meadow communities are used for haymaking. In some areas, cattle are grazed in autumn and early spring.

Such excessive use of meadow grasses has given rise to quinoa sloughs formed by Tatar quinoa and ephemeral groups formed by deskurenia and bluegrass (Ivanov, 1958).

Conclusion. The following conclusions were reached based on the research:

- Improving the quality of generalized maps at various scales requires the implementation of objective, automated methods of cartographic generalization in a digital environment;

- A method for creating a digital geobotanical map based on ArcGIS software, accessible to a wide range of GIS users, has been developed, allowing the use of scanned cartographic bases, photographic plans, and other raster materials. Future plans include the publication of an atlas of the West Kazakhstan region.

References

About the region on the website of the Akimat of the West Kazakhstan region. (2010). http://westkaz.kz/?section=14&action=&lang=ru. (in English).

Alekhin V.V. (1938). Metodika polevogo izucheniya rastitel'nosti i flory. [Methods of field study of vegetation and flora], Moscow: Narkompros. — 208 p. https://books.totalarch.com. (in Russian).

Andryushchenko O.N. (1958). Estestvenno-istoricheskie rajony Prikaspijskoj nizmennosti

(Mezhdurech'e Volga-Ural). [Natural and historical areas of the Caspian depression (between the Volga-Urals)]. Works of the geographical faculty of the Belarusian University, Minsk. — 137-219. https://books.totalarch.com. (in Russian).

Blanco E., Zari M. P., Raskin K., Clergeau P. (2021). Urban ecosystem-level biomimicry and regenerative design: Linking ecosystem functioning and urban built environments. Sustainability (Switzerland), 13(1): 404. DOI: 10.3390/su13010404 (in English).

Chibilev A.A. (1999). Strategiya sohraneniya prirodnogo raznoobraziya v Rossij¬sko-Kazahstanskom prigranichnom regione. [Strategy for Preserving Natural Diversity in the Russian-Kazakh Border Region]. Nature Conservation. Russian Academy of Sciences, 4:116-123. https://books.totalarch.com. (in Russian).

Darbaeva T.E., Utaubaeva A.U., Tsygankova T.A. (2003). Rastitel'nyj mir Zapadno-Kazahstanskoj oblasti. [The flora of the West Kazakhstan region], Uralsk. — 92 p. https://books.totalarch.com. (in Russian).

Darbaeva, T. E. (2006). Parcial'nye flory melovyh vozvyshennostej severo-zapadnogo Kazahstana. [Partial floras of the chalk uplands of northwestern Kazakhstan]. Uralsk. — 266 p. https://books.totalarch.com. (in Russian).

Debelo P.V., Fomin V.P., Mazyarkina T.N. (2000). Protected Urals: (specially protected objects). [Zapovednoe Priural'e: (osobo ohranyaemye ob"ekty)], Uralsk: Poligrafservis. — 56 p. https://books.totalarch.com. (in Russian).

Ivanov V.V. 1958. Stepi Zapadnogo Kazahstana v svyazi s dinamikoj ih pokrova. [Steppes of Western Kazakhstan in connection with the dynamics of their cover]. Moscow: Leningrad: Publishing House of the USSR Academy of Sciences. — 288 p. https://books.totalarch.com. (in Russian).

Kambo A., Drogemuller R., Yarlagadda P.D.V. (2019). Assessing Biophilic Design Elements for ecosystem service attributes - A subtropical Australian case. Ecosystem Services, 39: 100977. DOI: 10.1016/j.ecoser.2019.100977 (in English).

Kushnyr' O.V. (2014). Analiz kontsentratsii naseleniya po dannym s rastrovoy strukturoy [Analysis of Population Concentration Using Raster Data]. Geodesy and Cartography, 7. — 39-43. https://geocartography.ru. (in Russian).

Makarov V.Z., Novakovskiy B.A., Chumachenko A.N. (2002). Ekologo-geograficheskoye kartografirovaniye gorodov [Ecological-Geographical Mapping of Cities]. Moscow: Nauchnyy mir. — 125 p. https://books.totalarch.com. (in Russian).

Osadowski Z. Drzymulska D. Dobrowolski R. Mazurek M. (2019). Current state and vegetation history of spring-fed fens in Western Pomerania (Northern Poland): a case study of the Chociel River valley. Wetlands Ecology and Management, 1(27): 23-38. DOI: 10.1007/s11273-018-9640-9 (in English).

Petrenko A.Z., Dzhubanov A.A., Fartushina M.M., Irkalieva R.M., Ramazanov S.K., Sdykov M.N., Darbaeva T.E., Kolchenko O.T., Chernyshov D.M. (1998). Prirodno-resursnyj potencial i proektiruemye ob"ekty zapovednogo fonda Zapadno-Kazahstanskoj oblasti. [Natural resource potential and planned objects of the protected fund of the West Kazakhstan region]. Uralsk: West Kazakhstan State University. — 176 p. https://books.totalarch.com. (in Russian).

Petrenko A.Z., Dzhubanov A.A., Fartushina M.M., Chernyshev D.M., Tubetov Zh.M. (2001). Zelenaya kniga Zapadno-Kazahstanskoj oblasti. Kadastr ob"ektov prirodnogo naslediya. [Green Book of West Kazakhstan Region. Cadastre of natural heritage objects], Uralsk: Publishing House of West Kazakhstan State University. — 194 p. https://books.totalarch.com. (in Russian).

Romanyuk F.A., Kordyukov A.V. (2021). Vegetation cover of the lahar valley on the Sarychev Peak volcano (Matua Isl., Middle Kuril Islands) after the Eruption in 2009: current state and features of succession processes. Journal of Mountain Science, 7(18):1762-1777. DOI: 10.1007/s11629-020-6437-0 (in English).

Salikhov T.K. (2017). Rare, relict and vulnerable endangered plant species of the "Bokeyorda" Projected State Nature Reservation of West Kazakhstan region. Reports of National Academy of Sciences of the Republic of Kazakhstan, 3 (367). — 127-136. https://www.webofscience.com. (in English).

Salikhov T.K., Salikhova T.S., Tolegenov I.M., Sharipova B.U., Kapbasova G.A. (2023). Study of the Vegetation Cover of Ecosystems of the Chingirlau district of the West Kazakhstan region Based on the use of GIS Technologie. NEWS of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, 4(460):187-197. https://www.scopus.com. (in English).

Salikhov T.K., Abekeshev A.I., Abisheva G.O., Issayeva Z.B., Khussainov M.B. (2024). Study of the Ecosystem and Unique Natural objects of the Chingirlau district of the West Kazakhstan region using GIS Technologies. NEWS of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, 5 (467):128-154. http://www.geolog-technical.kz/en/archive/2024/20245/. (in English).

Smirnov I.A., Nikonov M.V. (2020). The current state of wood and shrubby vegetation in the parks of Novgorod region and measures for their conservation. "International scientific and practical conference biotechnology in the agro-industrial complex and sustainable environmental management". IOP Conference Series-Earth and Environmental Science, 613:012140. DOI: 10.1088/1755-1315/613/1/012140 (in English).

Shomanova Z., Safarov R., Shomanov A., Shomanov A., Tleulessov A.,Berdenov Z., David L. (2019). Aspects of assessment of ecological impact of an ash-sludge collector of pavlodar aluminum plant (Kazakhstan). Journal of Landscape Ecology, 17(1):47-62. DOI: 10.1589/46732019171 (in English).

Semeraro T., Buccolieri R. (2022). Editorial: "Urban Ecosystem Service Assessments". Frontiers in Environmental Science 10: 825002. DOI: 10.3389/fenvs.2022.825002 (in English).

Yu P., Zhou J.X., Li X.M. (2009). A set pair analysis model for urban ecosystem health assessment. 3rd International Conference on Bioinformatics and Biomedical Engineering, Beijing, Peoples R China, 1(11):6381-6384. DOI: 10.1109/icbbe.2009.5162238. (in English).

Zari M.P. (2019). Devising Urban Biodiversity Habitat Provision Goals: Ecosystem Services Analysis. Forests, 5(10): 391-398. DOI: 10.3390/f10050391 (in English).

Publication Ethics and Publication Malpractice in the journals of the Central Asian Academic Research Center LLP

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the journals of the Central Asian Academic Research Center LLP implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier. com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The Central Asian Academic Research Center LLP follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics. org/files/ u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/ or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the Central Asian Academic Research Center LLP.

The Editorial Board of the Central Asian Academic Research Center LLP will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:
www:nauka-nanrk.kz
http://www.geolog-technical.kz/index.php/en/
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Ответственный редактор *А. Ботанқызы*
Редакторы: *Д.С. Аленов, Т. Апендиев*
Верстка на компьютере: *Г.Д. Жадырановой*

Подписано в печать 06.02.2026.
Формат 70x90$^{1}/_{16}$. 20,5 п.л.
Заказ 1.

«Central Asian Academic Research Center» LLP
Алматы, Шевченко к-сі, 28