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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
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©T.K. Salikhov[1,2*], Y.S. Kabiyev[3], B.B. Doskenova[4], H. Onal[5], Zh.B. Akhmetzhanov[6], 2025.
[1]L.N. Gumilyov Eurasian National University, Astana, Kazakhstan;
[2]ESIL University, Astana, Kazakhstan;
[3]Kh. Dosmukhamedov Atyrau University, Atyrau, Kazakhstan;
[4]M. Kozybayev North Kazakhstan State University, Petropavlovsk, Kazakhstan;
[5]Balikesir University, Balikesir, Turkey;
[6]Al-Farabi Kazakh National University, Almaty, Kazakhstan.
E-mail: tuatai_76@mail.ru

RESEARCH OF THE SOIL COVER ECOSYSTEM IN THE WEST KAZAKHSTAN REGION ON THE BASIS OF REMOTE SENSING AND GIS-TECHNOLOGY

Salikhov Talgat Kumarovich – Candidate of Agricultural Sciences, Associate Professor of L.N. Gumilyov Eurasian National University, Astana, Kazakhstan; Professor of ESIL University, Astana, Kazakhstan, E-mail: tuatai_76@mail.ru, https://orcid.org/0000-0002-8720-0931;
Kabiyev Yerlan Syrymovich – PhD, Associate Professor at Kh. Dosmukhamedov Atyrau University, Atyrau, Kazakhstan, E-mail: yerlanustaz@gmail.com, https://orcid.org/0000-0002-4600-6550;
Doskenova Banu Beisenovna – Candidate of Biological Sciences, Head of the Department of Geography and Ecologyof M. Kozybayev North Kazakhstan State University, Petropavlovsk, Kazakhstan, E-mail: bdoskenova@ku.edu.kz, https://orcid.org/0000-0001-7369-0987;
Hakan Onal – PhD, professor of Balikesir University, Balikesir, Turkey, E-mail: onal@balikesir.edu.tr, https://orcid.org/0000-0001-8434-9880;
Akhmetzhanov Zhanbolat Bekmaganbetovich – 1st year 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.

Abstract. Soil research at the present stage is aimed at studying the ecological state of the soil cover and for management, regulation and rational use of land it is necessary to conduct a quantitative and qualitative assessment of soil resources. Therefore, rational use and protection of the soil cover in market conditions requires adequate application of new scientific and methodological approaches based on Earth remote sensing methods and new information technologies.

The purpose of our research is to study the current state of the soil cover and develop thematic maps of the West Kazakhstan region based on the use of Earth remote sensing methods and GIS technologies.

To carry out research work, generally accepted methods of environmental, physical, water-physical, chemical, physicochemical, cartographic and remote sensing, corresponding to GOST and others were used. Physicochemical indicators of soils were studied by generally accepted methods. The development of a large-scale soil map using GIS technologies was carried out on the basis of ArcGIS. Soil studies were conducted to establish the taxonomic affiliation of soils, identify patterns of their formation and determine the structure of the soil cover to assess the resistance of soils to technogenic impacts. As a result of the studies, field studies were conducted with mapping of the soil cover using traditional ground methods and using GIS technologies based on the widespread use of aerial photographs of various resolutions. This made it possible to characterize soil combinations by the signs of their belonging to a certain genetic-geometric form, the conditions of their location and their quantitative indicators.

The results of the study can be used in studying the soil cover of the West Kazakhstan region under the influence of endogenous and exogenous processes to predict and improve soil fertility.

Key words: soil cover, ecosystem, territory, digital maps, GIS technologies.

©Т.Қ. Салихов[1,2*], Е.С. Кабиев[3], Б.Б. Доскенова[4], Х. Онал[5], Ж.Б. Ахметжанов[6], 2025.

[1]Л.Н. Гумилев атындағы Евразия ұлттық университеті, Астана, Қазақстан;
[2]ESIL университеті, Астана, Қазақстан;
[3]Х. Досмұхамедов атындағы Атырау университеті, Атырау, Қазақстан;
[4]М. Қозыбаев атындағы Солтүстік Қазақстан мемлекеттік университеті, Петропавловск, Қазақстан;
[5]Балыкесир университеті, Балыкесир, Түркия;
[6]әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан.
E-mail: tuatai_76@mail.ru

ҚАШЫҚТЫҚТАН ЗОНДТАУ ЖӘНЕ ГИС ТЕХНОЛОГИЯЛАРЫНЫҢ НЕГІЗІНДЕ БАТЫС ҚАЗАҚСТАН ОБЛЫСЫ ЭКОЖҮЙЕЛЕРІНІҢ ТОПЫРАҚ ЖАМЫЛҒЫСЫН ЗЕРТТЕУ

Салихов Талғат Құмаруұлы – ауыл шаруашылығы ғылымдарының кандидаты, Л.Н. Гумилев атындағы Еуразия ұлттық университетінің қауымдастырылған профессоры, Астана, Қазақстан; ESIL университетінің профессоры, Астана, Қазақстан, E-mail: tuatai_76@mail.ru, https://orcid.org/0000-0002-8720-0931;

Кабиев Ерлан Сырымұлы – PhD, Х. Досмұхамедов атындағы Атырау университетінің қауымдастырылған профессоры, Атырау, Қазақстан, E-mail: yerlanustaz@gmail.com, https://orcid.org/0000-0002-4600-6550;

Доскенова Бану Бейсеновна – биология ғылымдарының кандидаты, М.Қозыбаев атындағы Солтүстік Қазақстан мемлекеттік университетінің География және экология кафедрасының меңгерушісі, Петропавловск, Қазақстан, E-mail: bdoskenova@ku.edu.kz, https://orcid.org/0000-0001-7369-0987;

Хакан Онал – PhD, Балыкесир университетінің профессоры, Балыкесир, Түркия, E-mail: onal@balikesir.edu.tr, https://orcid.org/0000-0001-8434-9880;
Ахметжанов Жанболат Бекмағанбетұлы – әл-Фараби атындағы Қазақ ұлттық университетінің 8D01503 – География ОБ 1 курс докторанты, Алматы, Қазақстан, E-mail: Akhmetzhanov.zhanbolat@mail.ru, https://orcid.org/0009-0001-1893-4659.

Аннотация. Қазіргі кезеңде топырақты зерттеу топырақ жамылғысының экологиялық жағдайын зерттеуге бағытталған және жерді басқару, реттеу және ұтымды пайдалану үшін топырақ ресурстарына сандық және сапалық бағалау жүргізу қажет. Сондықтан нарық жағдайында топырақ жамылғысын ұтымды пайдалану және қорғау Жерді қашықтықтан зондтау әдістеріне және жаңа ақпараттық технологияларға негізделген жаңа ғылыми-әдістемелік тәсілдерді барабар қолдануды талап етеді.

Біздің зерттеу жұмысымыздың мақсаты – Батыс Қазақстан облысының топырақ жамылғысының қазіргі жағдайын зерттеу және қашықтықтан зондтау әдістерін және ГАЖ технологияларын қолдану негізінде тақырыптық карталарын жасау. Ғылыми зерттеулерді жүргізу үшін жалпы қабылданған экологиялық, физикалық, су-физикалық, химиялық, физикалық-химиялық, картографиялық және ГОСТ-қа сәйкес келетін қашықтықтан зондтау әдістері қолданылды. Топырақтардың физика-химиялық көрсеткіштері жалпы қабылданған әдістермен зерттелді. GIS технологияларын қолдана отырып, ауқымды топырақ картасын жасау ArcGIS негізінде жүзеге асырылды.

Топырақтың техногендік әсерлерге төзімділігін бағалау үшін топырақтың таксономиялық тиістілігін анықтау, олардың түзілу заңдылықтарын анықтау және топырақ жамылғысының құрылымын анықтау мақсатында топырақ зерттеулері жүргізілді. Жүргізілген зерттеулердің нәтижесінде әртүрлі рұқсаттағы аэрофототүсірілімдерді кеңінен қолдану негізінде дәстүрлі жер әдістерін қолдана отырып және ГАЖ технологияларын пайдалана отырып, топырақ жамылғысын картаға түсіру арқылы далалық зерттеулер жүргізілді. Бұл топырақ комбинацияларын олардың белгілі бір генетикалық-геометриялық формаға жату белгілеріне, орналасу жағдайларына және олардың сандық көрсеткіштеріне қарай сипаттауға мүмкіндік берді.

Зерттеу нәтижелерін эндогендік және экзогендік процестердің әсерінен Батыс Қазақстан облысының топырақ жамылғысын зерттеуде топырақ құнарлығын болжау және жақсарту үшін пайдалануға болады.

Түйін сөздер: топырақ жамылғысы, экожүйе, аумақ, цифрлық карталар, ГАЖ технологиялары.

©Т.К. Салихов[1,2*], Е.С. Кабиев[3], Б.Б. Доскенова[4], Х. Онал[5], Ж.Б. Ахметжанов[6], 2025.

[1]Евразийский национальный университет имени Л.Н. Гумилева, Астана, Казахстан;

[2]Университет ESIL, Астана, Казахстан;

[3]Атырауский университет имени Х. Досмухамедова, Атырау, Казахстан;

[4]Северо-Казахстанский государственный университет им. М. Козыбаева, Петропавловск, Казахстан;

[5]Университет Балыкесир, Балыкесир, Турция;

[6]Казахский национальный университет имени аль-Фараби, Алматы, Казахстан.

E-mail: tuatai_76@mail.ru

ИССЛЕДОВАНИЯ ПОЧВЕННОГО ПОКРОВА ЭКОСИСТЕМ ЗАПАДНО-КАЗАХСТАНСКОЙ ОБЛАСТИ НА ОСНОВЕ ДИСТАНЦИОННОГО ЗОНДИРОВАНИЯ И ГИС-ТЕХНОЛОГИЙ

Салихов Талгат Кумарович – кандидат сельскохозяйственных наук, ассоциированный профессор Евразийского национального университета им. Л.Н. Гумилева, Астана, Казахстан; профессор университета ESIL, Астана, Казахстан, E-mail: tuatai_76@mail.ru, https://orcid.org/0000-0002-8720-0931;

Кабиев Ерлан Сырымович – PhD, Ассоциированный профессор Атырауского университета им. Х.Досмухамедова, Атырау, Казахстан, E-mail: yerlanustaz@gmail.com, https://orcid.org/0000-0002-4600-6550;

Доскенова Бану Бейсеновна – кандидат биологических наук, заведующий кафедрой географии и экологии Северо-Казахстанского государственного университета им. М. Козыбаева, Петропавловск, Казахстан, E-mail: bdoskenova@ku.edu.kz, https://orcid.org/0000-0001-7369-0987;

Хакан Онал – PhD, профессор Университета Балыкесир, Балыкесир, Турция, E-mail: onal@balikesir.edu.tr, https://orcid.org/0000-0001-8434-9880;

Ахметжанов Жанболат Бекмаганбетович – докторант 1 курса ОП 8D01503 – География Казахского Национального университета им. аль-Фараби, Алматы, Казахстан, E-mail: Akhmetzhanov.zhanbolat@mail.ru, https://orcid.org/0009-0001-1893-4659.

Аннотация. Почвенные исследования на современном этапе направлены на изучение экологического состояния почвенного покрова и для управления, регулирования и рационального использования земель необходимо проводить количественную и качественную оценку почвенных ресурсов. Поэтому рациональное использование и охрана почвенного покрова в рыночных условиях требует адекватного применения новых научно-методических подходов на основе методов дистанционного зондирования Земли и новых информационных технологий.

Целью наших исследований является изучение современного состояния почвенного покрова и разработка тематических карт Западно-Казахстанской области на основе использования методов дистанционного зондирования Земли и ГИС-технологий. Для проведения научно-исследовательских

работ использовались общепринятые методы экологических, физических, водно-физических, химических, физико-химических, картографических и дистанционного зондирования, соответствующие ГОСТ и др. Физико-химические показатели почв изучались общепринятыми методами. Разработка крупномасштабной почвенной карты с использованием ГИС-технологий проводилась на базе ArcGIS.

Почвенные исследования проводились для установления таксономической принадлежности почв, выявления закономерностей их формирования и определения структуры почвенного покрова для оценки устойчивости почв к техногенному воздействию. В результате исследований проведены полевые исследования с картографирование почвенного покрова традиционными наземными методами и с применением ГИС-технологий на основе широкого использования аэрофотоснимков различного разрешения. Это дало возможность охарактеризовать почвенные комбинации по признакам их принадлежности к определенной генетико-геометрической форме, условиям их расположения и их количественным показателям.

Результаты исследования можно будет использовать при изучения почвенного покрова Западно-Казахстанской области при влияний эндогенных и экзогенных процессов для прогнозировании и повышения плодородия почв.

Ключевые слова: почвенный покров, экосистема, территория, цифровые карты, ГИС-технологий.

Introduction

The soil cover of the Republic of Kazakhstan ranks ninth in the world in terms of area and is characterized by great diversity, including more than seven hundred types of soils differing in chemical, physicochemical properties and fertility levels. The soils of Kazakhstan develop in arid and extreme conditions, are subject to degradation and desertification processes, and differ from the soils of other countries in their low resistance to anthropogenic loads (Saparov, 2006).

The survey and qualitative assessment of soil resources conducted on the basis of regional soil maps showed that out of the total area of the republic of 272.5 million hectares, the steppe zone of chernozems accounts for 25.8 or 9.4%. This is the main agricultural zone for the production of commercial grain. The dry steppe and desert-steppe zone of chestnut soils occupies 90.4 million hectares or 33.2% of the territory. Unsustainable and semi-sustainable agriculture and meat and dairy farming are developed here. The largest area is occupied by the desert zone of brown, gray-brown and takyr-like soils - 119.2 million hectares or 43.7%. This is a livestock zone with oases of irrigated agriculture in water-rich areas. Soils of mountainous regions occupy 37.1 million hectares or 13.7% (Faizov, et al., 2006; Sagandykova, et al., 2024).

Soil research at the present stage is aimed at studying the ecological state of the soil cover (State land cadastre of the Republic of Kazakhstan, 1998) and for the management, regulation and rational use of lands it is necessary to carry out

a quantitative and qualitative assessment of soil resources, which are taken into account when calculating soil quality scores (Mishustin, et al., 1957). Taking into account that natural ecosystems are becoming fewer and fewer on our planet and it is possible that in the future they may completely disappear from the face of the earth, it is necessary to pay close attention to the study of virgin soils as natural self-regulating systems. Understanding the patterns and mechanisms of this self-regulation is very important for the correct use of soils in the national economy, for maintaining their fertility at a high level and creating agrobiocenoses with optimal properties.

Preservation and improvement of soil fertility is a major part of the general problem of rational use of land resources, increasing productivity and improving the soil ecology of agricultural landscapes.

Modern soil assessment is relevant for the development of the state and society because it provides information on accounting for geographical distribution, soil value, rational use, protection and planning of soil use.

Therefore, rational use and protection of soil cover in market conditions requires adequate application of new scientific and methodological approaches based on remote sensing methods and new information technologies. Therefore, in the course of writing the article, the current state of physical and geographical characteristics, the development of principles for physical and geographical assessment of lands, the identification of negative processes affecting the state of lands and the analysis of the physical and geographical state of lands were studied.

The fundamental principle for identifying valuable areas should be an ecosystem approach based on a comprehensive assessment of the ecological state of the natural components of the territory - ecosystems, plant communities, soil, wildlife and other components of the natural environment using remote sensing data and GIS technologies. The use of the ecosystem approach concept as a methodological basis for identifying steppe ecosystems will ensure an assessment of the qualitative potential of biodiversity based on the existing correlation between the ecotope (habitat type), vegetation type and animal population. The ecosystem approach allows for a component-by-component (relief, soil, vegetation and associated animal population) assessment of both the ecological potential of habitats and the diversity potential of biota (Salikhov, et al., 2024). Despite the abundance of literature devoted to soil cover, the biochemical mechanisms that control the formation of fertility remain insufficiently studied. The path to their understanding and management largely lies through the study of specific soil formation processes occurring in virgin and cultivated soils.

The goal of our research is to study the current state of the soil cover and develop thematic maps of the West Kazakhstan region based on the use of remote sensing (RS) methods and GIS technology.

Research materials and methods

In conducting experimental and research works, generally accepted methods of ecological, physical, water-physical, chemical, physical-chemical and remote sensing, corresponding to GOST, etc. were used. For conducting large-scale soil

surveys, the corresponding methodological recommendations were followed. Physicochemical parameters of soils were studied by generally accepted methods. To master the methods of GIS technology in soil research, paper soil maps of different scales from 1:25,000 to 1:100,000 were used (for searching and identifying reference areas). The development of a large-scale soil map using GIS technologies was carried out on the basis of the ArcGIS software product using scanned paper maps, and systematic soil names of soils of the West Kazakhstan region were also used (Salikhov, 2018; Salikhov, et al., 2024; Tuleyeva, et al., 2024).

Soil studies are carried out in order to establish the taxonomic affiliation of soils, identify patterns of their formation and determine the structure of the soil cover to assess the resistance of soils to technogenic impacts (Grishina, et al., 1991).

Comprehensive soil research work was carried out on the lands of the West Kazakhstan region. The research was carried out on a scale of 1:100,000-1:2000,000. Aerial photography and photo plans of the surveyed area were used in the research, and systematic soil names of the soils of the West Kazakhstan region were also used.

To determine the genetic name of the soils and select soil samples, the main sections are laid to a depth of 1.2-2.5 m, the number of which depended on the complexity category of the terrain and the scale of the survey (Salikhov, 2018).

To establish the contours of the distribution of soils, semi-pits were prepared to a depth of 75-120 cm, and to clarify their boundaries, diggings were made to a depth of 40-75 cm, the number of which was twice as much as the main sections.

Samples were taken from the soil sections for soil analysis to determine the physical, biological and chemical characteristics of the soils. For the complete determination of soil profile samples the following methods and calculations were used:

- determination of mechanical and microaggregate composition of soils (Methodological guidelines for soil appraisal in the Kazakhstanskaya SSR, 1979);
- determination of soil moisture by the soil drying method (Methodological guidelines for soil appraisal in the Kazakhstanskaya SSR, 1979);
- determination of the density of the solid phase of soils (Methodological guidelines for soil appraisal in the Kazakhstanskaya SSR, 1979);
- determination of the bulk density of soils (Methodological guidelines for soil appraisal in the Kazakhstanskaya SSR, 1979);
- determination of the moisture content of stable soil management (Methodological guidelines for soil appraisal in the Kazakhstanskaya SSR, 1979);
- determination of the minimum and total moisture capacity of soil management (Methodological guidelines for soil appraisal in the Kazakhstanskaya SSR, 1979);
- determination of the solid phase and total porosity of soils (Methodological guidelines for the appraisal of soils in the Kazakhstanskaya SSR, 1979);
- determination of the water-to-air ratio at various hydrological constants of soils (Methodological guidelines for the appraisal of soils in the Kazakhstanskaya SSR, 1979);
- determination of humus according to Tyurin (Salikhov, 2018);
- determination of mobile phosphorus according to Machigin (Salikhov, 2018);

- determination of hydrolyzable nitrogen according to Tyurin-Kononov (Salikhov, 2018);
- total nitrogen was determined according to Kjeldahl (Salikhov, 2018);
- mobile potassium was determined according to Protasov (Salikhov, 2018);
- pH was determined on an aqueous extract (Salikhov, 2018).

Field soil studies include the establishment and description of soil profiles; soil samples are taken if necessary. The location of the soil profile to characterize background soils is selected taking into account the most typical natural conditions for the contour. The depth of soil pits is determined by the depth of soil-forming processes. Taxonomic definition of soil is made on the basis of description of soil pit in accordance with the accepted classification.

Research object: soil cover of the West Kazakhstan region, where monitoring sites were designated, their data were applied to the topographic base and GPS coordinates were recorded.

Mapping was carried out using remote sensing data and GIS technologies. The initial stage of creating digital maps can be designated as processing high-resolution satellite data. For these purposes, specialized software products ENVI 4.0 are successfully used. They allow to make a number of necessary corrections and subsequent classifications with allocation of various classes for export to GIS. Topographic paper bases of 1:100,000 scale are also subject to appropriate processing: from scanning and georeferencing to vectorization and creation of a database. Today, it is advisable to create digital maps and Geodatabases using software products of the ESRI company such as ArcGIS, MAPINFO, which are recognized as the best in their field. All of the above vector layers, when superimposed on a map, will allow us to identify the nature of the distribution of various research objects in different types of soil.

The methodology used in the work is divided depending on the type of research. Thus, when performing descriptive studies, an analytical research method will be used, as well as an analysis of information about research objects, the flow of conditions in the area of the object's study, biota in the territory of the object's study. In addition, analytical research methods will be used when describing environmental risks and the ecological state in the territory of the restriction.

A systemic approach to studying the environment. The very idea of systemic use is proposed (Isachenko, 1991). This is the preservation of this or that phenomenon as a whole, complex, consisting of the interaction of elements. The idea is not new to many branches of knowledge, in particular, in geoecology. Geoecological studies of the city will be carried out on the basis of the methodology developed by (Glazovskaya, et al., 1989).

Comprehensive study of local territories by methodology. The work may use scientific and methodological solutions and ideas of complex and system mapping, laid down by (Berlyant, 1978; Isachenko, 1991). The constructions of mathematical and cartographic modeling will be carried out according to the methods known to scientists in the field of geoinformation mapping (Berlyant, 1978; Tikunova, et al., 2012; Lurye, 2008).

The comparative method of analysis will be used to analyze the research results obtained for different objects.

Particularly noteworthy is the complex nature of the research, the use of the latest research methods (GIS technologies, creation of geodatabases, coverage interpretation, etc.). An important stage of implementation is the conduct of seasonal natural, expeditionary research and research in different areas of the region.

Methods of collecting primary (initial) information, its source and application to solve project problems, data processing methods, as well as ensuring their reliability and reproducibility.

Results

The West Kazakhstan region occupies the northwestern part of Kazakhstan. Its geographic coordinates are between 51°35′ and 48° north latitude and 45°30′ and 54°35′ east longitude. The maximum length of the region from north to south is 425 km, from west to east - 585 km. Its total area exceeds 15 million hectares. The West Kazakhstan region is located in the central part of Eurasia, in the northwest of the Republic of Kazakhstan and borders on six regions: in the southwest - with Astrakhan; in the west - with Volgograd; in the north - with the Saratov and Orenburg regions of the Russian Federation; in the east - with Aktobe; in the south - with the Atyrau regions of Kazakhstan (Fig. 1). At the junction of the borders of the Saratov and Orenburg regions, the territory of the Samara region of Russia adjoins. The total length of the border with the Russian Federation is 2423 km. The climate of the West Kazakhstan region is characterized by sharp continentality, which increases from the northwest to the southeast.

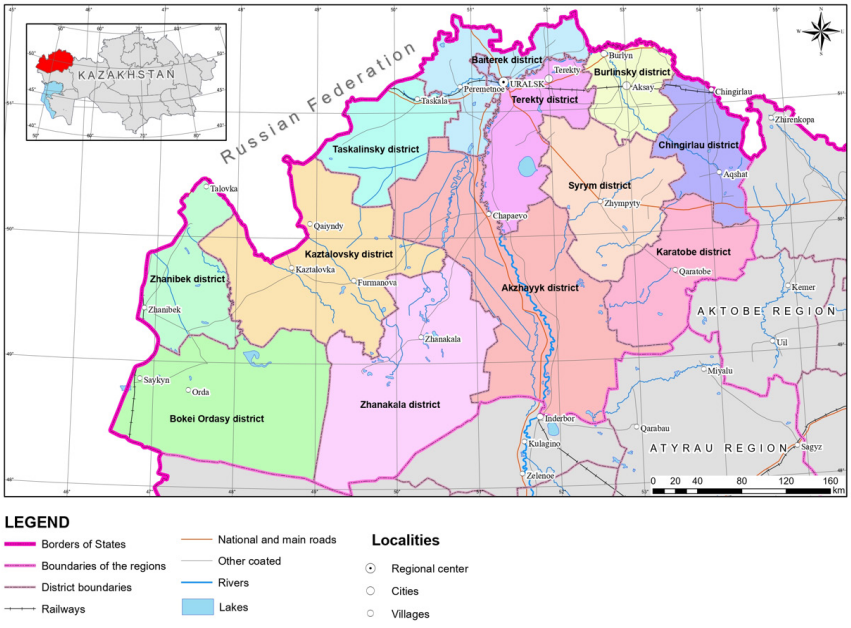

Figure 1 – Administrative map of the West Kazakhstan region

It manifests itself in sharp temperature contrasts of day and night, winter and summer, in the rapid transition from winter to summer. The entire region is characterized by instability and deficiency of precipitation, little snow and strong blowing of snow from the fields, great dryness of air and soil, intensity of evaporation processes and abundance of direct sunlight throughout the growing season. Winter is cold, mostly cloudy, but not long, and summer is hot and quite long.

The surface of the region regularly descends from the northeast to the southwest and is quite clearly divided into five large geomorphological regions: the western part of the Sub-Ural plateau, the southern part of the Obshchy Syrt upland, the Predsyrt ledge, the northern part of the Caspian lowland and the valley of the middle reaches of the Zhaiyk River (Ural). In the south, within the Caspian lowland, there are sand massifs of Naryn, Akkum, Karagash and others (Fig. 2). The highest point of the region, an upland in the area of the former village of Otradnoye, its height above sea level is 262 meters (Shybyndy).

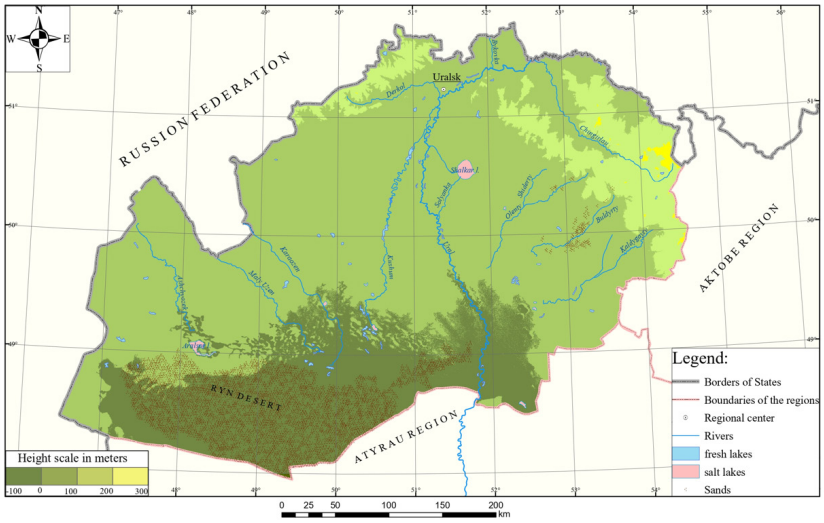

Figure 2 – Physical and geographical map of ecosystems of the West Kazakhstan region

The soils are southern chernozems, dark chestnut, medium chestnut, light chestnut, solonetz and solonchak. In the southern regions there are brown soils, solonetz and solonetzic soils, there are sand massifs (Kotin, 1967).

This systematic description identifies the soil subdivisions that we encountered in the territory of the study area. Detailed diagnostic indicators are given for the most common soil varieties within the West Kazakhstan region. Characteristic morphological genetic features of soils are indicated, based on the available data from field studies and office processing.

The soil cover of the study area is successively replaced from north to south by the following 5 soil subzones of the steppe, desert-steppe (semi-desert) and desert zone:

subzone of southern chernozem soils (moderately arid steppe);
subzone of dark chestnut soils (dry steppe);
subzone of medium chestnut soils (dry steppe);
subzone of light chestnut soils (semi-desert);
subzone of brown soils (northern desert).

In the surveyed area, the soil type - chestnut soils are mainly formed in the structure of the soil cover. Chestnut soils are formed in the conditions of the dry steppe zone, with a non-leaching type of water regime, under the fescue-feather grass association, on loess-like loams. Due to the aridity, the sharply continental climate, specific conditions for soil formation are created.

The development of a large-scale soil map using GIS technologies was carried out on the basis of the ArcGIS software product using scanned paper maps with a scale of 1:25,000 to 1:100,000.

Figure 3 shows a large-scale soil map of the ecosystems of the West Kazakhstan region, which we created using the above-described method based on scanned soil maps.

The Zhaiyk River basin in the study area within the endorheic basin is composed of lacustrine-alluvial saline deposits and is an area of accumulation of liquid and solid runoff from adjacent territories. The close occurrence of groundwater and the high degree of salinity of tertiary clays, which act as parent rocks, predetermine the dominance of hydromorphic and semi-hydromorphic soils of varying degrees of salinity in the structure of the soil cover.

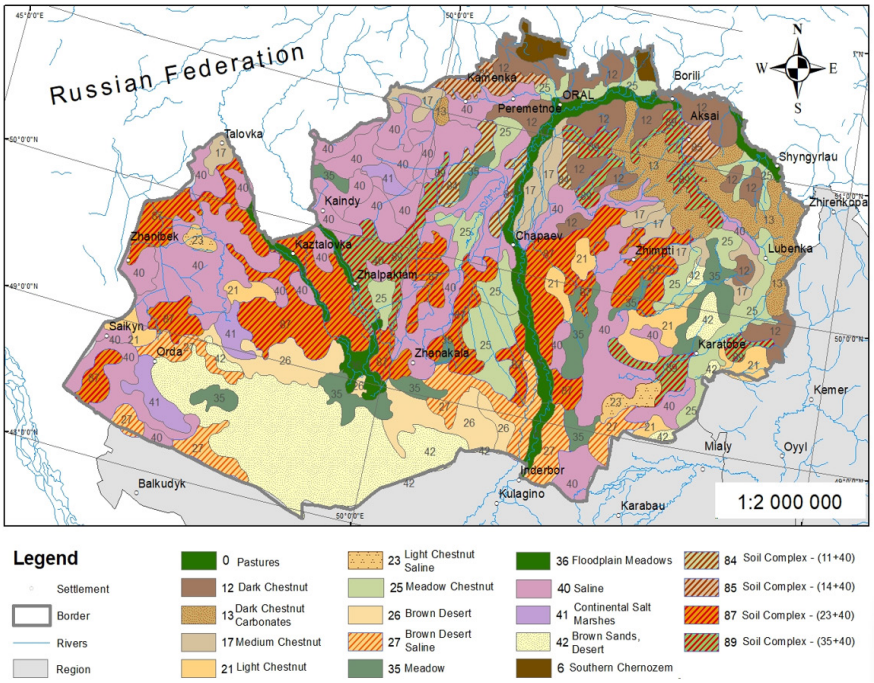

Figure 3 – Soil map of ecosystems of the West Kazakhstan region

The soil cover of the study area is very diverse (Fig. 3). The parent rocks are light loams and sandy loams, less often medium loams, and in the Zhaiyk River valley, alluvial deposits of various mechanical compositions. The soil cover of the territory is characterized by high salinity, mainly medium mechanical composition and also has a distribution of hydromorphic soils, solonchaks and solonetz. Homogeneous soil massifs are rare, most often in the form of complexes and combinations.

The soil cover of the study area is characterized by heterogeneity and a complex structure with a wide development of soil combinations (complexes, combinations, patches). Its formation occurs in conditions of arid and sharply continental climate of temperate, dry and desert steppes. According to the nature of soil moisture, the areas are divided into three series: automorphic, semi-hydromorphic and hydromorphic. The automorphic series includes three types of zonal. soils: chernozems, represented by the subtype of southern chernozems; chestnut, divided into three subtypes: dark chestnut, medium chestnut and light chestnut, and brown.

The main types of soil cover of the territory are described below. Southern chernozems are confined to the highest places of the Utva-Ilek watershed, which are clearly expressed in the relief salt-dome uplifts, and are also sporadically found on the General Syrt. The parent rocks are eluvium of chalk rocks. The thickness of the humus horizon (A+B) is 45-65 cm, boils from the surface from hydrochloric acid. The humus content in the horizon A is 4.5-6%. In terms of mobile phosphorus reserves, they are classified as low- and medium-provided forms available to plants. They are rich in mobile potassium and, compared to other soils, contain quite a lot of hydrolyzable nitrogen. A more complete picture of their morphological structure can be obtained from the following descriptions.

Section 001. Found 14.5 km east of the village of Beibitshilik, Baiterek district. Absolute height 126 m. Flat surface of the White Syrt. Arable land, wheatgrass sowing. The humus horizon (A+B) is 60 cm thick. The soil effervesces from hydrochloric acid on the surface. Carbonates are released in the form of vague spots from 60 to 103 cm. There are no salts.

A_a 0-20 cm. Dark gray, fresh, slightly compacted, strongly rooted, fine-grained-silty-lumpy, clayey.

B 20-60 cm. Brownish-gray with separate yellow-brown mole-types, fresh, compacted, rooted, granular-lumpy, clayey.

C_K 60-103 cm. Yellow-brown with whitish vague spotted accumulations of carbonates and gray-brown small streaks, fresh, dense, prismatic-nutty, clayey.

C_2 103-170 cm. Pale, fresh, highly compacted, large-block, clayey.

Southern solonetzic chernozems occupy small areas on the slopes of the General Syrt, in the northern part of the region. Unlike other types of southern chernozems, they are significantly compacted in the lower part of the humus horizon, which is due to the presence of absorbed sodium (up to 10% of the total bases) in the absorbing complex, and also contain less organic matter. Usually, solonetz spots are found among them. This type is used for arable land, but requires a decrease in the density of the subsoil layer, which is achieved by using special agricultural technology.

Dark chestnut soils are very common in the region. They are formed on flat elevated watershed areas and in the upper parts of gentle slopes. The vegetation cover in the virgin state is represented by fescue-feather grass associations with an admixture of forbs and shrubs. Due to the almost continuous ploughing of the territory, it has been preserved only in very small areas. The groundwater table is deep (usually deeper than 10 m), so it does not affect soil formation. The parent rocks for dark chestnut soils are most often eluvial deposits of the Paleogene and Upper Cretaceous age, as well as Neogene and Quaternary deposits.

Section 002. Situated 9.5 km southwest of the Beles railway station in the Baiterek district. Absolute height 80 m. Flat elevated plain. Pashiya, wheat crop. Humus horizon thickness (A+B) 66 cm. Soil effervesces from 20-22 cm. Carbonates are released from 66 to 115 cm in the form of clearly defined brownish-white spots, salts from 150 cm to the bottom (170 cm) in the form of rare white spots.

A_a 0-20 cm. Dark chestnut, fresh, loose, rooted, loosely lumpy-silty, clayey,

B 20-66 cm. Brown-chestnut, fresh, compacted, weakly rooted, lumpy finely nutty, clayey.

C_1 66-115 cm. Yellow-brown with brownish-white clearly defined spots of carbonates, fresh, dense, nutty, clayey.

C_2 115-150 cm. Pale, fresh, compacted, fine-pored, lumpy, clayey.

C_3 150-170 cm. Brownish-yellow with rare white small spots of salts, moistened, compacted, lumpy, clayey.

Dark chestnut carbonate soils are widespread in the elevated areas of the Sub-Ural chalk plateau, where they usually predominate among other soils. They are also found on the General Syrt. Unlike dark chestnut normal soils, they effervesce from hydrochloric acid from the surface and have a more powerful humus horizon. In the virgin state, they are cracked from the surface, and when cultivated in the subsoil layer, they retain a tongue and significant compaction. Dark chestnut carbonate soils are formed on elevated plain watershed areas, mainly on Cretaceous rocks, their eluvium and less often on younger carbonate rocks. Their vegetation cover in the virgin state is represented by fescue-feather grass associations and other grasses. Groundwater lies deep (deeper than 10 m), as a result of which they do not have a significant effect on soil formation.

Section 003. It is laid 9.2 km south-southeast of the Angaty railway station, 34 km south of the village of Burlin in the Burlin district on a flat elevated plain. Absolute height 112 m. Arable land, barley sowing. The thickness of the humus horizon (A + B) is 48 cm. The soil effervesces from hydrochloric acid from the surface. Carbonates are released from 48 to 83 cm in the form of sharply defined spots, salts from 115 cm to the bottom (155 cm) in the form of small spots.

A_a 0-20 cm. Dark chestnut, fresh, loose, rooted, lumpy-silty, heavy loamy.

B_1 20-32 cm. Brown-chestnut, fresh, compacted, coarsely lumpy, weakly rooted, clayey.

B_2 32-48 cm. Yellow-brown with rare brown-chestnut streaks, fresh, compacted, few roots, lumpy, clayey.

C_1 48-83 cm. Brownish-yellow with brownish-white carbonate accumulations in the form of spots, fresh, dense, roots are rare, prismatic-nutty, medium loamy.

C_2 83-115 cm. Brownish-yellow, moist, compacted, roots are found singly, structureless, finely porous, medium loamy.

C_3 115-155 cm. Brownish-yellow with small white salt spots, moist, loamy, no roots, medium loamy.

Medium-chestnut soils are formed on rocks of light mechanical composition (sandy loams, sands and light loams of alluvial origin, usually layered). Their vegetation cover is most often represented by fescue-sandy-feather grass groups. Characteristic features of medium chestnut soils are low humus content (according to this feature they are often close to light chestnut soils), slightly increased (in comparison with medium chestnut normal soils) thickness of the humus horizon, low absorption capacity, good washability of the profile from easily soluble salts. Usually they contain a small amount of nutrients, their humus horizon is weakly dissected and has a brownish-chestnut color. Here are descriptions of the soil profile of the soils.

Section 004. It is laid 11 km south of the village of Sasai in the Akzhayik district on a flat surface of a low ridge elongated in the meridional direction. Absolute height 52 m. Vegetation cover is represented by fescue, wormwood. The soil effervesces from HCl from 30 cm.

A_1 0-20 cm. Chestnut, fresh, slightly compacted, strongly rooted, lumpy-silty, sandy loam.

B 20-30 cm. Brown-chestnut, fresh, compacted, rooted, lumpy, sandy loam.

C_1к 30-85 cm. Yellowish-whitish, dry, dense, roots are rare, large-block, sandy, light loamy.

C_2к 85-140 cm. Yellow-brown with sharply defined moderately numerous clusters of carbonates in the form of eyes, fresh, dense, prismatic-nutty, clayey.

C_3k 140-190 cm. Yellow-brown with a bluish tint and rare white eye-shaped accumulations of carbonates, moist, structureless, clayey.

Medium chestnut soils are formed on flat elevated plains with deep (deeper than 8 m) occurrence of groundwater under wormwood-feather grass vegetation. Soil-forming rocks are eluvial deposits of various mechanical composition. The morphological structure of their profile is similar to the structure of the profile of dark chestnut soils described above, only differing from them in a slightly smaller thickness of the humus horizon and a higher occurrence of the carbonate horizon. For a more complete characterization of the morphological structure, we will provide descriptions of specific profiles.

Section 005. It is laid 18 km southwest of the village of Konyr, Syrymsky district, on an elevated section of a flat plain. Absolute height is 250 meters. Fallow. The vegetation cover is represented by feather grass, fescue and crested wheatgrass. The thickness of the humus horizon (A+B) is 56 cm. The soil effervesces from 37-38 cm. Carbonate accumulations in the form of white sharply defined spots from 56 to 108 cm. No salt emissions were detected.

A_a 0-20 cm. Chestnut, fresh, compacted, rooted, lumpy-silty, clayey.

B_1 20-37 cm. Brown-chestnut, fresh, highly compacted, rooted, coarsely lumpy-nutty with noticeable vertical cracking, clayey.

B_2 37-56 cm. Yellow-brown with thin brown-chestnut streaks from the overlying horizon, fresh, compacted, weakly rooted, blocky, clayey.

C_1 56-108 cm. Whitish-yellow with large, rare white eye-shaped accumulations of carbonates, dry, dense, prismatic-nutty, roots are rare, clayey.

C_2 108-155 cm. Pale, moist, compacted, roots are sparse, lumpy, finely porous, clayey.

Light chestnut soils are widespread in the northern part of the Caspian Lowland. The vegetation cover is represented by wormwood-fescue groups. The humus horizon has a thickness of 35-45 cm, with a clear division into two parts: the upper light-chestnut color of a powdery-lumpy structure with noticeable horizontal stratification and the lower brownish-chestnut color and a lumpy-sheath structure. Deeper than the humus horizon is a horizon with abundant carbonates in the form of a continuous whitish layer, while in dark chestnut and medium chestnut soils, carbonates are released in the form of spots. Even deeper, from 120-130 cm, is a horizon with a significant content of water-soluble salts. For a more complete characterization of the soils under consideration, we will provide morphological descriptions and data from their analyses.

Section 006. It is laid 25 km northwest of the village of Karatobe on a flat, slightly elevated plain used for pasture. Absolute height is 48 m. Virgin land. The vegetation cover is represented by white wormwood, fescue and prostrate izena. The projective cover of the soil surface with vegetation is 50%. Grass height is 15-20 cm. Humus horizon thickness (A+B) is 42 cm. Carbonates are present from 42 to 128 cm as a continuous whitish horizon and rare spots. Salt secretions are present from 169 cm to the bottom (200 cm) as rare white spots.

A 0-10 cm. Light chestnut, dry, slightly compacted, strongly rooted, powdery-lumpy, light loamy.

AB 10-20 cm. Brownish-chestnut, fresh, strongly compacted, rooted, lumpy, medium loamy.

B 20-42 cm. Brown-chestnut, fresh, dense, weakly rooted, lumpy-nutty, medium loamy.

C_1к 42-128 cm. Yellow-whitish with rare white large spotted accumulations of carbonates, dry, dense, roots are rare, prismatic-nutty, light loamy.

C_2 128-169 cm. Grayish-yellow, fresh, loose, structureless, sandy.

C_3 169-200 cm. Brownish-yellow with small white rare spots of salts, moistened, slightly compacted, no roots, structureless, light loamy with lenses of sandy loam.

Light chestnut solonetzic soils, as well as light chestnut normal soils, are widespread in the northern part of the Caspian Lowland. They are most often found in the right-bank areas of the region, where the parent rocks have a heavy mechanical composition. The humus horizon is divided into two parts: the upper part is light chestnut in color, has a powdery-lumpy structure with noticeable

horizontal stratification, and the lower part is brownish-chestnut in color and has a lumpy-nutty structure. Morphologically expressed solonetzic soils are often not confirmed analytically (by the content of exchangeable sodium).

Section 007. It is located 25 km to the south of the village of Kaztalovka. Absolute, height 21 m. Very flat plain with barely noticeable microdepressions. The section is described on a level area. The vegetation cover is represented by a chamomile-white wormwood-fescue association. The projective cover of the soil surface by vegetation is 70%. The height of the grass stand is 30 cm. The thickness of the humus horizon (A + B) is 50 cm. The soil effervesces from 35 cm, carbonates are observed from 50 to 110 cm, salts from 140 cm to the bottom (220 cm) in the form of veins.

A 0-7 cm, Light chestnut, dry, slightly compacted, strongly rooted, dusty-powdery, heavy loamy. AB 7- 15 cm. Light chestnut with a brownish tint, dry, compacted, rooted, loosely lumpy, heavy loamy.

B_1 15-32 cm. Brownish-light chestnut, dry, highly compacted, weakly rooted, unclearly prismatic-nutty, heavy loamy.

B_2 32-50 cm. Chestnut-brown, dry, dense, weakly rooted, finely nutty, heavy loamy.

C_1k 50-75 cm. Whitish-brown, dry, very dense, roots are found singly, lumpy, sandy, heavy loamy.

C_2k 75-110 cm. Yellow-brown with whitish spots of carbonates, dry, very dense, nutty, heavy loamy.

C_3 110-140 cm. Yellow-brown, slightly moistened, compacted, lumpy, clayey.

C_4 140-200 cm. Yellow-brown with small white veins of salts, moistened, compacted, lumpy, heavy loamy.

Meadow-chestnut soils are formed in relief depressions among dark chestnut and medium chestnut soils on rocks of light mechanical composition (sands and sandy loams). They are formed under the influence of additional ground and surface moisture under meadow-steppe vegetation on close (2.5-4 m from the surface) weakly mineralized groundwater. Ancient alluvial weakly layered sandy and sandy loam deposits serve as parent rocks. The characteristic morphological features of these soils are: a large humus horizon with a low humus content, deep soil washing from easily soluble salts, reduced effervescence from hydrochloric acid, observed below the lower boundary of the humus horizon, and weak structuring of the soil profile. For a more complete picture of the morphology of these soils, we will describe a specific section.

Section 008. It is located 12 km southeast of the village of Toriyatbas in the Chingirlau district. Absolute height 130 m. Flat, slightly depressed plain with separate small massifs of blowing hilly sand. The section is located on the floodplain terrace of the Zhosaly River (one of the tributaries of the Buldurty River). Pasture. The vegetation is represented by Stipa Ioannina, Reed Grass, Artemisia paniculata, and Giant Hair Grass. The projective cover of the soil surface by vegetation is about 70%. Height 60 (70) cm. The thickness of the humus horizon (A+B) is 82

cm. Effervescence from hydrochloric acid to the bottom (170 cm) was not detected. There are no accumulations of carbonates and salts.

A 0-39 cm. Gray-chestnut, fresh, slightly compacted (almost loose), rooted, loosely lumpy-silty, sandy.

B 39-82 cm. Brown-chestnut, fresh, slightly compacted, slightly rooted, loosely lumpy-silty, sandy.

BC 82-137 cm. Brownish-yellow, fresh, slightly compacted, roots are rare, structureless, sandy.

From C 137-170 cm. Light yellow, moist, slightly compacted, roots are found singly, structureless, sandy.

Brown desert soils are common in the southern part of the region, where they occur on rocks of light mechanical composition, sands and sandy loams. The vegetation cover is represented by erkekov-white wormwood groups. The thickness of the humus horizon is 40-45 cm. Effervescence from hydrochloric acid is detected from 40-50 cm. Water-soluble salts in significant quantities are not found within the upper two-meter thickness. The humus content in the upper layer is 0.4-0.6%. In farms, they are used as pastures. Brown soils are usually formed on rocks of loamy mechanical composition. On top of these soils, there is a humus horizon of brown color with a thickness of up to 35-40 cm, the lower part of which is more compacted than the upper one. Effervescence from hydrochloric acid is observed from 15-20 cm, and often from the surface. Below the humus horizon is a carbonate horizon, usually including part of the humus horizon and having a thickness of 50-70 cm. Deeper than the carbonate horizon is a horizon containing lightly soluble salts and parent rock not affected by soil formation (usually also saline). Let us provide morphological descriptions of the section of brown normal soils.

Section 009. It is located 21.5 km southeast of the village of Taipak, Akzhayik district, on a level area of a flat, slightly elevated plain. The vegetation cover is complex, and is represented by gray wormwood, desert wheatgrass, viviparous bluegrass, tulips, and milfoil. The projective soil cover with vegetation is 50%. The absolute altitude of the area is 3 m. The thickness of the humus horizon (A + B) is 28 cm. The soil effervesces from hydrochloric acid from 25 cm. Carbonates are released from 49 to 122 cm in the form of white spots. Salts were not detected.

A 0-13 cm. Grayish-brown, dry, loose, weakly rooted, scaly-silty, medium loamy.

B 13-28 cm. Brown, dry, compacted, weakly rooted, coarsely lumpy, medium loamy.

BC 28-49 cm, Light brown, dry, highly compacted, weakly rooted, finely porous, lumpy-nutty, heavy loamy.

C_1к 49-122 cm. Yellow-brown, with rare white blurry spots of carbonates, dry, highly compacted, roots occur singly, prismatic-nutty, heavy loamy.

C_2 122-155 cm. Pale yellow, fresh, highly compacted, no roots, lumpy, finely porous, medium loamy.

Brown desert solonetzic soils differ from normal soils by greater compaction

of the lower part of the humus horizon and its nutty structure, and salts occurring closer to the surface. In the composition of absorbed bases, they contain about 10% of absorbed sodium from the sum of absorbed bases. Here is how one of the profiles of brown solonetzic soils is described.

Section 010. It is laid B 15 km south-southeast of the village of Taipak on the left bank of the Zhaiyk River within a flat plain. The vegetation cover is complex, at the section it is represented by gray wormwood, desert wheatgrass, and milfoil.

A 0-15 cm. Grayish-brown, dry, loose, weakly rooted, porous, layered-silty (and the layering and scaly nature are clearly visible in the lower part of the horizon), heavy loamy.

B 15-30 cm. Darkish-brown, fresh, highly compacted, rooted, nutty, clayey.

C_1 30-67 cm. Yellow-brown with vague spots of carbonates, fresh, compacted, roots are rare, lumpy, clayey.

C_2k 67-110 cm. Brownish-yellow with white sharply outlined spotted accumulations of carbonates, fresh, compacted, roots are found singly, prismatic-nutty, clayey.

C_3 110-200 cm. Brownish-yellow with small white spots of salts, moistened, slightly compacted, no roots, structureless, sandy loam.

Meadow (meadow-brown ordinary, in places solonetzic) soils are formed among brown soils on low relief elements, receiving additional moisture due to surface or groundwater. Groundwater is highly mineralized and lies at a depth of 3-6 m from the soil surface. The vegetation cover is represented by wormwood or grass-wormwood groups. The thickness of the humus horizon reaches 45-50 cm, and its upper part has a layered structure. Here is a description of the characteristic profile of these soils.

Section 011. It is laid B 13.2 km northeast of the village of Sarman, Akzhayik district, in a microdepression on a flat plain. The vegetation cover is complex, near the section it is represented by desert wheatgrass, Austrian wormwood and viviparous bluegrass. The projective cover of the soil surface with vegetation is 65%. The height of the grass is 15-30 cm. The thickness of the humus horizon (A + B) is 36 (70) cm. The soil effervesces from hydrochloric acid from 33 cm. Carbonates are released in the form of eye clusters from 70 to 118 cm, salts from 150 cm to the bottom (175 cm) in the form of pseudomycelium.

A 0-8 cm. Brown with a grayish tint, dry, loose, rooted, layered-dusty with slight lumps, heavy loamy.

AB 8-19 cm. Brown, dry, weakly compacted, weakly rooted, loosely lumpy, heavy loamy.

B 19-36 cm. Brown, fresh, compacted, weakly rooted, lumpy-lumpy, heavy loamy.

C_1 (BC) 36-70 cm. Yellow-brown, fresh, highly compacted, roots are rare, lumpy, clayey.

C_2k 70-118 cm. Brownish-yellow with white clusters of carbonates in the form of eyes, fresh, dense, roots are found singly, prismatic-nutty, clayey.

C_3 113-150 cm. Yellow, moistened, compacted, structureless, heavy loamy.

C_4 150-175 cm. Yellow-brown with white mycelial accumulations of salts and numerous small rusty spots, moistened, compacted, structureless, medium loamy with clay interlayers.

Meadow soils (meadow-brown deep effervescent soils) are formed in low areas among brown deep effervescent soils on sandy and sandy loam soil-forming rocks. The vegetation is dominated by desert wheatgrass with an admixture of milkweed, kermek, bulbous bluegrass, sand sedge, tamarisk, bitterling and some other species. Groundwater is highly mineralized and lies at a depth of 2.5-3.5 m. The thickness of the humus horizon is 50-60 cm. Effervescence from hydrochloric acid from 60-70 cm. They are used as pasture lands. Solonetz soils (among dark chestnut, medium chestnut and light chestnut soils) have become quite widespread despite the relatively good natural drainage of the area, which was facilitated by the prevalence of heavy loamy deposits among the parent rocks, the almost ubiquitous salinity of the rocks and the significant dryness of the climate. Their vegetation cover is represented by black wormwood-fescue groups. Compared with zonal soils, they contain a small amount of humus and nitrogen. Salt horizons are located at a depth of 45-65 cm. The thickness of the humus horizon (A+B) is 30-40 cm. Effervescence from hydrochloric acid from 20-25 cm. These solonetz soils usually occur in patches among dark chestnut, medium chestnut and light chestnut soils, reducing the productivity of the massifs. Areas with a large number of solonetz spots are used for hayfields and pastures. Here are descriptions of typical profiles.

Section 012. It is located 5 km west of the village of Karagandy in the Terekty district on a flat complex plain, the main background of the soil cover of which is dark chestnut solonetzic soils. Microdepression. The vegetation cover is represented by yarrow-leaved chamomile, fescue, white wormwood and black wormwood. The projective cover of the soil surface with vegetation is 50%, the height of the grass stand is 15-25 cm. The thickness of the humus horizon (A + B) is 42 cm. The soil effervesces from hydrochloric acid from 28 cm. Carbonates stand out in the form of white, clearly outlined spots on a yellow-brown background from 42 to 105 cm, salts from 126 cm to the bottom (155 cm) in the form of small white spots.

A 0-10 cm. Light gray, dry, loose, rooted, lamellar, coarse-pored, dusty, medium loamy.

B 10- 24 cm. Reddish-brown (chocolate), fresh, dense, rooted, coarse-nutty, vertically fissured, clayey.

B_2 24-48 cm. Brown, fresh, dense, weakly rooted, coarse-nutty, clayey.

C_1k 42-105 cm. Brownish-yellow with white accumulations of carbonates in the form of spots, fresh (almost dry), dense, roots are rare, prismatic-nutty, clayey.

C_2 105-126 cm. Light yellow, fresh, compacted, no roots, lumpy, finely porous, heavy loamy.

C_3 126-155 cm. Light yellow with small white salt spots, fresh, compacted, no roots, lumpy, heavy loamy.

Continental solonchaks are formed in flat depressions of the relief under chee,

saltworts. The accumulation of salts on their surface occurs due to the suction of weakly mineralized, close to the surface (1-3 m) groundwater. They have a loose structure. They are used as pastures. Let us describe the characteristic profile of these solonchaks.

Section 013. It is located 14 km southwest of the village of Zhumala, Taskala district. Absolute height is 12 m. Depressed plain with complex vegetation and soil cover. The section is located on a micro-elevated horseshoe-shaped area, facing the convex side to the north, with an area of 25-35 m². The vegetation cover is represented by saltworts (Salsola herbacea, S. brachiata, etc.). The projective cover of the soil surface with vegetation is 40%. Height 10 (35) cm. The thickness of the humus horizon (A + B) is 23 (35) cm. Salts are released almost throughout the entire profile in large quantities, first up to 65 cm in the form of small veins, then from 65 to 140 cm in the form of numerous druses and rare veins and from 140 to 220 cm in the form of separate druses.

I 0-10 cm. Grayish-white with white specks and small veins of salts, dry, loose, weakly rooted, structureless (dispersed), clayey.

II 10-23 cm. Brown-gray with numerous white small veins of salts, dry, compacted, weakly rooted, unstable lumpy, clayey.

III 28-35 cm. Yellow-brown with small gray-brown streaks and numerous white small veins of salts, moist, compacted, roots are rare, unstable lumpy.

IV 35-65 cm. Yellow-brown with numerous small white veins of salts, moist, compacted, no roots, structureless, clayey, when drying, salt efflorescence appears on the section wall.

V 65-140 cm. Brown with abundant mass releases of salts in the form of veins and druses, moist, compacted, structureless, clayey.

VI 140-260 cm. Yellow-brown with separate gray druses of salts (apparently, gypsum), damp, and from 200 cm wet, compacted, structureless, clayey. Groundwater, salty to the taste, emerges from the bottom in separate streams.

Dry steppe hilly fixed sands are found among dark chestnut and medium chestnut soils and are ancient delta formations reworked by the wind. The largest massif of these sands, adjacent to the forest dacha Karaagash from the north, is covered with Cossack juniper, sand sedge, sand wormwood and individual stunted birches. They are used for pastures.

Desert hilly weakly fixed sands differ from similar fixed sands by a significant sparseness of the vegetation cover, due to the fact that cattle breaks the surface. Near large settlements (Orda, Zhana Kazan) as a result of breaking up, small areas of dune sands appeared. To fix them, it is necessary to regulate grazing and artificially sow grass.

Most often, the sands are covered with Schober's saltpeter, tamarisk and sometimes sarsazan. The spaces between the piles are covered with sarsazan, wormwood, camel thorn, etc. They represent low-productivity pasture lands.

Floodplain soils (forest-meadow soils) are found in the near-river part of the Zhaiyk and Elek (Ilek) river floodplains. They are usually formed on coarse sandy

layered deposits. The vegetation cover is represented by willow-poplar and oak forests, as well as willow thickets. The relief is flat with a well-defined mesorelief, represented by winding channel-like depressions and ridge-like elevations. Floodplain forest-meadow layered deep-boiling soils do not have constant morphological features and genetic properties of the profile due to the different age and layering of rocks. On top, they have a thin (1-5 cm) litter, under which there is a humus horizon, and buried humus layers are found deeper. Effervescence from hydrochloric acid deeper than 2 m. The vegetation cover usually includes willow, sedge, smooth elm, cinnamon rose, stone bramble, common reed, burnet, and creeping couch grass. The stratification is clearly expressed, with interlayers of light mechanical composition of sand and sandy loam predominating. Here is a description of a typical profile of these soils.

Section 014. It is located 6.3 km west-southwest of the village of Mambetai and 25 km south of the Uralsk railway station on the left bank of the Zhaiyk in the near-river part of the floodplain in an elongated depression with willow-aspen forest. In addition to aspen and willow, there are smooth elm, cinnamon rose, stone bramble, creeping couch grass, common reed, burnet, and sedge. The thickness of the humus horizon (A+B) is 54 cm. The soil does not boil to the bottom (2 m).

A_0 0-2 cm. Weakly decomposed litter, consisting mainly of aspen leaves and other woody and herbaceous litter.

A 2-23 cm. Layered, dark gray, clayey with brown-yellow sandy layers, many rusty spots, moist, compacted, strongly rooted, firmly lumpy.

B 23-54 cm. Layered, predominantly sandy loam layers of yellow color, which alternate with darker colored clay layers. Many small rusty spots, moist, compacted, layered-loamy-non-firmly lumpy, many large roots. C1 54-118 cm. Layered, mainly sandy loam and light loamy with heavier layers. Grayish-yellow with large rusty and bluish-gray spots, damp, compacted, weakly rooted.

C 118-200 cm. Dark gray with a brown tint and large rusty spots, damp (almost raw), large porosity is noticeable, compacted, weakly rooted (tree roots), structureless, clayey with lighter layers.

Discussion

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).

We have provided the information necessary for mapping soil cover structures and their quantitative assessment, described in the remote sensing database. Data integration is carried out through the spatial and attribute component: the results of topographic and thematic maps. At the same time, the creation of a database of attributes of the Earth's remote sensing involves the digitization of thematic maps

tied to a single cartographic projection (representing a topographic map of scale 1:25,000). As a result of the work, thematic maps and attribute databases of GIS soils were created.

The ecological determinants of soil carbon and its sensitivity to warming are poorly understood. The authors compare soil samples from paired urban and natural ecosystems and show that the microbiome is a more important driver of soil carbon in urban green spaces than in natural ecosystems under warming conditions (Delgado-Baquerizo, et al., 2023). While the contribution of biodiversity to supporting multiple ecosystem functions in natural ecosystems is well established, the relationship between aboveground and belowground diversity and ecosystem multifunctionality in urban green spaces remains largely unknown (Fan, et al., 2023).

Thus, this made it possible to characterize the soil combinations according to their belonging to a certain genetic-geometrical form, conditions of location in the terrain, and quantitative indicators.

Conclusions

Thus, modern methods in the field of spatial analysis and methods of geoinformation modeling were used during the research. As a result of the research, mapping of the soil cover was carried out using traditional terrestrial methods with the use of GIS technologies based on the wide use of aerial photographs of various resolutions. This gave an opportunity to characterize the soil combinations according to the signs of their belonging to a certain genetic-geometrical form, the conditions of their location and their quantitative indicators.

Thus, the following conclusions can be made:

- meadow-chernozem soils have high fertility, which allows cultivating most of the cultivated plants growing in the region. However, due to the fact that they often occur in a complex with a large number of solonetz soils or occupy narrow ravine massifs that are inconvenient for cultivation, they are used as hayfields and pastures.

- dark chestnut and medium chestnut soils, occurring in uniform massifs and with solonetz soils up to 10%, are assessed as arable lands of average quality, requiring in places measures to combat solonetzism. When cultivating them, it is necessary to take into account the compaction of the solonetzic horizon, which increases sharply when the soil dries out.

- light chestnut eroded soils develop in conditions of highly dissected relief (steep slopes, ravines). Characterized by a small thickness of the humus horizon (as a result of washout), increased effervescence from hydrochloric acid and a carbonate horizon close to the surface. The vegetation cover is sparse. They are used as low-productivity pasture lands.

- meadow-chestnut soils are characterized by significantly greater compaction and reduced porosity of the upper horizons compared to similar horizons of meadow-chestnut dark carbonate soils. They are usually used as pasture lands.

- brown soils are mainly used as pasture lands. With artificial irrigation, non-

complex areas of them can be used for agriculture. However, when irrigating, it is imperative to provide for their drainage, since with the existing salinization of soils and high aridity, secondary soil salinization processes can easily develop here and their withdrawal from agricultural use for a long time. There are ample opportunities for developing irrigation of brown soils, mainly of light mechanical composition, in the area of the Kamysh-Samara lakes.

- floodplain soils are valuable forestry lands. Their use as arable lands is inappropriate, since there are other soils that are free of forests and have high natural fertility. Some humus horizon, lower content of organic matter in it and poorer vegetation cover. They are used as hayfields and pastures.

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