ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ

Satbayev University

ХАБАРЛАРЫ

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
НАУК РЕСПУБЛИКИ
КАЗАХСТАН
Satbayev University

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF
KAZAKHSTAN
Satbayev University

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

3 (453)

MAY – JUNE 2022

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

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«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген **№ KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19
http://www.geolog-technical.kz/index.php/en/

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан **№ KZ39VPY00025420,** выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соеденений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19

http://www.geolog-technical.kz/index.php/en/

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).
The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420,** issued 29.07.2020.
Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*
Periodicity: 6 times a year.
Circulation: 300 copies.
Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19
http://www.geolog-technical.kz/index.php/en/

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS of the National Academy of Sciences of the Republic of Kazakhstan
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 3, Number 453 (2022), 226-242
https://doi.org/10.32014/2022.2518-170X.192
UDC 910.3:631.4 (574)

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STUDY OF THE SOIL COVER OF ECOSYSTEMS OF THE CHINGIRLAUS DISTRICT OF THE WESTERN KAZAKHSTAN REGION ON THE BASIS OF THE APPLICATION OF GIS TECHNOLOGIES

Abstract. Preservation and improvement of soil fertility is the main part of the general problem of rational use of land resources, increasing productivity and improving the soil ecology of agricultural landscapes. Rational use and protection of soils in market conditions requires adequate application of new scientific and methodological approaches. One of such systematic-analytical methods of soil cadastre organizations is a combination of traditional terrestrial methods with technologies of geoinformation systems (GIS). The study of the current state of the soil cover and the compilation of a soil map of the Chingirlau district of the West Kazakhstan region on the basis of applying GIS technologies. In the study area, dark chestnut soils are formed in the soil cover in combination with various soil combinations. They are formed in the conditions of the dry steppe zone, with the non-wash type of water regime, under the haymooth, meadow-grass, herbaceous-fat-grass, black-wormwood-meadow and meadow-white-wormwood-kokpekovic plant communities, on loesslike loams. The aggregate of information necessary for mapping soil cover patterns and their quantification has been described in GIS databases. Data integration has been realized through the spatial and attributive component in the form of: the results of topographic and thematic maps. At the same time, the creation of attributive GIS databases involves the digitization of thematic maps tied into a single

cartographic projection (as a topographic map with a scale of 1: 50 000). As a result of the study, thematic maps and attributive databases of GIS of soils were formed. As a result of research, based on GIS technology, a digital soil map of the Chingirlau district of the West Kazakhstan region has been developed using the ArcGIS software product.

Key words: geoinformation systems, soil cover, soil map, dark chestnut soils, morphological structure.

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ГИС-ТЕХНОЛОГИЯЛАРЫН ҚОЛДАНУ НЕГІЗІНДЕ БАТЫС ҚАЗАҚСТАН ОБЛЫСЫ ШЫҢҒЫРЛАУ АУДАНЫ ЭКОЖҮЙЕЛЕРІНІҢ ТОПЫРАҚ ЖАМЫЛҒЫСЫН ЗЕРТТЕУ

Аннотация. Топырақ құнарлығын сақтау және жақсарту жер ресурстарын ұтымды пайдалану, өнімділікті арттыру және ауылшаруашылық ландшафттарының топырақ экологиясын жақсартудың жалпы мәселесінің негізгі бөлігі болып табылады. Нарықтық жағдайларда топырақты ұтымды пайдалану үшін жаңа ғылыми-әдістемелік тәсілдерді қолдануды талап етеді. Топырақ кадастырын ұйымдастырудың осындай жүйелі-талдамалық тәсілдерінің бірі геоақпараттық жүйелер (ГАЖ) технологияларымен дәстүрлі жерүсті әдістерінің үйлесуі болып табылады. Экожүйелердің топырақ жамылғысының қасиеттерінің қазіргі жағдайын зерттеу және ГАЖ технологияларын қолдану негізінде Батыс Қазақстан облысы Шыңғырлау ауданының топырақ картасын құрастыру. Зерттелетін аумақта құрғақ дала аймақ жағдайында су режимінің шайылмайтын түрінде бетегелі-астық тұқымдас, әртүрлішөптесін-астық тұқымдас жусанды, тобылғы-астық тұқымдас жусанды, жусанды-бетегелі шөптесін өсімдіктер бірлестіктердің астында қара қоңыр топырақтардың кешеніңде әртүрлі топырақ түрлері лес тәрізді саздақты болып қалыптасқан. Топырақ жамылғысының құрылымдарын картаға түсіру және олардың сандық бағалауы үшін

қажетті ақпараттың жиынтығы ГАЖ деректер базасында сипатталған. Мәліметтерді біріктіру кеңістіктік және атрибутивтік компонент арқылы жүзеге асырылады: топографиялық және тақырыптық карталардың нәтижелері. Сонымен қатар, атрибутивтік ГАЖ деректер қорын құру бір картографиялық проекцияда (бұл 1:50 000 масштабтағы топографиялық карталар болатын) байланыстырылған тақырыптық карталарды цифрлауды көздейді. Жүргізілген жұмыстардың нәтижесінде ГАЖ-ның тақырыптық карталары мен атрибутивтік мәліметтер базасы қалыптастырылды: топырақтар. Зерттеу нәтижесінде GIS технологиясы негізінде ArcGIS бағдарламалық өнімі арқылы Батыс Қазақстан облысы Шыңғырлау ауданының цифрлық топырақ картасы жасалды.

Түйін сөздер: географиялық ақпараттық жүйелер, топырақ жамылғысы, топырақ картасы, қара қоңыр топырақтар, морфологиялық құрылымы.

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ИЗУЧЕНИЕ ПОЧВЕННОГО ПОКРОВА ЭКОСИСТЕМ ЧИНГИРЛАУСКОГО РАЙОНА ЗАПАДНО-КАЗАХСТАНСКОЙ ОБЛАСТИ НА ОСНОВЕ ПРИМЕНЕНИЯ ГИС-ТЕХНОЛОГИЙ

Аннотация. Сохранение и повышение плодородия почв является основной частью общей проблемы рационального использования земельных ресурсов, увеличение продуктивности и улучшение почвенной экологии агроландшафтов. Рациональное использование и охрана почв в рыночных условиях требует адекватного применения новых научно-методических подходов. Одним из таких системно-аналитических способов организаций почвенного кадастра является сочетания традиционных наземных методов с технологиями геоинформационных систем (ГИС). Изучение современного состояния свойств почвенного покрова экосистем и составление почвенной карты Чингирлауского района Западно-Казахстанской области на основе применения ГИС-технологий. На исследуемой территории формируются

темно-каштановые почвы в комплексе с различными почвенными сочетаниями в условиях сухостепной зоны, при непромывном типе водного режима, под типчако-злаковым, разнотравно-злаково-полынным, таволгово-злаковым с полынью, полынно-ковыльно-типчаковым растительным сообществам, на лессовидных суглинках.

Совокупность информации, необходимой для картографирования структур почвенного покрова и их количественной оценки описывается в базах данных ГИС. Интеграция данных реализуется через пространственную и атрибутивную составляющую в виде: результатов топографической и тематических карт. При этом создание атрибутивных баз данных ГИС предполагает оцифровку тематических карт, привязанных в единой картографической проекции (в качестве которой служили топографические карты масштаба 1:50000). В результате работы сформированы тематические карты и атрибутивные базы данных ГИС: почв. В результате исследований на основе ГИС-технологии разработана цифровая почвенная карта Чингирлауского района Западно-Казахстанской области с помощью программного продукта ArcGIS.

Ключевые слова: геоинформационные системы, почвенный покров, почвенная карта, темно-каштановые почвы, морфологическое строение.

Introduction. According to Salikhov (2017 b: 2, 2020: 1), preserving and increase in fertility of soils is the main part of a common problem of rational use of land resources, increase in productivity and improvement of soil ecology of landscapes.

Soils are an important component of the natural and biological resources of any country and they determine the socio-economic wealth of the country and greatly affect on the political relations. Thus, soil is considered as the most important part of the natural environment, characterized by certain natural (space, vegetation, etc.), socio-economic (means of production, value, etc.), production (subject, tool and means of production,) characteristics. Complete and reliable information on soils, including their quantitative and qualitative characteristics, should provide an opportunity for the executive authorities to make informed decisions on the development of specific territories and the country as a whole. Therefore, the need for objective and systematized information about the country's soil resources is constantly growing. The latter necessitates the need to create a fundamentally different system of accounting, assessment and monitoring of soil resources, different from the management of other types of material resources. The state of the soil cover of Kazakhstan. The territory of Kazakhstan is characterized by a complex and diverse soil cover, which is subject to certain geographical patterns. The richest soil resources of the republic

are far from being fully studied, not uniformly, and are not yet used rationally enough. The current state, further expansion and intensification of agriculture in Kazakhstan is closely dependent on the correct use of its soil cover (Espolov, 2006: 4).

Research materials and methods. The aim of our research is to study the current state of the soil cover of ecosystem and develop a soil map of the Chingirlau district of the West Kazakhstan region on the basis of applying GIS technologies for solving long-term problems of monitoring land resources and developing the agro-bioindustry. In this regard, in studies on the territory of the Chingirlau district of the West Kazakhstan region, some biological, chemical and physical properties and morphological features of soils were studied: by conventional methods (Salikhov, 2016: 71, Garmaev, 2019: 5, Bekbayeva, 2019:4). In order to conduct large-scale soil research, it has been adhered to the relevant guidelines (Kashkimbayeva, 2020: 3, Pyankov, 2022: 7). For topographical and geodetic work, paper soil maps of different scale have been applied, ranging from 1-100 000 to 1:50 000 (for searching and selecting 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 aerial photographs (Salikhov, 2017 b:4).

Results and discussion. In this systematic description, the soil subdivisions that we encountered on the territory of the study area are identified. Detailed diagnostic indicators have been given for the most common soil varieties within the Chingirlau district of the West Kazakhstan region. Specific morphological genetic features of the soil cover are indicated, based on the available data of field research and cameral processing.

In the study area, dark chestnut soils are formed in the soil cover in combination with various soil combinations. They are formed in the conditions of the dry steppe zone, with the non-wash type of water regime, under the haymooth, meadow-grass, herbaceous-fat-grass, black- wormwood-meadow and meadow-whitewormwood-kokpekovic plant communities, on loesslike loams.

Dark chestnut normal soils are widespread in the area of the Chingirlau district of West Kazakhstan region (WKO). They are confined to watershed plains composed of loamy and sandy loam deposits. The vegetation is fescue-feather grass with a slight admixture of xerophilous forbs. The projective cover of the soil surface with vegetation is 60-70%.

The morphological structure of the dark chestnut soils differs from that of the southern chernozems by some features, the main of which are the smaller thickness of the humus horizon and its lighter color. The thickness of the humus horizon (A+B) of dark chestnut soils is on average 45-55 cm. According to the thickness of the humus horizon, among the dark chestnut normal soils, as well as other generic groups, mediumthick and thin species are distinguished.

Depending on the processes of soil formation and the nature of their manifestation, the following genera are distinguished within the subtype under consideration: normal, carbonate, solonetzic, slightly deflated, slightly washed away, carbonate-saline residual-carbonate saline residual-carbonate, rubble, primitive, incompletely developed and underdeveloped. Let us dwell on a detailed description of the morphological and biochemical features of the distinguished generic groups of dark chestnut soils.

Noticeable carbonate excretions, most often in the form of white-eye. are noted at a depth of 40-45 cm. Boiling from hydrochloric acid is observed from 35-40 cm. Gypsum in the form of small scales and drusen is found from 100-120 cm. Of course, these are only averages, from which deviations up or down are often observed.

Morphological and some analytical data for specific sections in the study area.

Section 001. Founded on a gently sloping plain. The vegetation is fescue-feather grass with a slight admixture of herbs. The projective cover of the soil surface with vegetation is 70-75%. Allocations of carbonates - from 16 to 95 cm, gypsum - from 122 cm. Boiling from hydrochloric acid - from 25-28 cm.

A 0-15 cm. Dark gray with a brownish tint, dry, compacted, lumpy, medium loamy; transition is noticeable.

B_1 15-33 cm. Brownish-dark gray, dry, dense, coarse-cloddy, medium loamy; transition is noticeable.

B_2 33-46 cm. Lighter than the previous one, dry, dense, lumpy-prismatic, heavy loamy.

C_1 46-95 cm. Brownish-yellow dense heavy loam with a large amount of white-eye.

C_2 95-125 cm. Yellow loam, fresh, with gypsum secretions in the form of small crystals.

Section 002. Founded on a gently sloping undulating plain. Vegetation meadowsweet-cereal with wormwood.The projective soil cover with vegetation is 60%.

The thickness of the humus horizon (A+B) – 55 cm. Isolation of carbonates in the form of white-eye – from 55 to 95 cm. Boiling from hydrochloric acid is noted at a depth of 45cm. Gypsum in the form of nests and scales – from 123 cm.

Section 003. Found on the second floodplain terrace of the Shyngyrlau River. The vegetation is fescue-feather grass. The projective vegetation cover of the soil surface is about 60%.

Thickness of humus horizon 50 cm. Isolation of carbonates in the form of a bright white-eye – from 48 to 90 cm. Boiling from hydrochloric acid – from 45 cm. No gypsum up to 160 cm.

A 0-15 cm. Grayish-brown, dry, friable, loose-cloddy, sandy loamy, riddled with roots; the transition to the next horizon is noticeable.

B_1 15-30 cm. Grayish-light brown with sharp lighter inflections of the parent rock, dry, friable, sandy loamy, slightly penetrated by plant roots.

B_2 30-50 cm. Lighter than the previous one, with wide inlets of the parent rock and bright white-eyed lighter color, compacted, lumpy, sandy loam with single plant roots.

C_1 50-90 cm. Brownish-yellow sandy loam with a large amount of white-eyed sandy loam, slightly compacted.

C_2 90-160 cm. Yellowish-brown light loam, moist with sharp spots of carbonates.

It can be seen from the above descriptions that the morphological parameters of the soils under consideration are closely related to their mechanical composition. Soils of a heavier mechanical composition are distinguished by a darker color of the humus horizon and a high occurrence of gypsum (section 001). In addition, they have a different form of carbonate release, in «heavy» soils, which are found mainly in the form of blurry spots or a rare white-eye. Soils of light mechanical composition have a more uniform, and lightened color of the humus horizon. Carbonates are usually isolated as white eyes (section 003). Gypsum up to 150-160 cm not found.

In terms of nutrient reserves, dark chestnut soils are poorer than southern chernozems. In addition, the reserves of humus are largely determined by the mechanical composition. "Light" varieties are significantly poorer in humus than heavier varieties (Table 1). The amount of gross nitrogen in the upper horizon does not exceed 0.20%. Its content decreases with depth. The C:N ratio is quite wide – 12-12.7 (in the upper horizon), below it becomes narrower.

The accumulation of carbonates is noted along the lower boundary of the humus horizon, where their amount reaches 6-7% (at a depth of 50-90 cm). Dark chestnut soils are insufficiently provided with mobile forms of phosphorus, the amount of which does not exceed 6.0 mg per 100 g soil.

Table 1 - Chemical and physico-chemical properties of dark chestnut soils

Sample depth cm	Humus, %	Gross nitrogen, %	C:N	CO_2, %	Absorbed bases m-Eq. per 100 g				pH	Mobile forms, mg/100 g of soil	
					Ca^-	Mg^-	Na+K	sum		P_2O_5	K_2O
0-10	4,1	0,20	12,0	-	18,8	3,0	0,4	22,2	7,2	2,2	61,0
20-30	3,1	0,17	10,7	0,6	21,8	2,9	0,3	25,0	8,3	1,1	28,8
35-45	2,0	0,11	10,3	4,0	15,0	6,1	0,2	21,3	8,6	1,2	13,8
55-65	-	-	-	7,1	-	-	-	-	8,6	-	-
125-135	-	-	-	4,4	-	-	-	-	8,2	-	-

Of the absorbed bases (Table 1), in dark chestnut normal soils, calcium predominates (up to 87% of the total), magnesium is contained to a lesser extent and there is very little absorbed sodium – no more than 2% of the total absorbed bases. The reaction of the soil solution is alkaline. The pH value increases with depth, reaching a maximum in the carbonate accumulation horizon.

Dark chestnut soils are not saline. The amount of water-soluble salts in the humus horizon does not exceed 0.1% (Table 2), and a rather high content of water-soluble salts is noted only in the parent rock.

Table 2 - Content of water-soluble salts in dark chestnut soils, %

Section number	Sample depth, cm	Dense residue	Alkalinity		Cl	SO_4	Ca	Mg	Na (by difference)
			HCO_3	CO_3					
001	0-10	0,107	0,019	No	No	No	0,003	No	0,004
	20-30	0,062	0,030	-	0,002	-	0,005	0,002	0,003
	35-45	0,047	0,036	-	нет	-	0,003	0,003	0,004
	55-65	0,083	0,040	-	0,008	-	0,003	0,004	0,009
	125-135	0,746	0,021	-	0,130	0,315	0,050	0,035	0,119

The dense residue here increases to 1%. Alkalinity in dark chestnut soils is low. It slightly increases downward, reaching its maximum value in the carbonate horizon. Of the water-soluble salts, calcium sulfates predominate, especially in the lower part of the profile.

The granulometric composition of dark chestnut soils is heterogeneous (Table 3). Along with “heavy” soils, “light” soils are widespread here, mostly confined to high floodplain terraces of rivers.

Table 3 - Granulometric composition of dark chestnut soils

Section No	Sample depth, cm	Hygroscopic water, %	Loss from HCl treatment, %	Fraction content, % to abs. dry soil. Fraction sizes, mm							
				3-1	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
001	0-10	3,6	2,6	No	9,5	25,4	20,0	5,2	9,9	27,3	42,4
	20-30	3,2	1,9	-	13,8	21,5	18,7	6,3	10,5	27,3	44,1
	35-45	2,8	2,3	-	11,6	25,5	13,0	6,0	13,4	28,2	47,6
	55-65	3,0	1,5	-	12,2	22,8	12,5	5,7	17,5	27,8	51,5
	125-135	3,0	3,1	-	9,7	39,9	9,7	7,3	3,3	27,0	37,6

The distribution of fractions over the horizons of the considered soils is fairly uniform in both “heavy” and “light” varieties (Table 4). Only in section 002 is there a noticeable depletion of silt in the upper horizon, which is probably caused by the blowing of these particles from the surface of the arable land.

Table 4 - Biochemical and physicochemical properties of dark chestnut solonetsous soils

Sample depth, cm	Humus, %	Gross nitrogen, %	C:N	CO_2 of carbonates, %	Absorbed bases m-Eq. per 100 g				pH
					Ca^-	Mg^-	Na+K	sum	
0-10	3,8	0,20	10,7	-	19,4	0,9	0,6	23,0	7,5
11-21	1,8	0,14	7,4	-	15,4	1,9	0,9	18,2	8,0
26-36	1,0	0,08	7,0	4,0	7,7	1,9	1,7	11,3	8,5
45-55	-	-	-	4,8	-	-	-	-	8,8
75-85	-	-	-	3,2	-	-	-	-	8,5
115-125	-	-		1,7	-	-	-	-	8,2

Dark chestnut normal soils are arable, but their quality is largely determined by their mechanical composition. From an agronomic point of view, medium loamy and heavy loamy dark chestnut soils are regarded as arable lands, the effective use of which is possible with conventional agricultural technology. “Light” varieties of them refer to arable lands, the use of which in agriculture is possible only if anti-erosion measures are applied. To obtain high and stable yields on the described soils, it is necessary to carry out measures to combat the accumulation and preservation of moisture, the use of organomineral fertilizers, especially phosphorus fertilizers, since they are extremely insufficiently supplied with phosphorus

Dark chestnut solonetsous soils are much rarer than carbonate ones and are concentrated mainly around the Sorkol lakes and the Ashchy river. They are common on lake terraces, in river valleys and in depressions. Soil-forming rocks are alluvial and eluvial-deluvial deposits of various thickness, rubble and salinity. The vegetation is feather grass-fescue-wormwood. Projective coverage - 40-50%.

A feature of the morphological structure of dark chestnut solonetsous soils, as well as all solonetzic soils in general, is the presence of a compacted horizon of a cloddy-prism-like or nutty-prism-like structure. The depth of this horizon from the surface is variable and ranges from 10-15 to 30-40 cm. The thickness of the horizon (A+B) is 30-40 cm. The occurrence of easily soluble salts occurring at a depth of 60-80 cm. Boiling from hydrochloric acid is noted in the lower part of horizon B.

To characterize dark chestnut solonetsous soils, we present a description of the section.

Section 004. It was founded in the south-eastern part of the Akshat village. The vegetation is wormwood-feather grass-fescue with a large amount of thorax. The projective cover is about 40%. Carbonates in the form of white-eye are released at a depth of 27 cm. Gypsum and easily soluble salts are found from 60 cm. Boils from hydrochloric acid from 25 cm

A 0-11 cm. Grayish dark brown. dry, compacted, lumpy-silty, clayey; the transition is clear.

B_1 11-23 cm.Brownish-dark brown, dry, dense, nutty-prismatic, clayey; transition to the next horizon - clear

B_2 23-37 cm.Brownish-brown, with carbonates in the form of a white-eye, dense, nutty-lumpy. clayey.

C_1 37-60 cm.Brownish-yellow dense clay.

C_2 60-115 cm. Brownish-yellow less compacted clay with gypsum and easily soluble salts.

Section 005. Laid down on the territory of the Almaznensky rural district. The vegetation is forbgrass-wormwood. Power of humus horizon(A+B) - 47 cm. Evaporation - from 25 cm. carbonates in the form of an indistinct white-eye are noted in the lower part of horizon B.

The content of humus in dark chestnut solonetsous soils ranges from 2.8 to 3.5%, depending on the conditions of occurrence. In small depressions, due to the runoff of water, the vegetation is richer, and the soil, naturally, is enriched with organic matter to a greater extent. With depth, the amount of organic matter sharply decreases (Table 4).

According to the humus content, there is also a change in the amount of nitrogen and the C:N ratio. The upper horizon contains up to 0.20% nitrogen, in the next one it is much less - 0.14%, and the C:N ratio drops from 10.7 in the upper horizon to 7-7.4 in the next.

The maximum accumulation of carbonates is noted under the illuvial horizon at a depth of 40-50 cm.

Of the absorbed bases in dark chestnut solonetsous soils, calcium and magnesium are of the greatest importance, the amount of which varies, respectively, from 84.6 to 68% and from 10.4 to 16.8% of the total bases. Along with absorbed calcium and magnesium, the soils under consideration contain a significant amount of absorbed sodium and potassium (up to 15% of the total amount of absorbed bases).

The reaction of soils to alkaline pH varies from 7.5 to 8.8, with the highest pH value being observed in solonetz and subsolonetz horizons.

Unlike normal dark chestnut soils, alkaline soils are characterized by an increased content of watersoluble salts already under the humus horizon. At a depth of 45-55 cm (Table 5), the amount of salts reaches 0.384%, below it it increases to 1.472%.

Table 5 - The content of water-soluble salts in dark chestnut solonetsous soils,%

Sample depth, cm	Dense residue	Щелочность		Cl	SO_4	Ca	Mg	Na (by difference)
		HCO_3	CO_3					
0-10	0,031	0,021	No	0,002	No	0,005	No	0,003
11-21	0,074	0,049	-	0,004	0,001	0,005	0,001	0,014
26-36	0,138	0,059	No	0,029	0,007	0,002	0,001	0,040
45-55	0,384	0,052	-	0,050	0,160	0,005	0,006	0,111
75-85	1,365	0,017	No	0,061	0,889	0,095	0,064	0,239
115-125	1,472	0,014	-	0,028	1,003	0,212	0,051	0,164

The total alkalinity is not constant over the horizons, it has a clear tendency to increase with increasing depth. The maximum value of alkalinity is noted in the solonetzic horizon. Of the water-soluble salts, sodium and calcium sulfates predominate and, to a lesser extent, magnesium sulfates.

In terms of mechanical composition, dark chestnut solonetsous soils are dominated by heavy loamy and medium loamy varieties, sometimes with stumps (Table 6).

Table 6 - Granulometric composition of chestnut solonetsous soils

Sample depth, cm	Hygro-scopic water, %	Fraction sizes, mm; their content, % to absolutely dry soil							
		3-1	1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0.01
0-10	2,8	0,2	0,9	10,9	25,1	14,2	28,2	20,5	62,9
11-21	3,4	0,2	0,6	3,0	15,3	12,0	25,3	42,7	80,8
26-36	3,2	0,3	0,8	4,4	16,7	13,6	23,6	40,6	77,8
45-55	3,0	0,2	1,0	4,6	19,0	11,7	25,2	38,3	75,2
75-85	3,6	0,6	0,8	5,4	22,9	9,2	20,7	40,4	70,3
155-125	4,8	0,1	0,9	11,0	15,7	11,1	21,7	39,5	72,3

The distribution of fractions over the horizons clearly indicates the ongoing processes of solonetzization. In relation to the clay fraction at a depth of 11-36 cm, an illuvial horizon is formed. The movement of this fraction from the upper horizon to the lower one leads to a relative increase in the number of large fractions here. According to the classification of N.A. Kachinsky, the considered soil belongs to light clayey silty-silty varieties.

Dark chestnut solonetsous soils are rare in homogeneous arrays. For the most part, they are distributed in combination with solonetzes, the number of which determines the nature of the use of a particular massif. In addition, these complex sites are in most cases scattered over small areas. In this regard, the nature of the agricultural use of these massifs is determined by the number of solonetzes in relation to the conditions of occurrence.

Plots occupying large areas and containing no more than 20% of solonetzes can be used in agriculture, provided that anti-alkaline measures and measures are taken to accumulate and preserve moisture in the soil. If solonetzes contain more than 20% of the total area, then the development of arrays for agricultural crops is quite difficult and is associated with high costs for melioration of solonetzes. In this case, it is advisable to use them as pastures.

Rational use and protection of soils in market conditions requires adequate application of new scientific and methodological approaches. One of such systematic-analytical methods of soil cadastre organizations is a combination of traditional terrestrial methods with technologies of geoinformation systems (GIS) based on extensive use of satellite images in different resolutions. This approach underlies the agrarian geo-information systems of the developed countries of the world, where soils are the main subsystem of this information product.

In these territories, we conducted soil cover studies based on the geosystemic approach and new information technologies.

Figure 1 illustrates the soil map of the Chingirlau district of the West Kazakhstan region, which has been created using the above-described technique based on scanned soil maps (Table 7).

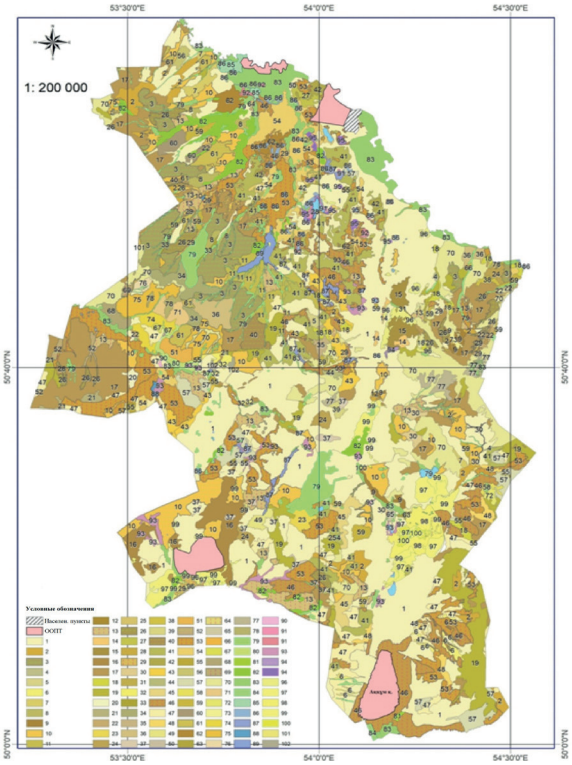

Figure 1 - Soil map-scheme of the Chingirlau district of the West Kazakhstan region

Table 7– Legend to the soil map of the Chingirlau district of the West Kazakhstan region

Soil No	Soil name
1	2
1	dark chestnut medium thick medium loamy
2	dark chestnut medium-thick light loamy
3	dark chestnut medium sandy
4	dark chestnut, medium-thick, heavy loamy with dark chestnut, medium solonetz-saline, thin 10-30%
5	dark chestnut medium with meadow chestnut medium 10-30%
6	dark chestnut medium-sized with small chestnut salt licks 10-30%
7	dark chestnut medium sandy with small chestnut solonetzes 10-30%
8	dark chestnut medium-sized with solonetzes small chestnut 30-50%
9	dark chestnut medium-sized with solonetzes small chestnut 30-50%
10	dark chestnut low power
11	dark chestnut low power
12	dark chestnut low power
13	dark chestnut low-power with dark chestnut slightly deflated 10-30%
14	dark chestnut low-power with dark chestnut slightly deflated 10-30%
15	dark chestnut low-power with dark chestnut slightly deflated 10-30%
16	dark chestnut thin slightly crushed with dark chestnut carbonate slightly washed away slightly crushed 10-30%
17	dark chestnut thin with dark chestnut underdeveloped 10-30%
18	dark chestnut low-power with meadow-chestnut medium-thick 10-30%
19	dark chestnut thin with small chestnut salt licks 10-30%
20	dark chestnut slightly washed out
21	dark chestnut, slightly washed out with meadow chestnut medium-thick 10-30%
22	dark chestnut, slightly washed out with meadow chestnut medium-thick 10-30%
23	dark chestnut slightly deflated
24	dark chestnut carbonate medium power
25	dark chestnut carbonate medium power
26	dark chestnut carbonate medium thick slightly crushed with dark chestnut slightly washed away 10-30%
27	dark chestnut calcareous medium-thick slightly gravel with meadow-chestnut medium-thick 10-30%
28	dark chestnut carbonate low-power
29	dark chestnut carbonate thin slightly crushed with dark chestnut carbonate slightly washed away slightly crushed 10-30%
30	dark chestnut carbonate thin weakly crushed with dark chestnut underdeveloped medium crushed 10-30%
31	dark chestnut carbonate slightly washed away
32	dark chestnut carbonate slightly eroded with dark chestnut underdeveloped weakly gravel 10-30%

33	dark chestnut carbonate slightly washed out with dark chestnut medium washed out 10-30%
34	dark chestnut carbonate slightly eroded with dark chestnut medium eroded 10-30% and meadow chestnut medium eroded 10-30%
35	dark chestnut carbonate slightly eroded with meadow-chestnut medium eroded 10-30%
36	dark chestnut carbonate slightly washed away with small chestnut solonetzes 10-30% and medium thick meadow chestnut up to 10%
37	dark chestnut carbonate slightly deflated with dark chestnut slightly deflated 10-30%
38	dark chestnut, carbonate-saline, slightly eroded with dark chestnut, medium eroded
39	dark chestnut slightly solonetsous medium-thick
40	dark chestnut slightly solonetsous medium-thick
41	dark chestnut slightly solonetsous medium-thick
42	dark chestnut slightly solonetzic medium-thick with dark chestnut saline medium-thick 10-30%
43	dark chestnut, weakly solonetzic, medium-thick, with small chestnut solonetzes 10-30%
44	dark chestnut slightly solonetsous thin with dark chestnut slightly deflated 10-30%
45	dark chestnut medium solonetzic medium thick with small chestnut solonetzes 10-30%
46	dark chestnut solonchak medium power
47	dark chestnut solonchak medium power
48	dark chestnut solonchak medium power
49	dark chestnut solonchakous thin with meadow chestnut solonchak 10-30%
50	dark chestnut solonchakous thin with typical solonchaks 10-30%
51	dark chestnut underdeveloped medium gravel
52	dark chestnut underdeveloped slightly gravel
53	dark chestnut underdeveloped medium crushed with dark chestnut underdeveloped medium crushed 10-30%
54	dark chestnut underdeveloped medium crushed with dark chestnut underdeveloped medium crushed 30-50%
55	dark chestnut underdeveloped slightly gravel with dark chestnut underdeveloped medium gravel
56	dark chestnut underdeveloped medium gravel
57	dark chestnut underdeveloped medium gravel
58	dark chestnut underdeveloped medium gravel
	Table continuation
1	2
59	dark chestnut underdeveloped
60	dark chestnut underdeveloped medium gravelly with dark chestnut underdeveloped 10-30%
61	dark chestnut underdeveloped medium gravelly with dark chestnut underdeveloped 10-30%
62	dark chestnut underdeveloped medium crushed with outcrops of dense rocks 10-30%
63	medium-thick chestnut soils with small chestnut salt licks up to 10%
64	medium-thick chestnut soils with small chestnut salt licks up to 10%
65	medium-thick chestnut with small chestnut salt licks 30-50%

66	medium-thick chestnut with small chestnut salt licks 30-50%
67	meadow-chestnut medium
68	meadow-chestnut medium
69	meadow-chestnut medium
70	meadow-chestnut medium solonetzic-saline
71	meadow chestnut
72	meadow chestnut
73	meadow chestnut
74	meadow-chestnut slightly solonetsous
75	meadow chestnut medium solonetzic solonchak
76	meadow-chestnut solonchak
77	meadow-chestnut solonchak
78	meadow-chestnut solonchak
79	meadow-chestnut solonchak
80	floodplain meadow chestnut solonchak
81	floodplain meadow chestnut solonchak
82	floodplain meadow chestnut solonchak
83	floodplain meadow chestnut solonchak
84	small chestnut salt licks with medium-thick meadow-chestnut soils 10-30%
85	salt marshes typical
86	sor solonchaks
87	small chestnut salt licks with medium-thick meadow-chestnut soils 10-30%
88	salt marshes typical
89	sor solonchaks
90	fixed flat sands with fixed ridge-hilly sands 10-30%
91	fixed flat sands with ridge-hilly semi-fixed sands 10-30% and meadow chestnut saline sands up to 10%
92	fixed flat sands with ridge-hilly semi-fixed sands 10-30% and meadow chestnut sands up to 10%
93	fixed flat sands with fixed ridge-hilly sands 10-30% and semi-fixed ridge-hilly sands up to 10%
94	fixed ridge-hilly sands
95	fixed ridge-hilly sands with semi-fixed ridge-hilly sands up to 10-30%
96	semi-fixed ridge-hilly sands with fixed ridge-hilly sands up to 30-50%
97	ridge-hilly semi-fixed sands with fixed ridge-hillocky sands up to 10-30% and meadow chestnut strongly solonetzic-saline sands up to 10%
98	semi-fixed ridge-hilly sands with fixed ridge-hilly sands up to 30-50%
99	ridge-hilly semi-fixed sands with fixed ridge-hillocky sands up to 10-30% and meadow chestnut strongly solonetzic-saline sands up to 10%
100	semi-fixed ridge-hilly sands with fixed ridge-hilly sands up to 30-50%
101	tight rock outcrops
102	clay outcrops

Conclusions. Based on the conducted research, the following conclusions can be drawn:

- in the study area, dark chestnut soils are formed in the soil cover in combination with various soil combinations. They are formed in the conditions of the dry steppe zone, with the non-wash type of water regime, under the haymooth, meadow-grass, herbaceous-fat-grass, black-wormwood-meadow and meadowwhite-wormwood-kokpekovic plant communities, on loesslike loams;

- to improve the quality of generalized maps (regional, provincial and other), it is necessary to create objective automated methods for generalizing maps in the digital environment;

- as a result of our research, we have developed a simple and at the same time practically accessible to a wide audience of GIS users the methodology for compiling a digital soil map using the ArcGIS software product. To compile a map, it is possible to use any scanned cartographic basics, photographic plans, and if there are other raster materials. And as evidence of efficiency, with its help a large-scale soil map of Chingirlau region of the West Kazakhstan region was created based on the soil maps of rural counties made by GIS technology software.

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ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Редакторы: *М.С. Ахметова, А. Ботанқызы, Р.Жәлиқызы, Д.С. Аленов*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 15.06.2022.
Формат 70x90$^{1}/_{16}$. Бумага офсетная. Печать – ризограф.
17,5 п.л. Тираж 300. Заказ 3.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-19