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Soil Nomenclature of the Kostanay Region, Kazakhstan according to the WRB System

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ABSTRACT

The study aimed to correlate the principal soil types and subtypes of the Kostanay Region of Kazakhstan with the World Reference Base for Soil Resources (WRB) and to provide a unified nomenclature suitable for international soil research. The analysis was based on regional soil maps, the National Atlas of the Republic of Kazakhstan, published studies on soil morphology and properties, and the fourth edition of WRB (2022). More than 30 national classification units and eight soil complexes identified within the region were compared with corresponding WRB reference soil groups and qualifiers. The main zonal soils were correlated with Calcic Chernozems (Pachic), Calcic Chernozems, Gypsic Kastanozems (Humic), Gypsic Kastanozems, Calcisols, and Luvic Calcisols, while the principal intrazonal soils corresponded to Fluvisols, Gleyic Chernozems, Gleyic Kastanozems, Solonetz, and Technosols. The most widely applicable supplementary qualifiers were Aric, Sodic, and Endoprotosalic, with Katocalcic, Skeletic, Hyperhumic, Salic, and Urbic used for specific profile features. The dominant soil groups were identified for all 16 districts of the Kostanay Region. The proposed WRB-based nomenclature provides a standardized basis for soil mapping, monitoring, agricultural assessment, and international comparison of regional soil data.

Keywords: *Soil taxonomy, World reference base for soil resources, Diagnostic horizon, Soil profile, Agricultural lands*

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INTRODUCTION

At present, specialists from various countries are actively implementing the International Soil Classification System and the World Reference Base for Soil Resources (WRB) (IUSS Working Group WRB, 2022). In soil studies of the Republic of Kazakhstan, the USSR Soil Classification (Egorov *et al*., 1977) with regional additions (Erokhina *et al*., 2006) has been used for many decades. The new international system and the older national classifications are based on similar principles and reflect the current understanding of soil-forming processes. The international soil classification system is represented by reference soil groups with a set of principal and supplementary qualifiers (Krasilnikov *et al*., 2009; Shi *et al*., 2010; Gerasimova & Bogdanova, 2015; Gerasimova, 2019), while diagnostic horizons are used for soil identification. In scientific publications in soil science and related fields, most international journals use the WRB system. Correlating the WRB classification system with soil classifications used in the Republic of Kazakhstan is therefore an important task.

Soils are a key component of landscapes and an indispensable natural resource for agricultural production, ensuring the food and environmental security of the region. In the Kostanay Region, the area of land involved in agricultural use amounts to 11.073 million hectares (Ministry of Agriculture of the Republic of Kazakhstan, 2023). The Kostanay Region is one of the main agricultural regions of the Republic of Kazakhstan. From north to south, three latitudinal soil zones are distinguished within the region, each subdivided into several subzones (Baisholanov, 2017). The diversity of climatic conditions and soil-forming parent materials determines the complex structure of the soil cover in the Kostanay Region. The main types of zonal and intrazonal soils used in agriculture across vast areas of Kazakhstan have developed here. Chernozems and Kastanozems are the most valuable soils on arable land, pastures, and hayfields. For effective interaction between specialists from different countries and for the exchange of research data on Chernozems and Kastanozems soil groups of major agricultural importance in the Kostanay Region of the Republic of Kazakhstan the International Soil Classification System should be applied.

Under conditions of climate change and intensification of agricultural production, many steppe soils are subject to degradation and desertification due to water and wind erosion, dehumification, desiccation, pasture trampling, solonetzization, and salinization (Robinson *et al*., 2003; Meyer *et al*., 2008; Issanova *et al*., 2014; Koshen *et al*., 2019; Filippova *et al*., 2020; Hu *et al*., 2020). As a result of degradation processes, soil fertility declines, soil structure changes, the thickness of the humus profile decreases, the agronomically valuable structure of soil aggregates deteriorates, and secondary accumulations of gypsum and salts develop in lower horizons. Degraded Chernozems and Kastanozems may lose their humus horizons, transforming into semi-desert and even desert soils (Kabała *et al*., 2019; Deckers *et al*., 2024). At the same time, land degradation dynamics in some regions of Eurasia are multidirectional and may become favorable with the implementation of soil conservation and agroforestry reclamation measures (Kulik *et al*., 2018; Lyu *et al*., 2020; Ryspekov *et al*., 2021; Kust *et al*., 2024). The WRB international classification system provides extensive opportunities for describing spatial variability and different stages of evolution, transformation, degradation, and restoration of all soil types within the territory of the Republic of Kazakhstan.

This research aims to establish a definitive correlation between the WRB system's classification nomenclature and the principal soil types and subtypes previously recognized within the national framework for the Kostanay Region, located in the Republic of Kazakhstan, for standardized comparative analysis.

MATERIALS AND METHODS

The Kostanay Region is a major industrial and agricultural region of the Republic of Kazakhstan. The study used information presented on maps published in specialized editions (Medeu, 2006; Baisholanov, 2017). Within the territory of the Kostanay Region, natural zones change in accordance with the law of latitudinal zonation. From north to south, three natural zones are distinguished: steppe, semi-desert, and desert. Within the steppe zone, three subzones are identified: moderately humid, moderately arid, and dry steppe. The administrative division of the Kostanay Region includes 16 districts and 4 cities of regional subordination **(Figure 1)**.

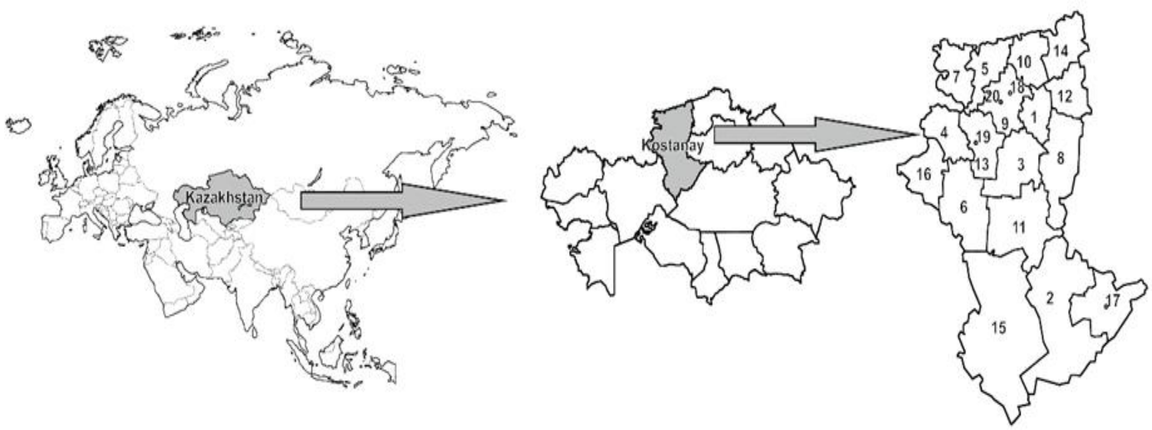

Figure 1. Location within the map of Eurasia and administrative division of the Kostanay Region of the Republic of Kazakhstan Administrative division of Kostanay region: 1. Altynsarin District; 2. Amangeldi District; 3. Auliekol District; 4. Denisov District; 5. Fyodorov District; 6. Kamysty District; 7. Karabalyk District; 8. Karasu District; 9. Kostanay District; 10. Mendykara District; 11. Nauyrzym District; 12. Sarykol District; 13. Beimbet Mailin district (formerly Taran district); 14. Uzunkol District; 15. Zhangeldi District; 16. Zhitikara District; 17. Arkalyk; 18. Kostanay; 19. Lisakovsk; 20. Rudny.

The soil map of the entire territory of the Republic of Kazakhstan presented in the National Atlas has a scale of 1:5,000,000 (Medeu, 2006). Additional information on horizon properties, profile structure, soil types, subtypes, and varieties was obtained from studies conducted in different districts of the Kostanay Region.

The research methods included establishing correspondence between the names of all soil types, subtypes, and varieties identified in the Kostanay Region according to the soil classification system of the Republic of Kazakhstan and the standards of the International Soil Classification System WRB, the fourth edition of which was published in 2022 (IUSS Working Group WRB, 2022). For the identified classification units, information was compiled on soil profile structure and the distribution of different soils across individual districts of the Kostanay Region.

RESULTS AND DISCUSSION

On the soil map of the Republic of Kazakhstan (Medeu, 2006), more than 30 classification units and 8 soil complexes are distinguished within the Kostanay Region. The main zonal soils of the Kostanay Region are represented by subtypes of chernozems, chestnut soils, and brown desert soils identified using the national classification system. In all districts of the region, intrazonal soils are also widespread, including meadow alluvial soils, meadow chernozems, meadow chestnut soils, and solonetz soils (Erokhina *et al*., 2006).

In the natural zone of moderately humid steppes, ordinary chernozems prevail; according to the International Soil Classification System (IUSS Working Group WRB, 2022), these correspond to Calcic Chernozems (Pachic) **(Table 1)**. The upper part of these soils is formed by the diagnostic chernic (Ah) horizon, which is defined by its dark color, granular or crumb structure of soil aggregates, and organic carbon content exceeding 1%. The supplementary qualifier "pachic" indicates that the thickness of the chernic horizon exceeds 50 cm **(Figure 2)** (Zhalankuzov, 2014). The supplementary qualifier Hyperhumic is applicable to horizons with a weighted mean soil organic carbon content ≥ 5% in the 0–50 cm layer.

Table 1. Main types and subtypes of zonal soils of the Kostanay Region in the national and international classification systems

Soil names according to the soil classification of the Republic of Kazakhstan (Medeu, 2006)	Soil names in the International Classification System (IUSS Working Group WRB, 2022)	Specifying supplementary qualifiers (IUSS Working Group WRB, 2022)
	Zonal soils	
Ordinary chernozems	Calcic Chernozems (Pachic)	(Aric, Hyperhumic)
Carbonate ordinary chernozems	Katocalcic Chernozems (Pachic)	(Aric)
Solonetzic ordinary chernozems	Calcic Chernozems (Pachic, Sodic)	(Aric, Endoprotosalic)
Southern chernozems	Calcic Chernozems	(Aric)
Carbonate southern chernozems	Katocalcic Chernozems	(Aric)
Solonetzic southern chernozems	Calcic Chernozems (Sodic)	(Aric, Endoprotosalic)
Dark chestnut soils	Gypsic Kastanozems (Humic)	(Aric)
Carbonate dark chestnut soils, locally residually carbonate	Gypsic Calcic Kastanozems (Humic)	(Aric)
Solonetzic dark chestnut soils	Gypsic Kastanozems (Humic, Sodic)	(Aric, Endoprotosalic)
Shallow skeletal dark chestnut soils	Gypsic Skeletic Kastanozems (Humic)	(Aric)
Medium chestnut soils	Gypsic Kastanozems	(Aric)
Solonetzic medium chestnut soils	Gypsic Kastanozems (Sodic)	(Endoprotosalic)
Shallow skeletal medium chestnut soils	Gypsic Skeletic Kastanozems	
Light chestnut soils	Calcisols	
Solonetzic light chestnut soils	Calcisols (Sodic)	(Salic)
Shallow skeletal light chestnut soils	Skeletic Calcisols	
Brown semi-desert soils	Luvic Calcisols	
Solonetzic brown semi-desert soils	Luvic Calcisols (Sodic)	(Salic)

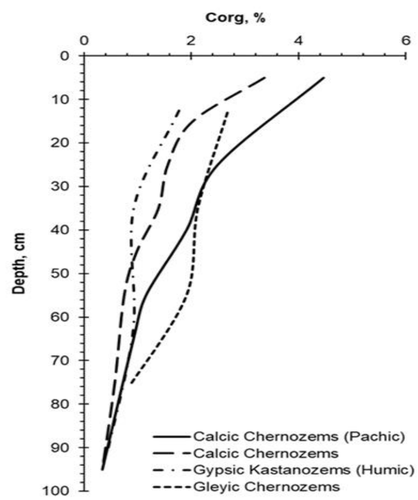

Figure 2. Distribution of organic carbon content in soil profiles of the Kostanay Region: ordinary chernozem (Calcic Chernozems (Pachic)), southern chernozem (Calcic Chernozems), dark chestnut soil (Gypsic Kastanozems (Humic)), meadow chernozem soil (Gleyic Chernozems)

Extensive agricultural activities characterize much of the Kostanay Region, leaving minimal virgin steppe terrain untouched. Consequently, the upper soil layer across vast tracts is consistently ploughed. According to international standards (IUSS Working Group WRB, 2022), this layer is designated as an Aric horizon (Ap) provided it exceeds 10 cm in thickness, originates at the surface, maintains structural uniformity through cultivation, and features a distinct, level lower boundary. This specific horizon serves as a supplementary qualifier in soil classification. Conversely, various districts within the region utilize land for pastures, hayfields, or fallow purposes. Soils in these areas often lack a standard ploughed horizon or exhibit significant post-agrogenic evolution; therefore, the application of the Aric horizon terminology and the corresponding Aric qualifier is deemed inappropriate for these distinct, non-cultivated segments of the regional landscape.

The middle and lower parts of chernozem profiles are represented by the calcic (Bk) horizon, characterized by the accumulation of secondary carbonates with a content in the fine earth fraction of ≥ 15%. Secondary carbonates may occur as calcite crystals smaller than 1 mm or as pedogenic features such as impregnation of soil aggregates, coatings, veins, soft and/or hard concretions, and nodules. In some districts of the Kostanay Region, carbonate chernozems are observed, in which strong effervescence in reaction with HCl is recorded in the upper part of the profile (above a depth of 50 cm). According to the International Soil Classification System, such soils can be classified as Katocalcic Chernozems **(Table 1).**

In all soil zones of the Kostanay Region, solonetzic soils are present and are distinguished at the level of soil genus in the national classification (Egorov *et al.*, 1977). In solonetzic chernozems, a sodic (Bn) horizon forms, in which the exchangeable sodium content exceeds 6% of the total exchangeable cations **(Figure 3)** (Almanova *et al.*, 2021). These soils have lower fertility, and their agricultural use requires reclamation measures. In the international classification system, the qualifier Sodic should be added to the names of solonetzic soils. In some solonetzic soils, a weak accumulation of readily soluble salts may occur in deeper horizons; this process is reflected by the supplementary qualifier Endoprotosalic.

In the natural zone of moderately arid steppes of the Kostanay Region, the main soil subtype is southern chernozem. According to the international classification, it belongs to the Calcic Chernozems soil group. The thickness of the chernic horizon in these soils is less than 50 cm; therefore, the Pachic qualifier is not applied **(Table 1)**. The soil organic carbon content in the profiles of these chernozems is 1.5–2 times lower than in Calcic Chernozems (Pachic) **(Figure 2)** (Zhalankuzov & Nazanova, 2015). Within the Calcic Chernozems soil group, extensive areas are also occupied by the Aric classification unit, corresponding to arable soils.

Within the Kostanay Region, carbonate soils (katocalcic) are distinguished within the Calcic Chernozems group; in these soils, carbonate features are observed even within the chernic horizon. Solonetzic varieties of Calcic Chernozems (Sodic) are confined to lowland plains underlain by saline clays or heavy loams. Soils with accumulation of readily soluble salts in the lower part of the profile are also found; this feature is indicated by the supplementary qualifier Endoprotosalic.

In the natural zone of dry steppes of the Kostanay Region, dark chestnut and medium chestnut soils are most widespread. A characteristic feature of these soils is the sandy nature of profile horizons. According to the International Soil Classification System, chestnut soils belong to the Gypsic Kastanozems (Humic) and Gypsic Kastanozems soil groups **(Table 1)**. For dark chestnut soils, the supplementary qualifier Humic is applicable, corresponding to a weighted mean organic carbon content ≥ 1% in the 0–50 cm layer **(Figure 2)** (Almanova *et al*., 2023).

In the lower part of these soil profiles, a gypsic horizon occurs, characterized by the accumulation of secondary gypsum, most often in the form of pedogenic features of various shapes. The main criterion for the Gypsic qualifier is a gypsum content ≥ 5% (by soil mass). When calcium sulfate is present in groundwater under dry climatic conditions, an overlying calcic horizon and an underlying gypsic horizon are formed. Their position within the soil profile may vary due to the lower solubility of carbonates compared to gypsum.

Large areas of land on Gypsic Kastanozems (Humic) and Gypsic Kastanozems are ploughed and belong to the Aric classification unit. Residually carbonate soils are widespread on elevated, leveled, weakly drained plains and in broad river valleys, where carbonate heavy loams and clays serve as parent materials. Such soils are assigned the Calcic qualifier.

A shortened profile and high stoniness are characteristic of shallow, skeletal chestnut soils occurring on the spurs of the Trans-Ural Plateau. According to the International Soil Classification System, the qualifier Skeletic should be added to the names of these soils, reflecting a content of coarse fragments ≥ 40% (by volume) on average within the 0–100 cm layer. In the natural zone of dry steppes of the Kostanay Region, solonetzic soils Gypsic Kastanozems (Humic, Sodic) and Gypsic Kastanozems (Sodic) are widespread, many of which are difficult to use as agricultural land. Among them, soils with accumulation of readily soluble salts in the lower part of the profile are common; this feature is reflected by the supplementary qualifier Endoprotosalic.

In the semi-desert (desert–steppe) zone of the Kostanay Region of the Republic of Kazakhstan, light chestnut and brown semi-desert soils prevail. According to the International Soil Classification System, they belong to the soil groups Calcisols and Luvic Calcisols **(Table 1)**. In these soils, the upper layer with an organic carbon content ≥ 1% is less than 30 cm thick; therefore, a chernic horizon is not distinguished. The calcic horizon is usually recorded at a depth of 25–40 cm. Solonetzic semi-desert soils are described using the supplementary qualifier Sodic. Arid climatic conditions and the geological and geomorphological features of soil-forming and underlying parent materials determine the widespread occurrence of saline soils, which are described by the qualifier Salic. Light chestnut shallow skeletal soils correspond to the soil group Skeletic Calcisols.

Across the entire territory of the Kostanay Region, intrazonal soils occur alongside zonal soils **(Table 2)**. In river and lake floodplains, meadow alluvial soils develop, which correspond to fluvisols in the International Soil Classification System. These soils are characterized by high fertility and are often used as arable land; therefore, many of them require the Aric qualifier.

Table 2. Main types of intrazonal soils and soil complexes of the Kostanay Region in the national and international classification systems

Soil names according to the soil classification of the Republic of Kazakhstan (Medeu, 2006)	**Soil names in the International Classification System (IUSS Working Group WRB, 2022)**	**Specifying supplementary qualifiers (IUSS Working Group WRB, 2022)**
	Intrazonal soils	
Meadow alluvial soils	Fluvisols	(Aric)
Meadow chernozem soils	Gleyic Chernozems	(Aric)
Meadow chestnut soils	Gleyic Kastanozems	(Aric)
Solonetz soils	Solonetz	
Saline solonetz soils	Salic Solonetz	
Technogenic soils	Technosols	
Urban soils	Urbic Technosols	
	Soil complexes	
Solonetzic ordinary chernozems + Solonetz	Calcic Chernozems (Pachic, Sodic) + Solonetz	(Endoprotosalic)
Solonetzic southern chernozems + Solonetz	Calcic Chernozems (Sodic) + Solonetz	(Endoprotosalic)
Solonetzic dark chestnut soils + Solonetz	Gypsic Kastanozems (Humic, Sodic) + Solonetz	(Endoprotosalic)
Solonetzic medium chestnut soils + Solonetz	Gypsic Kastanozems (Sodic) + Solonetz	(Endoprotosalic)
Solonetzic light chestnut soils + Solonetz	Calcisols (Sodic) + Solonetz	(Salic)
Meadow alluvial soils + Solonetz	Fluvisols + Solonetz	(Endoprotosalic)

Meadow chernozem soils + Solonetz	Gleyic Chernozems + Solonetz	(Endoprotosalic)
Meadow chestnut soils + Solonetz	Gleyic Kastanozems + Solonetz	(Salic)

Meadow chernozem soils, identified in the zones of moderately humid and moderately arid steppes, are confined to watershed depressions, valleys, and large lake basins such as Sarykol and Koibagar. In the International Soil Classification System, these soils are classified as Gleyic Chernozems. They are characterized by increased humus content in the upper and middle parts of the profile **(Figure 2)** (Almanova *et al*., 2021), as well as by gleying features expressed as bluish and rusty mottles in the lower horizons. Gleyic Chernozems on arable land are assigned the Aric qualifier.

Meadow chestnut soils are formed in the dry steppe zone on depressed plains and on above-floodplain river and lake terraces. In the International Soil Classification System, they correspond to Gleyic Kastanozems. These soils are characterized by moisture supply from surface water and/or shallow groundwater (3–6 m). Gleyic Kastanozems contain more humus than zonal Gypsic Kastanozems. Their profiles are not characterized by the accumulation of carbonates and readily soluble salts in the upper and middle parts, while signs of gleying are observed in the lower horizons. Cultivated Gleyic Kastanozems, according to the International Classification System, are described using the supplementary qualifier Aric.

Throughout the Kostanay Region, Solonetz soils are widely distributed, forming both large individual massifs and complexes with other solonetzic soils. In the International Soil Classification System, Solonetz constitutes a separate soil group (Solonetz) **(Table 2)**. These soils have a diagnostic natric horizon, the upper boundary of which occurs at a depth of 20–50 cm, where the exchangeable sodium content is ≥ 15% of the total exchangeable cations **(Figure 3)** (Lyubimova *et al*., 2016). Solonetz forms complexes with many zonal and intrazonal solonetzic soils, resulting in a complex soil cover structure. The profiles of Solonetz are often saline; the presence of this feature should be described using the Salic qualifier.

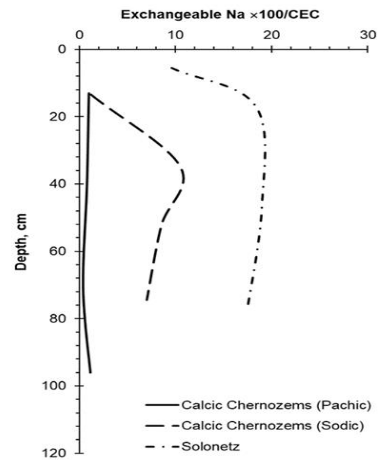

Figure 3. Distribution of exchangeable sodium content in soil profiles of the Kostanay Region: ordinary chernozem (Calcic Chernozems (Pachic)), solonetzic southern chernozem (Calcic Chernozems (Sodic)), solonetz soil (Solonetz).

In urban areas and in mining and industrial territories, natural soils are typically replaced by technogenically disturbed or anthropogenic soils. According to the International Soil Classification System, these soils belong to the Technosols soil group. If the horizons of such soils consist of ≥ 35% (by volume) of construction debris and other wastes accumulated in human settlements, they are assigned the Urbic qualifier.

The presented soil nomenclature of the Kostanay Region of the Republic of Kazakhstan **(Tables 1 and 2)** includes about 50 classification units. Agricultural lands may also contain soils affected by water or wind erosion processes. The presence and degree of erosion are recorded through the description of surface irregularities (Jahn *et al*., 2006).

During soil diagnostics in the Kostanay Region of the Republic of Kazakhstan, soil profiles with varying morphological structures were identified **(Table 3)**. The morphological and chemical properties of the chernic (Ah) horizon vary considerably within a single soil group of Chernozems (Sorokin *et al*., 2021). The aric (Ap) plough horizon is diagnosed on agricultural lands, which predominate across most of the Kostanay Region.

Table 3. Soil horizons and examples of soil profile structures of the Kostanay Region in the International Classification System

Soil	Soil horizons and examples of profile structure	
Calcic Chernozems (Pachic)	Ah-Bhw-Bkw-Ck	Ah-Bhw-Bwk-Ck
Calcic Chernozems (Pachic, Aric)	Ap-Ah-Bhw-Bkw-Ck	Ap-Bhw-Bwk-Ck
Katocalcic Chernozems (Pachic)	Ah-Bhkw-Bk-Ck	Ah-Bhwk-Bkw-Ck
Katocalcic Chernozems (Pachic, Aric)	Ap-Ah-Bhkw-Bkw-Ck	Ap-Bhwk-Bkw-Ck
Calcic Chernozems (Pachic, Sodic)	Ah-Bhw-Bkwn-Cky	Ah-Bhw-Bwkn-Cky
Calcic Chernozems (Pachic, Sodic, Aric)	Ap-Ah-Bhw-Bkwn-Cky	Ap-Bhw-Bwkn-Cky
Calcic Chernozems	Ah-Bwh-Bkw-Ck	Ah-Bw-Bkw-Ck
Calcic Chernozems (Aric)	Ap-Bwh-Bwh-Bkw-Ck	Ap-Bwh-Bkw-Ck
Katocalcic Chernozems	Ah-Bwhk-Bkw-Ck	Ah-Bwk-Bkw-Ck
Katocalcic Chernozems (Aric)	Ap-Bwh-Bkwh-Bkw-Ck	Ap-Bwhk-Bkw-Ck
Calcic Chernozems (Sodic)	Ah-Bwh-Bkwny-Ckyz	Ah-Bw-Bkwny-Ckyz

Calcic Chernozems (Sodic, Aric)	Ap-Bwh-Bkwny-Ckyz	Ap-Bw-Bkwny-Ckyz
Gypsic Kastanozems (Humic)	Ah-Bwhk-Cky	Ah-Bhwk-Cky
Gypsic Kastanozems (Humic, Aric)	Ap-Bwhk-Cky	Ap-Bhwk-Cky
Gypsic Calcic Kastanozems (Humic,)	Ah-Bkwh-Cky	Ah-Bkhw-Cky
Gypsic Calcic Kastanozems (Humic, Aric)	Ap-Bkwh-Cky	Ap-Bkhw-Cky
Gypsic Kastanozems (Humic, Sodic)	Ah-Bkwhn-Ckyz	Ah-Bkhwn-Ckyz
Gypsic Kastanozems (Humic, Sodic, Aric)	Ap-Bkwhn-Ckyz	Ap-Bkhwn-Ckyz
Gypsic Kastanozems	Ah-Bwk-Cky	Ah-Bwk-Cky
Gypsic Kastanozems (Aric)	Ap-Bwk-Cky	Ap-Bwk-Cky
Gypsic Kastanozems (Sodic)	Ah-Bkwn-Ckyz	Ah-Bknw-Ckyz
Luvic Calcisols	A-Bkw-Ck	A-Ck
Luvic Calcisols (Sodic)	A-Bknw-Ckz	A-Bnkw-Ckz
Fluvisols (Aric)	Ah-C1-2C2-3C3	Ap-C1-2C2-3C3
Gleyic Chernozems (Aric)	Ah-Bhwg-Bgkw-Cgk	Ap-Bhwg-Bgkw-Cgk
Gleyic Kastanozems (Aric)	Ah-Bhgkw-Cgk	Ap-Bhwg-Bgkw-Cgk
Solonetz	Ah-Bnt-Ckz	A-Btn-Bk-Ckyz
Technosols, Urbic Technosols	Ahτ-2B-3C	Ahu-2Bu-3Bw-3C

Note. Horizon indices: Ah – chernic; p – aric; Bw – cambic; h – humic; k – protocalcic, calcic; n – sodic, natric; y – gypsic; z – protosalic, salic; t – clay accumulation; u – urbic; τ – human-transported natural material; C – parent material.

In some soil groups—Chernozems, Kastanozems, and Calcisols—several processes may be observed simultaneously in the middle part of the soil profile, including humus redistribution, accumulation of secondary carbonates and gypsum, and solonetzization. For the B horizons, indices are listed in decreasing order of the intensity of soil-forming processes, with the most strongly expressed process indicated first **(Table 3)**.

In both the International Soil Classification System and the national soil classification of Kazakhstan, Solonetz soils are defined at a high taxonomic level. At the same time, solonetzic (sodic) variants are also distinguished within other soil groups, including Chernozems, Kastanozems, and Calcisols. However, the morphological and chemical criteria used to assess the degree of solonetzic development differ somewhat between classification systems (Pankova *et al*., 2018).

Profiles of Technosols are highly diverse. They may be disturbed by industrial activities and earthworks and can include horizons of relocated material as well as urbic horizons.

Within natural zones and individual districts of the Kostanay Region, the structure of the soil cover changes mainly in accordance with the law of latitudinal zonation. An important role is also played by regional characteristics of soil-forming and underlying parent materials (Ganea *et al*., 2024; Soman *et al*., 2024; Ahn *et al*., 2025; Castellano-Rioja, 2025; Cavero & Ferraz, 2025; Mikail *et al*., 2025; Petronis *et al*., 2025; Shen & Bao, 2025; Silik, 2025; Zulkarnain *et al*., 2025; Batra & Rajasekar, 2026; Merzouki *et al*., 2026; Mohammad, 2026; Shon & Yang, 2026).

In Karabalyk District, located in the northwestern part of the region **(Figure 1)**, Calcic Chernozems (Pachic, Aric) predominate, while solonetzic Calcic Chernozems (Pachic, Aric, Sodic) occupy smaller areas. In Uzunkol District in the northeastern part of the region, along with these soils, Calcic Chernozems (Pachic, Aric, Hyperhumic), Katocalcic Chernozems (Pachic, Aric), and Solonetz are also found **(Table 4)**.

Table 4. Nomenclature of predominant soil groups identified according to the International Classification in individual natural zones and districts of the Kostanay Region

Districts of the Kostanay Region (area)	Natural zone	Predominant soil groups (IUSS WRB, 2022)
Karabalyk District (6.9 thousand km^2)	Moderately humid steppe	Calcic Chernozems (Pachic, Aric); Calcic Chernozems (Pachic, Aric, Sodic)
Uzunkol District (7.2 thousand km^2)	Moderately humid steppe	Calcic Chernozems (Pachic, Aric); Calcic Chernozems (Pachic, Aric, Hyperhumic); Katocalcic Chernozems (Pachic, Aric); Calcic Chernozems (Pachic, Aric, Sodic); Solonetz
Fedorov District (7.2 thousand km^2)	Moderately humid and moderately arid steppe	Calcic Chernozems (Pachic, Aric); Calcic Chernozems (Pachic, Aric, Sodic); Calcic Chernozems (Aric); Calcic Chernozems (Sodic); Gleyic Chernozems; Solonetz
Mendykarin District (6.6 thousand km^2)	Moderately humid and moderately arid steppe	Calcic Chernozems (Pachic, Aric); Calcic Chernozems (Pachic, Sodic); Calcic Chernozems (Aric); Solonetz; Fluvisols (Aric)
Sarykol District (6.1 thousand km^2)	Moderately humid and moderately arid steppe	Calcic Chernozems (Pachic, Aric); Calcic Chernozems (Pachic, Sodic); Calcic Chernozems (Aric, Sodic); Gleyic Chernozems; Solonetz
Kostanay District (7.5 thousand km^2)	Moderately humid and moderately arid steppe	Calcic Chernozems (Aric); Calcic Chernozems (Aric, Sodic); Calcic Chernozems (Pachic, Sodic); Solonetz; Gleyic Chernozems
Altynsarin District (6.4 thousand km^2)	Moderately arid steppe	Calcic Chernozems (Aric); Calcic Chernozems (Aric, Sodic); Solonetz; Katocalcic Chernozems (Aric)

Denisov District (6.8 thousand km²)	Moderately arid steppe	Calcic Chernozems (Aric); Katocalcic Chernozems (Aric); Calcic Chernozems (Aric, Sodic); Solonetz
Beimbet Mailin District (formerly Taranovsky) (7.6 thousand km²)	Moderately arid and dry steppe	Calcic Chernozems (Aric); Gypsic Kastanozems (Humic, Aric); Katocalcic Chernozems (Aric); Calcic Chernozems (Aric, Sodic); Gypsic Kastanozems (Humic, Sodic); Solonetz; Fluvisols (Aric)
Zhitikara District (7.3 thousand km²)	Moderately arid and dry steppe	Calcic Chernozems (Aric); Calcic Chernozems (Aric, Sodic); Gypsic Kastanozems (Humic, Aric); Gypsic Skeletic Kastanozems (Humic); Solonetz
Karasu District (12.8 thousand km²)	Moderately arid and dry steppe	Calcic Chernozems (Aric); Katocalcic Chernozems (Aric); Calcic Chernozems (Aric, Sodic); Gypsic Kastanozems (Humic, Aric); Gypsic Kastanozems (Humic, Sodic); Solonetz; Gleyic Chernozems (Aric)
Auliekol District (11.1 thousand km²)	Dry steppe	Gypsic Kastanozems (Humic, Aric); Gypsic Kastanozems (Humic, Sodic); Solonetz
Kamysty District (12.1 thousand km²)	Dry steppe	Gypsic Kastanozems (Humic, Aric); Gypsic Kastanozems (Humic, Sodic); Gypsic Kastanozems (Sodic); Solonetz
Naurzum District (15.2 thousand km²)	Dry steppe and semi-desert	Gypsic Kastanozems (Humic, Aric); Gypsic Kastanozems (Humic, Sodic); Gypsic Kastanozems (Aric); Gypsic Kastanozems (Sodic); Solonetz; Gleyic Kastanozems (Aric)
Amangeldy District (22.6 thousand km²)	Dry steppe and semi-desert	Gypsic Kastanozems (Aric); Gypsic Kastanozems (Sodic); Calcisols; Skeletic Calcisols; Calcisols (Sodic); Solonetz; Fluvisols (Aric)
Zhangeldy District (37.6 thousand km²)	Dry steppe and semi-desert, desert	Gypsic Kastanozems (Aric); Gypsic Kastanozems (Sodic); Calcisols; Calcisols (Sodic); Solonetz; Luvic Calcisols; Luvic Calcisols (Sodic)

In Fedorov, Mendykarin, and Sarykol Districts, Calcic Chernozems (Pachic, Aric) are widespread, as well as complexes of Calcic Chernozems (Pachic, Aric, Sodic) with Solonetz. In the southern parts of these districts, soils with a thinner humus horizon—Calcic Chernozems (Aric)—predominate. Gleyic Chernozems are typical around lake basins. Fluvisols are widespread on floodplains and terraced sections of the Tobyl and Obagan rivers, although isolated Solonetz massifs also occur.

In the natural zone of moderately arid steppes, Calcic Chernozems (Aric) dominate in Kostanay, Denisov, and Altynsarin districts. Less widespread are Calcic Chernozems (Aric, Sodic) and their complexes with Solonetz. Katocalcic Chernozems (Aric) are present in the Denisov and Altynsarin Districts. Gleyic Chernozems and their complexes with Solonetz occur in river valleys. In the valleys of the Kamysty-Ayat and Obagan rivers, continuous Solonetz massifs are locally observed.

In Taranovsky (Beimbet Mailin) and Karasu districts, the northern parts are occupied by Calcic Chernozems (Aric) and their solonetzic variants. In the southern halves of these districts, Gypsic Kastanozems (Humic, Aric) prevail, while Katocalcic Chernozems (Aric) and complexes of Gypsic Kastanozems (Humic, Aric, Sodic) with Solonetz are found in peripheral areas. Fluvisols are extensively developed in the floodplain and on terraced sections of the Tobol River, while Solonetz are widespread in the Damdy River valley. The soil cover of many lake depressions (Tenteksor, Karasor, Sulukol lakes) includes large Solonetz massifs, whereas Gleyic Chernozems (Aric) are more common around Lake Koibagar.

In Zhitikara District, the northern part is occupied by Calcic Chernozems (Aric) and complexes of Calcic Chernozems (Aric, Sodic) with Solonetz. In the southern half of the district, Gypsic Kastanozems (Humic, Aric) and shallow skeletal Gypsic Skeletic Kastanozems (Humic) are widespread.

In the dry steppe zone of Auliekol and Kamysty Districts, the soil cover is formed by Gypsic Kastanozems (Humic, Aric), Gypsic Kastanozems (Humic, Sodic), Gypsic Kastanozems (Sodic), and their complexes with Solonetz. In the Obagan River valley, weakly drained lake depressions, and along the slopes of the Obagan–Torgai Depression, large areas are occupied by solonetz massifs.

The territory of Naurzum District lies within the dry steppe zone, where Gypsic Kastanozems (Humic, Aric) and Gypsic Kastanozems predominate. Gypsic Kastanozems (Sodic) are widespread in the Kyzbel mountain massif. Gleyic Kastanozems (Aric) occur in the southeastern part of the district. Solonetz massifs are common in river valleys.

In Amangeldy District, Gypsic Kastanozems (Aric) and Gypsic Kastanozems (Sodic) dominate in the northern part, while Calcisols, Calcisols (Sodic), and their complexes with Solonetz are widespread in the southern part. Skeletic Calcisols are developed on the spurs of the Kazakh Uplands. In river and lake valleys, complexes of Fluvisols with Solonetz are observed, which also form separate elongated massifs.

The northern section of Zhangeldy District resides within the dry steppe, dominated by Gypsic Kastanozems and their sodic variants. Moving into the central semi-desert region, the landscape is defined by Calcisols and sodic Calcisols, frequently appearing alongside Solonetzic complexes **(Table 4)**. The southern desert zone is primarily composed of Luvic Calcisols and their sodic counterparts. Solonetz soils are extensively distributed, manifesting either in conjunction with other soil types or as independent, vast tracts. Furthermore, sodic and salic variations of Calcisols and Luvic Calcisols, developed upon saline parent substrates, are also prevalent throughout these diverse geological segments, as documented in various technical studies (Essah *et al.*, 2024; Hillman, 2024; Souza *et al.*, 2024; Cuenca-Martínez *et al.*, 2025; Hart & Reed, 2025; Khalil & Nassar, 2025; Rani & Gehrke, 2025; Rivas & Molina, 2025; Rojas & Paredes, 2025; Silik, 2025).

In the four cities of regional subordination—Kostanay, Rudny, Lisakovsk, and Arkalyk—soils belonging to Urbic Technosols and Technosols are developed.

The presented soil nomenclature can be used in various agricultural and environmental studies in the Kostanay Region of the Republic of Kazakhstan. Diagnosis of soil horizons and profiles based on the International Soil Classification System is essential for soil monitoring, protection against degradation, prevention of solonetzization and salinization, and planning and implementing agromeliorative measures on agricultural lands (Agrawal *et al*., 2024; Bona & Lozano, 2024; Danchin *et al*., 2024; Khan *et al*., 2024; Qiao *et al*., 2024; Braun *et al*., 2025; Eid *et al*., 2025; O'Brien *et al*., 2026; Tran & Pham, 2026).

CONCLUSION

For the soil types and subtypes within the territory of the Kostanay Region of the Republic of Kazakhstan, the following names are proposed based on the International Soil Classification System: ordinary chernozems – Calcic Chernozems (Pachic); southern chernozems – Calcic Chernozems; dark chestnut soils – Gypsic Kastanozems (Humic); medium chestnut soils – Gypsic Kastanozems; light chestnut soils – Calcisols; brown semi-desert soils – Luvic Calcisols; alluvial meadow soils – Fluvisols; meadow chernozem soils – Gleyic Chernozems; meadow chestnut soils – Gleyic Kastanozems; and solonetz soils – Solonetz.

Among the supplementary qualifiers, the most widespread are the following: Aric (arable soils), Sodic (solonetzic soils), and Endoprotosalic (presence of readily soluble salts in the lower part of the profile). In some districts, soils with specific features are also found: Katocalcic, indicating the presence of carbonate features in the upper horizon, and Skeletic, characterizing shallow, stony soils.

The soil cover of the Kostanay Region has formed in accordance with natural zones characterized by latitudinal zonation. In all districts of the Kostanay Region, soil complexes with Sodic properties and soils belonging to the Solonetz group are widespread.

In mining, industrial, and urban areas, soils belonging to Technosols and Urbic Technosols predominate.

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REFERENCES

Agrawal, M., Shrivastava, S., Khare, R. L., Jaiswal, S., Singh, P., & Hishikar, R. (2024). Comparative analysis of nephrotoxicity in patients on tenofovir-containing and non-tenofovir antiretroviral therapy. *Annals of Pharmacy Practice and Pharmacotherapy, 4*, 24–33. doi:10.51847/ZTJxzvNZt4

Ahn, S., Kim, S., Zhang, H., Dobalian, A., & Slavich, G. M. (2025). The long-term effects of early-life adversity on health, lifestyle, and cognition. *Bulletin of Pioneer Research in Medical and Clinical Sciences, 5*(1), 13–27. doi:10.51847/6ZhsvRWk26

Almanova, Z. S., Kenzhegulova, S. O., Ridvan, K., Zhakenova, A. T., Yerzhan, D., & Kelvin, H. D. (2023). Modern assessment of fertility of dark chestnut soils of Kamystinsky district of Kostanay region. *Scientific Journal "Bulletin of Science of S.Seifullin Kazakh Agro Technical Research University". Agricultural Sciences, 4*(119), 97-105.

Almanova, Zh. S., Kenzhegulova, S. O., & Kalakova, M. E. (2021). Current state of soil fertility of agricultural soils of Fedorovsky district, Kostanay region. *Bulletin of the Kursk State Agricultural Academy, 9*, 81-86. (in Russian)

Baisholanov, S. S. (Ed.). (2017). Agro-climatic resources of Kostanay region: Scientific and applied reference. Astana, 139 p. (in Russian)

Batra, V., & Rajasekar, A. (2026). Alginate biocomposite with *Gymnema sylvestre* and *Curcuma longa* for oral disease: An in vitro study. *Annals of Dental Specialty, 14*(1), 37–43. doi:10.51847/ZCQwv6afwe

Bona, C., & Lozano, R. (2024). Delayed hematologic toxicities following axicabtagene ciloleucel and tisagenlecleucel CAR-T cell therapy: A retrospective analysis of lymphocytopenia, neutropenia, and thrombocytopenia. *Asian Journal of Current Research in Clinical Cancer, 4*(2), 1–4. doi:10.51847/13fIAq9Er0

Braun, D., Eckert, J., Lang, T., Schneider, L., & Wirth, F. (2025). High-resolution HLA-B allele and haplotype frequencies in the Qatari population: Implications for pre-emptive pharmacogenetic screening of drug hypersensitivity. *Special Journal of Pharmacognosy and Phytochemistry Biotechnology, 5*, 77–87. doi:10.51847/43hsE3qngg

Castellano-Rioja, C. (2025). Investigating the effect of providing required training to mothers of children with surgery and its effect on mothers' anxiety. *Journal of Integrative Nursing and Palliative Care, 6*, 7–11. doi:10.51847/m0J08PS92O

Cavero, M., & Ferraz, J. P. (2025). Sedentary behavior determinants in pregnant women during the second and third trimesters: Prospective findings from the large-scale Japan Environment and Children's Study. *Bulletin of Pioneer Research in Medical and Clinical Sciences, 5*(1), 1–12. doi:10.51847/bdDIEuY7cl

Cuenca-Martínez, F., Herranz-Gómez, A., Madroñero-Miguel, B., Reina-Varona, Á., Touche, R. L., Angulo-Díaz-Parreño, S., Pardo-Montero, J., Corral, T. D., & López-de-Uralde-Villanueva, I. (2025). A systematic review of the literature on the connection between cervical spine abnormalities and internal disorders of the temporomandibular joint. *Journal of Current Research in Oral Surgery, 5*, 1–10. doi:10.51847/e4CoCM6iSZ

Danchin, A., Ng, T. W., & Turinici, G. (2024). Transmission pathways and mitigation strategies for COVID-19. *Interdisciplinary Research in Medical Sciences Special, 4*(1), 1–10. doi:10.51847/p0YhQPxvkW

Deckers, J., Gerasimova, M., Kabala, C., Kravchenko, Y., & Nachtergaele, F. (2024). Chernozems Lecture Notes. WRB Documentation Centre. Draft v. 3, 30.10.2024, 16 p. IUSS WRB Working Group.

Egorov, V. V., Fridland, V. M., Ivanova, E. N., Rozov, N. I., Nosin, V. A., & Friev, T. A. (Comp.). (1977). Classification and diagnostics of soils of the USSR. Moscow: Kolos, 223 p. (in Russian)

Eid, M., Hassan, A., Abdelrahman, Y., & Saeed, O. (2025). Association of UGT1A1*28 and CYP2B6 c.516G>T variants with adverse effects in HIV patients receiving antiretroviral therapy in Chile. *Special Journal of Pharmacognosy and Phytochemistry Biotechnology, 5*, 88–95. doi:10.51847/gHbHJPAf9Q

Erokhina, O. G., Kusainova, M. M., Sokolov, A. A., & Pachikin, K. M. (2006). Soils of Kazakhstan. In The Republic of Kazakhstan. Vol. 1: Natural conditions and resources (pp. 316-361). Almaty: Republican Cartographic Factory of the Agency for Land Resources of the Republic of Kazakhstan. (in Russian)

Essah, A., Igboemeka, C., & Hailemeskel, B. (2024). Exploring gabapentin as a treatment for pruritus: A survey of student perspectives. *Annals of Pharmacy Education, Safety, and Public Health Advocacy, 4*, 1–6. doi:10.51847/h8xgEJE3NE

Filippova, N., Churkina, G., Utebayev, M., Rukavitsina, I., & Kunanbayev, K. (2020). The effect of spring wheat cultivation methods on some fertility indicators of Southern carbonate chernozem in Northern Kazakhstan. *Ecology, Environment and Conservation, 26*(3), 1235-1238.

Ganea, M., Marcu, O. A., & Csep, A. N. (2024). Finite element analysis of trabecular bone response to orthodontic forces in periodontal breakdown. *Asian Journal of Periodontics and Orthodontics, 4*, 121–138. doi:10.51847/DVdnjkDpYE

Gerasimova, M. I., & Bogdanova, M. D. (2015). Soils in national atlases of different countries. *Eurasian Soil Science, 9*, 911-922. doi:10.1134/S1064229315090045

Gerasimova, M. I. (2019). International soil classification and its potential application in geographic research. *Vestnik of the Moscow University. Series 5. Geography, 3*, 49-56. (in Russian)

Hart, O. B., & Reed, C. J. (2025). Anti-neuroinflammatory effects of 50% ethanolic *Curcuma longa* extract in LPS-stimulated BV2 microglia: Involvement of Nrf2/HO-1 signaling and inhibition of NF-κB/MAPK. *Journal of Medical Sciences Interdisciplinary Research, 5*(1), 1–12. doi:10.51847/bMiGiIU1tk

Hillman, T. (2024). A predictive approach for determining the optimal anti-CCR5 monoclonal antibody. *Interdisciplinary Research in Medical Sciences Special, 4*(1), 11–22. doi:10.51847/jVJ3mRs3yR

Hu, Y., Han, Y., & Zhang, Y. (2020). Land desertification and its influencing factors in Kazakhstan. *Journal of Arid Environments, 180*, 104203. doi:10.1016/j.jaridenv.2020.104203

Issanova, G., Saparov, A., & Ustemirova, A. (2014). Soil degradation and desertification processes within Kazakhstan. In Proceedings of the IV International conference "Ecology of urban areas 2014", October 9-10, 2014, Zrenjanin, Serbia (pp. 429-434). Novi Sad: Faculty of Technical Sciences, University of Novi Sad.

IUSS Working Group WRB. (2022). World reference base for soil resources. International soil classification system for naming soils and creating legends for soil maps (4th ed.). Vienna: International Union of Soil Sciences (IUSS).

Jahn, R., Blume, H. P., Asio, V. B., Spaargaren, O., & Schad, P. (2006). Guidelines for soil description (4th ed.). Rome: Food and Agriculture Organization of the United Nations (FAO).

Kabała, C., Charzyński, P., Czigány, S., Novák, T. J., Saksa, M., & Świtoniak, M. (2019). Suitability of world reference base for soil resources (WRB) to describe and classify chernozemic soils in Central Europe. *Soil Science Annual, 70*(3), 244-257. doi:10.2478/ssa-2019-0022

Khalil, Y. H., & Nassar, O. S. (2025). Small-molecule inhibition of SOST suppresses breast cancer bone metastasis. *Archives of International Journal of Cancer and Allied Sciences, 5*(1), 1–17. doi:10.51847/XR3tpAzZri

Khan, T. M., Tahir, H., Adil, Q., Baig, M. R., Jaber, A. A. S., Khaliel, A. M., & Mohammed, Z. M. (2024). A three-decade overview of female-specific cancers in Malaysia: A thorough examination. *Asian Journal of Current Research in Clinical Cancer, 4*(2), 5–18. doi:10.51847/LIdazW7afN

Koshen, B. M., Shayakhmetova, A. S., & Toktar, M. (2019). The processes of dehumification of humus in the soil Sarykol district of Kostanay region. *News of the National Academy of Sciences of the Republic of Kazakhstan. Series of Agricultural Sciences, 2*(50), 105-109.

Krasilnikov, P. V., Ibáñez-Marti, J.-J., Arnold, R., & Shoba, S. A. (Eds.). (2009). *Handbook of soil terminology, correlation and classification*. London: Routledge, 449 p. doi:10.4324/9781849774352

Kulik, K. N., Petrov, V. I., Rulev, A. S., Kosheleva, O. Y., & Shinkarenko, S. S. (2018). On the 30th Anniversary of the "General Plan to Combat Desertification of Black Lands and Kizlyar Pastures". *Arid Ecosystems, 8*(1), 1-6. doi:10.1134/S2079096118010067

Kust, G. S., Shklyaeva, D. S., Lobkovskiy, V. A., & Andreeva, O. V. (2024). Using the methodology of land degradation neutrality to assess the territory of the Caspian Region. *Arid Ecosystems, 14*, 159-168. doi:10.1134/S2079096124700033

Lyu, Y., Shi, P., Han, G., Liu, L., Guo, L., Hu, X., & Zhang, G. (2020). Desertification control practices in China. *Sustainability, 12*(8), 3258. doi:10.3390/su12083258

Lyubimova, I. N., Salpagarova, I. A., & Khan, V. V. (2016). The degree of intensivity of solonetzic process within the virgin soils and soils with agrogenic transformation in solonetzic complexes of frores-steppe and dry steppe zones. *Dokuchaev Soil Bulletin, 84*, 46-60. doi:10.19047/0136-1694-2016-84-46-60 (in Russian)

Medeu, A. R. (Ed.). (2006). National atlas of the Republic of Kazakhstan. Vol. 1: Natural conditions and resources. The soil map. Almaty: Republican Cartographic Factory of the Agency for Land Resources of the Republic of Kazakhstan, pp. 97-98. (in Russian)

Merzouki, M., Khibech, O., Fraj, E., Elmsellem, H., Chetouani, A., Bouammali, B., & Challioui, A. (2026). Computational screening of chalcone derivatives as novel acetylcholinesterase inhibitors for Alzheimer's disease. *Journal of Biochemical Technology, 17*(1), 129–136. doi:10.51847/PTHVL9LMg0

Meyer, B. C., Schreiner, V., Smolentseva, E. N., & Smolentsev, B. A. (2008). Indicators of desertification in the Kulunda Steppe in the south of Western Siberia. *Archives of*

Agronomy and Soil Science, 54(6), 585-603. doi:10.1080/03650340802342268

Mikail, E. H., Çora, H., & Çora, A. N. (2025). Global dynamics of organizational behavior: The impact of culture, power, and decision making in international relations. *Journal of Organizational Behavior Research, 10*(2), 1–11. doi:10.51847/Jj82lmv0X4

Ministry of Agriculture of the Republic of Kazakhstan. Committee on Land Resources Management. (2023). Consolidated analytical report on the state and use of the lands of the Republic of Kazakhstan for 2023. Astana, 336 p. (in Russian)

Mohammad, J. A. (2026). The correlation between resistin with metalloproteinase-8, and vitamins A, C, D, E among patients having stage III periodontitis. *Journal of Biochemical Technology, 17*(1), 1–9. doi:10.51847/FWBnvddtTt

O'Brien, K., Murphy, L., & Doyle, S. (2026). Digital twins in pharmaceutical manufacturing: A scoping review. *Pharmacophore, 17*(3), 22–32. doi:10.51847/XFqRZ24c7n

Pankova, E. I., Gerasimova, M. I. & Korolyuk, T. V. (2018). Salt-affected soils in Russian, American, and International Soil Classification Systems. *Eurasian Soil Science, 51*, 1297-1308. doi:10.1134/S1064229318110078

Petronis, Z., Dainius, R., & Kornelijus, M. (2025). Risk factors for bracket bond failure in orthodontic treatment: Findings from a controlled single-centre study. *Asian Journal of Periodontics and Orthodontics, 5*, 65–72. doi:10.51847/ahNovnBrIh

Qiao, J., Luo, B., Ming, J., Zhou, S., Chen, Y., & Zhang, X. (2024). Prevalence and implications of non-prescription antibiotic dispensing in Baghdad community pharmacies. *Annals of Pharmacy Practice and Pharmacotherapy, 4*, 34–41. doi:10.51847/5SuGTfpren

Rani, N., & Gehrke, P. (2025). Promoting intercultural competence in German medical students via innovative medical ethics education focused on Muslim patients: A pilot study. *Asian Journal of Ethics in Health and Medicine, 5*, 1–12. doi:10.51847/0foncaeXr1

Rivas, D. S., & Molina, P. A. (2025). UBE2J1 suppresses colorectal cancer progression via ubiquitin-mediated degradation of RPS3. *Archives of International Journal of Cancer and Allied Sciences, 5*(1), 18–39. doi:10.51847/7UbioAJLAO

Robinson, S., Milner-Gulland, E. J., & Alimaev, I. I. (2003). Rangeland degradation in Kazakhstan during the Soviet era: Re-examining the evidence. *Journal of Arid Environments, 53*(3), 419-439. doi:10.1006/JARE.2002.1047

Rojas, V. M., & Paredes, D. E. (2025). Exploring acceptability, implementation, and contextual factors in a school-based physical activity intervention: Qualitative process evaluation from a feasibility trial in Yangzhou, China. *Journal of Medical Sciences Interdisciplinary Research, 5*(1), 13–28. doi:10.51847/duZGj20T8V

Ryspekov, T., Jandák, J., Balkozha, M., & Winkler, J. (2021). Vegetation of abandoned fields on soil types of kastanozems in Northern Kazakhstan (Kostanay Region). *Journal of Ecological Engineering, 22*(10), 176-184. doi:10.12911/22998993/142188

Shen, F., & Bao, L. (2025). Studying the effects of music on the time to gain independent oral feeding in premature infants. *Journal of Integrative Nursing and Palliative Care, 6*, 1–6. doi:10.51847/xBTC4CiH10

Shi, X. Z., Yu, D. S., Xu, S. X., Warner, E. D., Wang, H. J., Sun, W. X., Zhao, Y. C., & Gong, Z. T. (2010). Cross-reference for relating Genetic Soil Classification of China with WRB at different scales. *Geoderma, 155*(3-4), 344-350. doi:10.1016/j.geoderma.2009.12.017

Shon, J., & Yang, D. (2026). Generational differences in the pay equity–job engagement relationship: The moderating role of generation. *Journal of Organizational Behavior Research, 11*(1), 1–14. doi:10.51847/XAPPcrleg6

Silik, O. E. (2025). Integrating artificial intelligence in oncology: Turkish medical oncologists' knowledge, attitudes, and ethical perspectives. *Asian Journal of Ethics in Health and Medicine, 5*, 13–24. doi:10.51847/ObxojlDDEH

Soman, C., Hawzah, A. A. A. A., Alsomali, M. A., Alghamdi, S. A. K., & AlOsaimi, M. M. (2024). Salivary specimen in COVID-19 testing for dental settings: A meta-analysis comparing saliva, nasopharyngeal and serum specimens. *Annals of Dental Specialty, 12*(1), 33–47. doi:10.51847/LNn8bSwowj

Sorokin, A., Owens, P., Láng, V., Jiang, Z.-D., Michéli, E., & Krasilnikov, P. (2021). "Black soils" in the Russian soil classification system, the US soil taxonomy and the WRB: Quantitative correlation and implications for pedodiversity assessment. *CATENA, 196*, 104824. doi:10.1016/j.catena.2020.104824

Souza, J. S., Reis, E. A., Godman, B., Campbell, S. M., Meyer, J. C., Sena, L. W. P., & Godói, I. P. D. (2024). Designing a healthcare utilization index to enable worldwide patient comparisons: A cross-sectional study. *Annals of Pharmacy Education, Safety, and Public Health Advocacy, 4*, 7–15. doi:10.51847/EeWKtBkVgK

Tran, M., & Pham, D. (2026). Predicting pediatric liquid palatability using sweeteners, bitterness, viscosity, and acceptability data. *Pharmacophore, 17*(3), 12–21. doi:10.51847/pkyYsQrE8h

Zhalankuzov, T. Zh. (2014). Monitoring studies of the ordinary Chernozems in Karabalyk research station. *Soil Science and Agrochemistry, 3*, 40-45. (in Russian)

Zhalankuzov. T. Zh., & Nazanova, G. K. (2015). Monitoring studies of normal southern Chernozems in Talapker research station. *Soil Science and Agrochemistry, 3*, 68-74. (in Russian)

Zulkarnain, B. S., Afrilla, D., Yusfra, Y., Oktavia, M., Widyasari, S. A., Khotib, J., Mohammad, Y., Alsagaff, M. Y., Nita, Y., & Jaya, H. P. (2025). Reasons and clinical outcomes of dual antiplatelet therapy cessation in coronary stenting patients: A systematic review. *Journal of Advanced Pharmacy Education and Research, 15*(4), 1–7. doi:10.51847/HFUptSzqzY