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ANALYSIS OF YELLOW SOILS DISTRIBUTED IN LANKARAN-ASTARA ECONOMIC REGION ACCORDING TO GRANULOMETRICAL COMPOSITION ELEMENTS

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Summary. The article examines the granulometric composition of yellow soils in the Lankaran-Astara economic region of Azerbaijan, focusing on the effects of soil texture on agricultural productivity and land management. The region, with its subtropical climate and diverse topography, supports a variety of soil types, including yellow soils, which are key to local agriculture. The study analyzes soil samples from Lankaran, Astara, and Masalli districts, highlighting the proportions of sand, silt, and clay at various depths. Results show that, across the region, as soil depth increases, clay content rises, while sand content decreases, particularly in deeper layers.

This trend suggests that the soils become finer-textured with greater depth, improving water retention but potentially complicating drainage. Silt content fluctuates, reflecting regional variations in sedimentation and weathering processes. The analysis of soil profiles indicates that yellow-brown and pseudopodzolized soils in Lankaran and Astara exhibit more significant increases in clay content, while Masalli soils show a less pronounced shift.

These findings have important implications for agricultural practices, as the shallower layers are well-drained but may require additional irrigation, while the deeper layers, with higher clay content, may retain more moisture but have lower permeability. The study provides valuable insights into the soil's suitability for various crops and offers guidance for sustainable land use and agricultural management in the region.

Keywords: Azerbaijan, composition, soil, sand, clay, silt, yellow soil.

Introduction. The Lankaran-Astara economic region, located in the southern part of Azerbaijan, holds significant strategic importance due to its abundant natural resources and agricultural potential [3, 4]. This region benefits from a subtropical climate, characterized by relatively high humidity and mild temperatures, largely due to its proximity to the Caspian Sea. The favorable climatic conditions in the area play a crucial role in the formation of diverse soil types. For instance, alluvial soils are commonly found around rivers and other water bodies, while tropical forests give rise to laterite and yellow soils. These soil variations are further influenced by the region's topography, including its mountainous and lowland areas. The region's rich natural environment supports the cultivation of a variety of crops, contributing to its agricultural prosperity. As a result, the Lankaran-Astara region is not only vital for Azerbaijan's agricultural production but also serves as a key area for understanding the interaction between climate, soil and land use [1].

The economic region encompasses both mountainous and flatland areas, which has led to the formation of soils with different physical and chemical compositions. In the mountainous areas, rocky and gravelly soils are more common, while in the flatlands, more fertile and water-retentive soils have developed. Additionally, the region's geological formations, which include volcanic rocks and schists, have influenced the chemical composition of the soils, leading to the formation of various soil types. These factors collectively contribute to the region's diverse soil landscape, which plays a crucial role in its agricultural productivity and natural resource management. The diversity of soils in the Lankaran-Astara economic region is primarily linked to the region's geographical location, climatic conditions, irrigation and hydrological factors, vegetation cover, and human activities. These factors interact with each other, creating the conditions for the formation of different soil types and compositions. As a result, the region's soil diversity plays a crucial role in the development of agriculture and serves as an important factor in the economic potential of the area. The region features a variety of soil types, each with its unique characteristics, which contribute to the overall productivity and agricultural practices in the region. This soil diversity not only supports the cultivation of a wide range of crops but also influences land use and environmental management strategies. The economic region is primarily characterized by a variety of soil types, including Mountain-Steppe (Phaeozems), Mountain-Forest Brown (Cambisols), Mountain-Forest Yellow-Brown (Acrisols), Mountain-Forest Brown (Kastanozems), Mining-Modified Mountain Brown (Kastanozems), Mountain-Forest Yellow (Pseudopodzolic) (Gleyic Lixisols), Gleyed Yellow (Pseudopodzolic) (Cleyic Luvisols), Steppe-Brown (Gleyic Kastanozems), Irrigated Steppe-Brown ((İrrigari Gleyic Kastanozems), Steppe-Grey (Gleyic Calsisols), Irrigated Alluvial-Steppe (Irrigated Gleyic Fluvisols), Irrigated Steppe-Perennial (Irrigated Gleysols) and Wetland (Humi Gleyic) soils [2,4]. Understanding and evaluating the distribution of these soil characteristics is crucial for the development of agriculture and other economic activities in the region. These diverse soil types not only influence agricultural practices and crop selection but also play a significant role in the management of land resources, ensuring sustainable development and maximizing the economic potential of the area.

One of the main soil types in the region is yellow soils, which are widely distributed, especially in this area. Their granulometric composition is one of the key factors directly influencing agricultural productivity [5, 6, 18, 20]. Granulometric composition refers to the structure of the soil, which is made up of various particles such as sand, clay, silt, and others. This composition plays a crucial role in determining the soil's water retention capacity, air permeability, and the development of plant roots [10, 11, 12, 13,14, 15,16, 17,19]. The granulometric composition of the soil also affects its relationship with the vegetation cover, its susceptibility to erosion, and its suitability for agriculture. In yellow soils, the granulometric composition typically shows a higher proportion of sand and silt, while the clay content is relatively low [7, 9]. This feature influences the soil's ability to retain water and its suitability for certain crops, as it tends to have good drainage but may require additional irrigation for optimal productivity. This allows the soil to have good water and air permeability, but it can sometimes lead to difficulties in water retention and cause moisture deficiency. The aim of this study is to analyze the granulometric composition of the yellow soils prevalent in the Lankaran-Astara economic region and assess these soils based on their composition. This analysis will help better understand the agricultural potential of the area and could aid in making informed decisions in land management practices. By examining the granulometric characteristics of the yellow soils, the study will provide insights into the suitability of the soil for various crops and agricultural activities, facilitating more effective and sustainable land use strategies.

Research object and method. The yellow soils possessing special soil-forming condition in the Lankaran, Astara and Masally regions was selected as a research object. They are located in: at a height of 500-1000 m above sea level, different inclined rocks, humid subtropical climatic condition, at an annual average temperature higher than $>10^0$C -3350-4800^0 C, moisture coefficient -1.2-1.5, drought index

– 0.6-1.5, total radiation -122-128 ccal/cm^2, t_{air}>10^0 -150 0210 days; t_{soil} >5^0 -210 -280 days, in the zones with oak, hornbeam and evergreen bushes, broad-leaved forests, the mountain-forest yellow-cinnamonic (Acrisols) formed as a result of the soil-forming process consisting of deluvial originally clayey-loams of eluvial sediments on yellow weathering crust; at a height of 100-700 m above sea level, possessing hilly low relief, moister-subtropical, winter is soft, the humidity coefficient – 1.0-1.5, drought index -0.55-1.5, the annual average temperatures higher than 10^{0}C – 3800-4400^0 C, Hyrkan flora with the climate possessing t_{soil} >5^0 -218 -280 days, t_{air} >10^0-150-210 days, total radiation -125-145 ccal/cm^2, iron tree, chestnut- leafy oak, evergreen plant complex, re-collapsed products of the yellow weathering crust and mainly mountain-forest yellow – Haplic Acrisols (Clayic, Humic) formed in the condition of non-carbonate clayey rocks without gravel; at a height from 50-100 m to 600-700 m above sea level, in the upland and foothill zones, consisting of weak-selection non-carbonate deluvial clayey-loams of the yellow weathering crust products, iron tree, chestnut-leafy oak, evergreen bushes, well-developed forest grass plants, possessing subtropical climate, mountain-forest yellow soils (psevdopod-zol) (Gleyic Lixisols) with humidity coefficient-1.0-1.5, drought index -0.55 -1.50, >10^0 -3350 4800^0, total radiation -122-128 ccal/cm^2, t_{air}>10^0 -150- 210 days, t_{soil}>5^0 -210 -280 days, at a height of 15-50 m above sea level, in the seashore valley and debris cones of the river ravines, consisting of soil-forming rocks, loamy ancient alluvial and sea sediments, sparse forest and bushes, humid-meadow and hydro-phile plants, river plantations, gleyey-yellow (psevdopodzol) (Cleyic Lixisols) soils. These soils pos-sesses humid subtropical climate condition, an amount of average annual rainfalls changes by 710-1300 mm [4, 7].

The granulometric content analysis of some investigated samples was determined by the N. A.Kachinsky method and some of them were obtained from the references [8] and they were used in the research.

Analyses of the consequences. When conducting land evaluation work, the first and most im-portant step is finding reliable and objective criteria that allow for an accurate assessment of soil quality. By studying domestic and international experience in applying various land evaluation methods and systems, it can be concluded that in almost all models, from the simplest to the most advanced, special attention is given to the granulometric composition of the soil. This highlights that the granulometric composition is a crucial factor that directly affects both the productivity of agricultural crops and the technological properties of soils. This, in turn, significantly influences the choice of land management methods, agricultural techniques, and the enhancement of agricultural production sustainability under various natural and economic conditions. The granulometric composition is a fundamental genetic char-acteristic of the soil, on which nearly all of its properties depend.

Research conducted in the Lankaran-Astara economic region has led to the determination of the granulometric composition of yellow soils. The soil analysis in this area primarily focused on identifying the proportions of sand, clay, and silt, which are crucial for understanding the soil's texture and its suitability for various agricultural and environmental purposes. The results provide valuable insight into the characteristics of the region's soils, which can be used for land management and agricultural planning. The result of the study is shown in the table below.

Table

Variation of granulometric compositional elements (clay, silt and sand fractions) in yellow soils of Lankaran-Astara economic region

Depth, cm	<0.001 mm, % silt	<0,01 mm, % clay	>0.001 sand	Depth, cm	<0.001 mm, % silt	<0,01 mm, % clay	>0.001 sand
Mountain-forest yellow-brown soil. Lankaran district				Mountain-forest yellow soil. Lankaran district			
2 - 8	21.3	57.9	78.7	0 – 15	12.95	39.8	87.05
8 - 22	24	64.35	76	15 – 25	8.35	43.9	91.65

22 - 45	49.15	80.55	50.85	25 - 55	16.25	48.4	83.75
45 - 78	46	75.4	54	55 – 75	20.2	53.85	79.8
78 - 115	34.4	65.55	65.6	75 – 85	27.7	43.45	72.3
115 - 155	33.2	63.75	66.8	85 -110	18.65	32.7	81.35
Mountain-forest yellow (pseudopodzolized) soil. Lankaran district				Clay-yellow (pseudopodzolized) soil. Lankaran district			
3 - 19	20.6	59.05	79.4	2 – 15	20.93	47.267	79.07
19 - 35	28.4	65.4	71.6	15 – 38	19.97	45.8	80.03
35 - 58	34.05	71.85	65.95	38 – 65	15.53	47.367	84.47
58 - 75	41.1	75.02	58.9	65 – 90	19.9	43.067	80.1
75 - 98	31.5	66.05	68.5	90 – 125	17.3	33.433	82.7
				125 – 160	11.67	26.733	88.33
Mountain-forest yellow-brown soil. Astara district				Mountain-forest yellow soil. Astara district			
0 - 23	29.05	60.25	70.95	0 – 23	21.15	42.3	78.85
23 - 42	36.7	74	63.3	23 – 48	14.35	43.25	85.65
42 - 96	41.8	68.9	58.2	48 – 87	28.85	66.25	71.15
96 - 118	36.05	70.95	63.95	87 – 123	20.1	57.75	79.9
118 -143	27	58.6	73				
Mountain-forest yellow (pseudopodzolized) soil. Astara district				Clay-yellow (pseudopodzolized) soil. Astara region			
0 - 27	23.95	53.15	76.05	0 – 34	25.15	54.7	74.85
27 - 69	35.5	60.08	64.5	34 - 76	29.1	56.15	70.9
69 - 97	37.1	60.9	62.9	76 - 107	31.6	64.9	68.4
97 - 135	38.15	52.35	61.85	107 – 139	21.65	41.45	78.35
135 -138	32.35	54.05	67.65	139 - 170	15.65	34.9	84.35
Mountain-forest yellow-brown soil. Masalli district				Mountain-forest yellow soil. Masalli district			
0 -17	16.49	62.99	83.51	1 9	26.87	64.03	73.13
17 - 33	22.22	65.23	77.78	9 - 32	29.24	63.7	70.76
33 - 47	27.13	56.59	72.87	32 – 46	42.54	69.22	57.46
47 - 67	27.625	50.71	72.375	46 – 77	34.33	55.79	65.67
57 - 100	33.03	51.69	66.97	77 – 114	33.79	65.39	66.21
100 - 125	26.86	38.54	73.14				
Mountain-forest yellow (pseudopodzolized) soil. Masalli district				Clay-yellow (pseudopodzolized) soil. Masalli district			
0 - 15	22.37	62.11	77.63	0 – 33	28.6	39.38	71.4
15 - 34	23.45	62.53	76.55	33 – 48	28	36.52	72
34 - 55	40.12	74.74	59.88	48 – 87	47.4	58.78	52.6
55 - 82	45.95	80.04	54.05	87 – 110	48.6	46.1	51.4
82 - 112	43.77	73.43	56.23				

The table provides information on the granulometric composition (clay, silt and sand fractions) of yellow soils in the Lankaran-Astara economic region, divided into different regions (Lenkoran, Astara and Masalli). Let's analyze and compare the data both by regions and by depth. The mountain-forest yellow-brown soil in Lankaran shows a significant increase in the silt and clay content with depth (especially from 2-8 cm to 22-45 cm). Clay content increases from about 58% to 80%, while sand content decreases. The silt content is relatively stable, but there is a noticeable decrease in the sand fraction. Mountain-forest yellow soil and pseudopodzolized yellow soil in Lankaran also demonstrate similar trends, where deeper layers have higher clay and silt percentages with lower sand fractions. Clay-yellow (pseudopodzolized) soil shows a steady decrease in silt content (from 47% to 26%) as the depth increases, and the clay content increases with depth.

In mountain-forest yellow-brown soil in Astara, there is a similar trend, with the clay content gradually increasing from 60% to 74%, while the sand fraction decreases from 71% to 63% with increasing depth. Mountain-forest yellow soil in Astara shows a steady increase in clay and silt content, especially in the deeper layers (from 42% to 66% for clay). The sand fraction is reduced in deeper layers. Pseudopodzolized soils in Astara show a substantial increase in clay and silt content at deeper layers, with clay content reaching 54% at 135-138 cm. The sand fraction also decreases across all depths.

In mountain-forest yellow-brown soil, clay and silt fractions increase with depth, though the changes are not as dramatic as in Lankaran or Astara. For example, clay content rises from 63% to 66% at 100-125 cm, while sand content remains relatively high throughout. Mountain-forest yellow soil shows a large increase in clay and silt content (up to 69% clay at 32-46 cm), while sand content decreases. In pseudopodzolized soils, clay content increases significantly with depth, especially from 62% to 80% between 15-34 cm and 55-82 cm, while sand content decreases in deeper layers. Clay-yellow pseudopodzolized soils show a gradual increase in clay content with depth, from 39% to 46%, while silt content decreases in deeper layers.

Comparison by Depth. In shallow layers (0-15 cm) across all districts (Lankaran, Astara, and Masalli), the soils generally have higher sand content (ranging from 50% to 80%), with lower clay and silt fractions. In Lankaran, the sand fraction is the dominant component, while in Astara and Masalli, the clay content is still significant. As we move to deeper layers, the clay fraction tends to increase, while sand content decreases. For example, in Lankaran's mountain-forest yellow-brown soil, the clay content increases from 57.9% at 2-8 cm to 80.55% at 22-45 cm, while sand content decreases accordingly. Similar trends are observed in the other districts as well. In deeper layers (above 50 cm), the soils in all regions show a consistent increase in clay content, with a corresponding decrease in sand content. For instance, in Lankaran's pseudopodzolized soils, the clay content increases from 59% at 3-19 cm to 75.02% at 58-75 cm, while the sand content decreases. Masalli District seems to show a relatively less drastic change in clay and silt fractions compared to Lankaran and Astara. However, clay content does increase progressively in deeper layers.

Across districts, as we move deeper, the clay fraction increases in most soil types, indicating a trend towards finer particles as we go further down into the soil profile. Sand content decreases with depth: As the depth increases, the sand fraction typically decreases, while the silt and clay fractions increase, suggesting a shift towards finer-textured soils deeper in the profile. Silt content fluctuates: While the silt fraction generally decreases in some soil types with increasing depth, it remains relatively stable or increases in others, suggesting different processes of sedimentation or weathering that might affect the silt content.

Conclusions. The granulometric composition of yellow soils in the Lankaran-Astara economic region exhibits significant variation both by region and depth, influencing the soil's suitability for agricultural and ecological purposes. The analysis of the soil profiles across Lankaran, Astara, and Masalli districts demonstrates a consistent trend: as soil depth increases, the clay content rises while the sand fraction decreases. This trend suggests the development of finer-textured soils at greater depths, which can influence water retention, permeability, and nutrient availability. In particular, the yellow-brown and pseudopodzolized soils in Lankaran and Astara show pronounced increases in clay content at deeper layers, which could improve the soil's water-holding capacity but also may necessitate adjustments in agricultural practices to avoid drainage issues. The changes in silt content are more variable, indicating different weathering and sedimentation processes at play across the region. In contrast, Masalli soils exhibit a less pronounced increase in clay content at deeper layers, suggesting that these soils may have different properties that could affect land use and crop selection. Overall, the depth-dependent shifts in soil texture highlight the need for region-specific land management strategies. In the shallower layers (0-15 cm), soils are coarser, with a higher proportion of sand, making them well-drained but potentially prone to moisture deficits. In deeper layers, the increased clay content may enhance water retention but also poses challenges for certain crops due to reduced permeability. The results of this study can inform sustainable agricultural practices and help optimize land use in the region, ensuring that the diverse soils of Lankaran, Astara, and Masalli can be used effectively for various crops while minimizing risks of erosion or soil degradation. Understanding the granulometric composition and its implications for soil behavior is critical in advancing both agricultural productivity and environmental stewardship in this economically important region of Azerbaijan.

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LƏNKƏRAN-ASTARA İQTİSADİ RAYONU ƏRAZİSİNDƏ YAYILAN SARI TORPAQLARIN QRANULOMETRİK TƏRKİB ELEMENTLƏRİNƏ GÖRƏ TƏHLİLİ

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Xülasə. Məqalədə Azərbaycanın Lənkəran-Astara iqtisadi rayonunda sarı torpaqların qranulometrik tərkib (qum, gil və lil) elementlərinə görə təhlili aparılaraq, onların torpaq idarəçiliyi təsirinə diqqət yetirilir. Həmçinin, iqtisadi rayonda subtropik iqlimin və müxtəlif torpaqəmələgətirən amillərin təsiri ilə bölgə yerli kənd təsərrüfatı üçün əsas olan sarı torpaqlar da daxil olmaqla, müxtəlif torpaq növlərinin yayıldığı göstərilir.

Tədqiqat zamanı Lənkəran, Astara və Masallı rayonlarından götürülmüş torpaq nümunələri təhlil edilir, müxtəlif dərinliklərdə qum, lil və gil nisbətlərinin müqayisəsi aparılır. Nəticələr göstərir ki, iqtisadi regionda torpağın dərinliyi artdıqca gil tərkibi yüksəlir, qumun miqdarı isə xüsusilə dərin qatlarda azalır. Bu tendensiya göstərir ki, torpaqlar daha çox dərinlikdə daha incə strukturlu olur, suyun saxlanmasını yaxşılaşdırır, lakin su buraxma qabiliyyətini çətinləşdirir. Lilin tərkibi müxtəlif olmaqla, çöküntü və aşınma proseslərində regional dəyişiklikləri əks etdirir.

Torpaq profillərinin təhlili göstərir ki, Lənkəran və Astarada sarı-qəhvəyi və psevdopodzollaşmış torpaqlarda gil tərkibində daha əhəmiyyətli artımlar, Masallı torpaqlarında isə daha az nəzərə çarpan yerdəyişmə müşahidə olunur. Bu nəticənin kənd təsərrüfatı təcrübələri üçün əhəmiyyətli təsiri var, çünki dayaz təbəqələr yaxşı su keçirəndir, lakin əlavə suvarma tələb edə bilər, daha yüksək gil tərkibli daha dərin təbəqələr isə daha çox nəm saxlaya bilər, lakin daha az keçiriciliyə malikdir. Tədqiqat göstərir ki, iqtisadi rayonda tədqiq olunan torpağın müxtəlif məhsullar üçün yararlığında və davamlı torpaq istifadəçiliyində alınan nəticələrdən istifadə oluna bilər.

Açar sözlər: Azərbaycan, struktur, torpaq, qum, gil, lil, sarı torpaq.

ОЦЕНКА ЖЕЛТЕЗЕМНЫХ ПОЧВ РАСПРОСТРАНЕННЫХ В ЛАНКЯРАНО-АСТАРИНСКОМ ЭКОНОМИЧЕСКОМ РАЙОНЕ ПО ЭЛЕМЕНТАМ ГРАНУЛОМЕТРИЧЕСКОГО СОСТАВА

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Резюме. Аннотация. Статья посвящена анализу гранулометрического состава желтых почв в Ленкоранско-Астаринском экономическом регионе Азербайджана, с акцентом на влияние текстуры почвы на сельскохозяйственную продуктивность и управление землей. Регион с его субтропическим климатом и разнообразным рельефом поддерживает различные типы почв, включая желтые почвы, которые играют ключевую роль в местном сельском хозяйстве. В исследовании анализируются образцы почвы из районов Ленкорань, Астара и Масаллы, с выделением соотношений песка, ила и глины на различных глубинах.

Результаты показывают, что с увеличением глубины почвы содержание глины увеличивается, а содержание песка уменьшается, особенно в более глубоких слоях. Эта тенденция предполагает, что почвы становятся более мелкозернистыми с увеличением глубины, что улучшает удержание воды, но может осложнить дренаж. Содержание ила колеблется, что отражает региональные различия в процессах оседания и выветривания.

Анализ почвенных профилей показывает, что желто-коричневые и псевдоподзолистые почвы в Ленкорани и Астаре имеют более выраженное увеличение содержания глины, в то время как почвы Масаллы демонстрируют менее выраженное изменение. Эти результаты имеют важные последствия для сельскохозяйственной практики, поскольку более поверхностные слои хорошо дренируются, но могут потребовать дополнительного орошения, в то время как более глубокие слои с более высоким содержанием глины могут удерживать больше влаги, но имеют более низкую проницаемость. Исследование предоставляет ценные данные о пригодности почвы для различных культур и дает рекомендации для устойчивого использования земель и управления сельским хозяйством в регионе.

Ключевые слова: Азербайджан, состав, почва, песок, глин, ил, желтая почва.

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