IRSTI 68.05.37 https://doi.org/10.26577/EJE.2024.v79.i2-04

Z.B. Yessimsiitova[1,2], A.A. Konysbayeva[1*]

[1]Al-Farabi Kazakh National University, Almaty, Kazakhstan
[2]LLC «Scientific production technical center "Jalyn"», Almaty, Kazakhstan
*e-mail: konysbaeva.aizhan@mail.ru

MORPHOLOGICAL DESCRIPTION OF SECTIONS AND SELECTION OF SOIL SAMPLES IN ZHAMBYL REGION

Soil contamination with heavy metals, especially in the vicinity of large cities and industrial centers, has become one of the pressing environmental problems. Over the past ten years, the Republic of Kazakhstan has seen a moderate increase in industrial output, with coal production growing by 20%, crude oil and natural gas production by 19%, and metal ore production by 27%. Technogenic pollutants enter the soil in the form of complex organic and mineral compounds, as well as in a metallic state, with subsequent decomposition to simple elements or the formation of new compounds. All this directly affects the environment, deteriorating soil-ecological conditions, and reducing soil fertility. In this regard, we carried out an analysis of the ecology of the soil cover, assessed the condition of the soil and the problems of their solution in the Zhambyl region. Analysis of the study showed that the negative impact of emissions from industrial enterprises and the growing amount of emissions from mobile sources on soil and plants has a strong impact on the soil surface, devoid of vegetation and susceptible to erosion processes. The obtained research results will make it possible to satisfy the need for fertilizers through the use of local raw materials, ensuring the preservation of soil fertility, increasing crop productivity, and obtaining environmentally friendly products at significantly lower costs. The article shows the results of comparison with the surface of damaged and cut off points P-1, P-2, P-3, P-4. Violations of the soil-ecological function of technogenic landscapes destroyed by emissions from mining and metallurgical enterprises were identified.

Key words: heavy metals, soil, production, erosion, pollution.

З.Б. Есимсиитова[1,2], А.Ә. Қонысбаева[1*]

[1]Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы қ., Қазақстан
[2]«Жалын» ғылыми өндірістік-техникалық орталығы» ЖШС, Алматы қ., Қазақстан
*e-mail: konysbaeva.aizhan@mail.ru

Жамбыл облысындағы бөлімдерді морфологиялық сипаттау және топырақ үлгілерін таңдау

Топырақтың ауыр металдармен ластануы, әсіресе ірі қалалар мен өнеркәсіп орталықтарының маңайында, өзекті экологиялық мәселелердің біріне айналды. Соңғы он жылда Қазақстан Республикасында өнеркәсіп өнімінің қалыпты өсуі байқалады, көмір өндіру 20%-ға, шикі мұнай мен табиғи газ өндіру 19%-ға, металл кенін өндіру 27%-ға өсті. Техногенді ластаушылар топыраққа күрделі органикалық және минералды қосылыстар түрінде, сондай-ақ металл күйінде, кейіннен жай элементтерге дейін ыдырай отырып немесе жаңа қосылыстардың түзілуімен түседі. Мұның бәрі қоршаған ортаға тікелей әсер етіп, топырақ-экологиялық жағдайды нашарлатып, топырақ құнарлығын төмендетеді. Осыған орай, топырақ жамылғысының экологиясына талдау жүргізіп, Жамбыл облысындағы топырақтың жай-күйі мен оларды шешу мәселелеріне баға бердік. Зерттеуді талдау өнеркәсіптік кәсіпорындар шығарындыларының кері әсері және жылжымалы көздерден шығарындылардың топырақ пен өсімдіктерге өсіп келе жатқан мөлшерінің өсімдіктерден айырылған және эрозия процестеріне бейім топырақ бетіне қатты әсер ететінін көрсетті. Алынған зерттеу нәтижелері жергілікті шикізатты пайдалану, топырақ құнарлығын сақтауды қамтамасыз ету, ауылшаруашылық дақылдарының өнімділігін арттыру, айтарлықтай аз шығынмен экологиялық таза өнім алу арқылы тыңайтқыштарға деген қажеттілікті қанағаттандыруға мүмкіндік береді. Мақалада P-1, P-2, P-3, P-4 зақымдалған және кесілген нүктелердің бетімен салыстыру нәтижелері көрсетілген. Тау-кен металлургия кәсіпорындарының шығарындылары нәтижесінде жойылған техногендік ландшафттардың топырақ-экологиялық функциясының бұзылуы анықталды.

Түйін сөздер: ауыр металдар, топырақ, өндіріс, эрозия, ластану.

З.Б. Есимсиитова [1,2], А.А. Конысбаева [1*]
[1]Казахский национальный университет им. аль-Фараби, г. Алматы, Казахстан
[2]ТОО «Научный производственный технический центр «Жалын», г. Алматы, Казахстан
*e-mail: konysbaeva.aizhan@mail.ru

Морфологическое описание разрезов и отбор почвенных образцов Жамбылской области

Загрязнение почв тяжелыми металлами, особенно в окрестностях крупных городов и промышленных центров, стало одной из актуальных экологических проблем. За последние десять лет в Республике Казахстан умеренно увеличился объем промышленности, например, рост добычи угля составил 20%, добыча сырой нефти и природного газа вырос 19%, а добыча металлических руд 27%. Вещества-загрязнители техногенного характера попадают в почву в виде сложных органических и минеральных соединений, а также в металлическом состоянии, с последующим разложением до простых элементов или образованием новых соединений. Всё это, напрямую влияет на экологию, ухудшению почвенно-экологического состояния, снижению плодородия почв. В связи с этим, нами проведен анализ экологии почвенного покрова, дана оценка состояния почвы и проблемы их пути решения Жамбылской области. Анализ исследования показал, что негативное воздействие выбросов промышленных предприятий и растущее количество выбросов от передвижных источников на почву и растения оказывает сильное влияние на поверхность почвы, лишена растительности и подвержена эрозионным процессам. Полученные результаты исследований позволят удовлетворить потребность в удобрениях за счет использования местных сырьевых ресурсов, обеспечивающих сохранение плодородия почвы, повышение продуктивности культур, получение экологически безопасной продукции со значительно меньшими затратами. В статье показаны результаты сравнения с поверхностью нарушенных и обрезанных точками Р-1, Р-2, Р-3, Р-4. Были определены нарушения почвенно-экологической функции техногенных ландшафтов, разрушенных выбросами горно-металлургических предприятий.

Ключевые слова: тяжелые металлы, почва, производство, эрозия, загрязнение.

Introduction

Today, in relation to the environment, the concept of “global change” has appeared, directly related to climate change, soil and water air, improper use of land, and violation of biodiversity [1,2]. In total, 346 enterprises and organizations in the Republic are registered in the direction of man-made disturbance of land. According to the data, over the past year more than 55 thousand hectares of man-made destruction have been identified, and more than 1.0 thousand hectares of land have been reclaimed. Only 0.6 thousand hectares of land have been restored to a satisfactory level. More than 60% of Kazakhstan’s mining deposits are located in desert and desert areas. The work carried out on the reclamation of technogenic dumps of the Kokzhon phosphorite deposit in the Zhambyl region is the first management of afforestation of technogenic disturbed lands in desert and semi-desert zones [3]. The correct use of land and the formation of land management are very relevant for the economy and ecology of Kazakhstan.

The ecology of areas located in transition zones in desert and semi-desert environments is extremely resistant to various environmentally harmful factors. Therefore, in projects to restore the vegetation cover of these areas, planting trees and shrubs, reclamation for agricultural use, and the formation of botanical gardens are one of the leading ways to improve the surface layer of embankments [4-6]. As a result of the disappearance of plant communities resistant to these zones in places of destruction of desert and semi-desert zones, the restoration of ecosystems takes a long time and causes difficulties in strategic management [7, 8].

Projects for agroecological reclamation of technogenic disturbed landscapes of mining production, graphical, linear, food chain, engineering, time projects [9]. Graphic and rectilinear design – full use of the terrain and earthen objects on which mining is carried out, and the implementation of local hydrological and climatic conditions with optimal distribution [10]. Designing food chains– reducing the toxicity of toxic substances to the population, taking measures to prevent and protect poisoning from various toxic substances [11]. Time project – stabilization of the time rhythm of local resources based on the results of the following agro-ecologically acceptable examinations [12-19].

It is important to determine the directions for the use of technogenic destroyed dumps of desert and semi-desert zones of the Zhambyl region and the formation of management. The region has a varied soil cover. In the lower reaches of the Shu and Talas rivers, as well as in depressions of desert relief, takyr-like soils and takyrs are common. Deserts are characterized by gray-brown soils, loose-sandy and sandy gray soils, while foothills are characterized by gray soils. Landscape diversity and climatic features of the territory determine the species composition and distribution of flora and fauna. The soils in the north-northeast of the deposit are gray-chestnut xeromorphic and gray-chestnut poorly developed on crushed eluvium and eluvium-deluvium of dense rocks. In the east there are ordinary northern xeromorphic gray soils. The soils on the southern side are ordinary northern mountain sierozems. In terms of granulometric composition, these soils are medium loamy. The southern part of the Karatau foothill plain is composed of Carboniferous rocks, which mainly include conglomerates, calcareous-gypsum-bearing rocks, underlain by red-colored arkose sandstones, consisting of quartz and orthoclase grains. The grain size is the same as regular sand. and limestones with interlayers of shale and sandstone. These rocks are covered by a thin thickness of 0.5-1 m of eluvial-deluvial, loamy-crushed stone Quaternary formations. The eastern part of the plain is formed by alluvial-proluvial and deluvial deposits and loess-like loams. At the base of the sequence there are pebbles that come to the surface in modern alluvial fans of mountain streams. The cover suite of loess-like deposits increases in thickness with distance from the mountains. Based on the above, physicochemical and morphological results were carried out that can be used to develop measures to increase the productivity of arable land in conditions of pollution of the natural environment, technogenic impact on the soil, in industrial regions in establishing the degree of erosion processes and proposals for increasing soil fertility and productivity in agriculture. To carry out this work, the goal was to identify technogenically contaminated lands in the zone of an industrial enterprise in the Zhambyl region, lay sections with a morphological description and select soil samples for laboratory and analytical studies.

Materials and methods

According to GOST 17.4.3.01–83, the size of the sample area and the number of samples met the requirements. GOST 17.4.4.02–84 is intended to control general and local soil pollution in the area of influence of an industrial facility when assessing the qualitative condition and monitoring the condition of the fertile soil layer. To collect soil samples for the study, soil samples were collected randomly at equal distances. For more accurate results, 12 samples must be collected from each such area using a shovel with a depression about 30 centimeters long, after which a uniform layer of 4-5 centimeters was cut from the soil. Accurate soil sampling was carried out along the horizons. During the research, the content of heavy metals in the soil was checked for compliance with established standards; the total humus content in the resulting soil samples was total humus according to Tyurin [20]; gypsum according to I.N.Antipova-Karataeva and L.Y Mamayeva [20]; total nitrogen according to Kyeldal [20]; hydrolysable nitrogen according to Tyurin and Kononova [20]; total phosphorus according to Michigan [20]; mobile phosphorus according to Michigan [20]; total potassium according to Michigan [21]; soil reaction according to the potenziometric method mobile potassium according to Michigan's method modified by Grabarov [20]; total carbonates by gas-volumetric method [22]; exchangeable basis (Ca, M, K, Na) according to Bobko & Askinazi [20] modified by Grabarov & Uvarova [20]; heavy methals (Zn, Cu, Pb, Cd) according to Soils. Determination of mobile compounds of manganese by Krupsky and Alexander method modification CINAO. N.A. [23]; granulometric composition according to Kachinsky [24]. The relief at the study site is uneven, the surface of the site is cut off at different levels. The thickness of layers A+B fluctuates on average between 45-50 cm. Soil profiles were laid, in which 12 soil samples were taken along genetic horizons with a continuous strip column for soil laboratory analyses.

Results and Discussion

The results of laboratory studies serve as the basis for assessing the current state of the physical and mechanical properties of soils and agrochemical indicators based on the content of plant nutrients in them. The types and volumes of laboratory tests are shown in Figure 1.

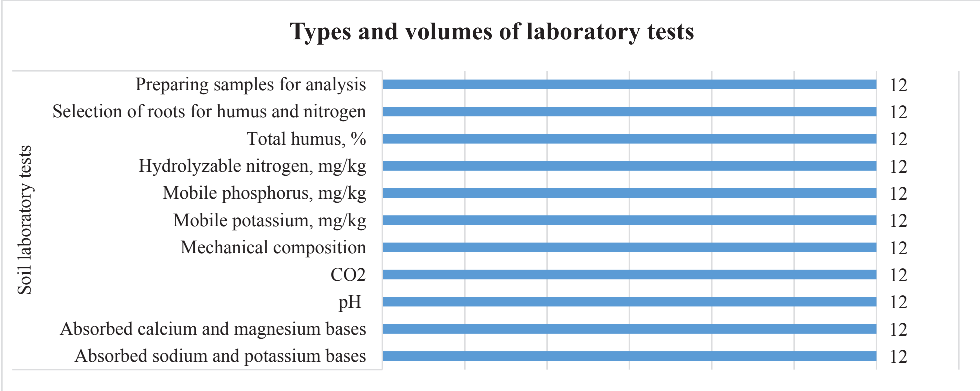

Figure 1 – Types and volumes of laboratory tests

Morphological description of sections and selection of soil samples in Zhambyl region:

Soil profile *1*

0-12 cm, light gray-brown, moist, lumpy-powdery-silty structures, loam, thick and thin roots are well distributed, the transition is noticeable in density.

12-31 cm, grayish brown, slightly compacted, lumpy-silty, coprolites; root passages, wavy border, clear transition.

31-50 cm, light gray, dry, nutty-silty, loamy, compacted, riddled with root hairs, the transition is noticeable in its composition.

50-75 cm, light brown, nutty-silty, carbonate, loam, dry, dense, riddled with fine root hairs.

Soil profile *2*

0-5 cm, light brown, moist, powdery-silty, loam, riddled with root hairs, the transition is noticeable by its structure.

5-13 cm, light gray, lumpy-silty, loamy, riddled with root hairs, the transition is noticeable in its composition.

13-35 cm, gray fawn, dry, powdery-silty, loam, riddled with root hairs, the transition is noticeable in density.

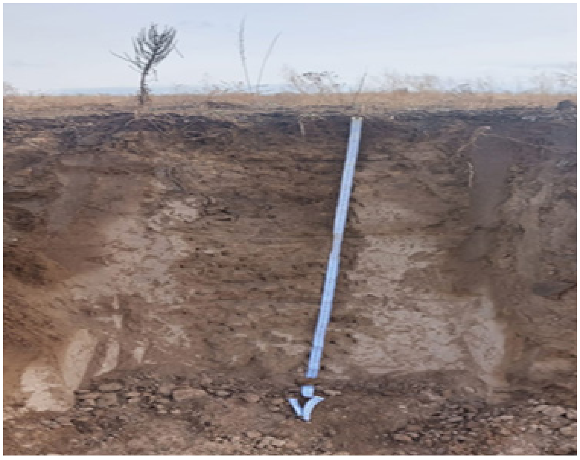

Figure 2 – Morphological description of soil profile -1

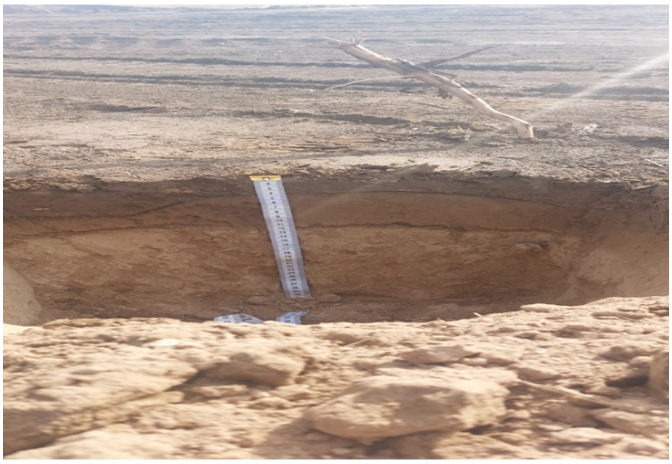

Figure 3 – Morphological description of soil profile – 2

Soil profile *3*

0-9 cm, light brown, moist, fresh, lumpy, dusty, loam, riddled with root hairs, wavy border.

9-40 cm, light gray, dry, lumpy-silty, loamy, riddled with root hairs, the transition is noticeable in its build.

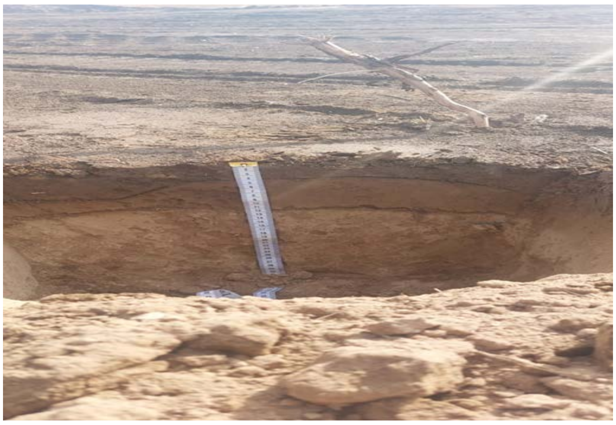

Figure 4 – Morphological description of soil profile -3

Soil profile *4*

0-10 cm, light gray-brown, moist, lumpy-powdery silty structure, loam, the transition is noticeable in density.

10-33 cm, light gray with a brownish tint, dry, nutty-silty, loam, slightly compacted, riddled with root hairs, coprolites, the transition is noticeable in composition. Boils violently from HCl.

33-45 cm, gray fawn, dry, dense, loam, riddled with root hairs, the transition is noticeable in density.

Soil profile 1. The humus content in soil profiles (0-75cm) from the top to the bottom layer is 1.31-0.83%. Mobile nitrogen in the 0-12cm layer is low (33.6-0.83 mg/kg). In the lower layers (12-75 cm) there is a very low content (0.83 mg/kg). Mobile phosphorus on average (16.0 mg/kg) is contained in the upper layer (0-12cm), very low (5.0 mg/kg) is contained in the lower layer (12-75cm). Mobile potassium in the upper layer (0-12cm) contains an increased 400.0 mg/kg, in the lower layer (12-75cm) it is low (130.0 mg/kg). The pH is 8.67-8.85. The amount of absorbed bases is 18.0 -15.3 mEq / 100 g. soil. CO2 is 1.97-5.74. Carbonate content increases from the top layer to the bottom. All soil profiles are carbonate. Soil profiles by pH value are alkaline 8.64-8.865. Physical soil clay 45.4%, granulometric silty-silt, heavy loam (Figures 2, 3, 4).

Figure 5 – Morphological description of soil profile -4

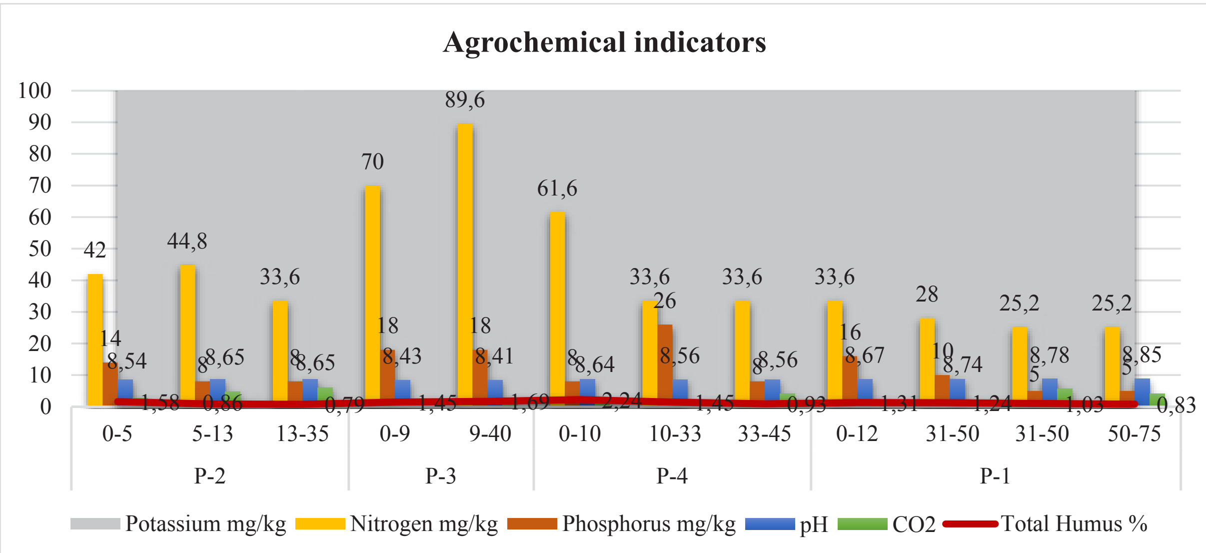

Figure 6 – Results of agrochemical properties of soil using the method of I.V. Tyurin

Soil profile 2. The humus content from the top to the bottom layers is 1.58-0.79%. Mobile nitrogen in the upper layer (0-5cm) is low (42.0 mg/kg), in the lower layer (5-35cm) it is low (44.8-33.6 mg/kg). Mobile phosphorus in the upper layer (0-5cm) is average (14.0 mg/kg), in the lower layer (5-35cm) it is very low (8.0 mg/kg). Mobile potassium in the upper layer (0-5cm) is medium (270.0 mg/kg), in the middle and lower layers (5-35cm) low (150-100 mg/kg). The amount of absorbed bases is 18.0 -15.3 mEq / 100 g. CO2-2.70-6.05. Carbonate content increases from the top layer to the bottom. All soil profiles are carbonate. All soil profiles are alkaline in pH value (8.54-8.65). Physical soil clay is 45.4%, the granulometric composition is silt-silt, heavy loam (Figures 2, 3, 4).

Soil profile 3. The humus content from the top to the bottom layers is 1.45-1.69%. Mobile nitrogen in the upper layer (0-9cm) is high (70.0 mg/kg), and in the lower layer (9-40cm) it is high (89.6 mg/kg). Available phosphorus is 18.0 mg/kg (average) in all layers. Mobile potassium is increased (380.0 mg/kg) in all layers. The amount of absorbed bases is 20.0 -15.1 mEq / 100 g. CO2 is 1.59-1.80.0. Carbonate content increases from the top layer to the bottom. All soil profiles are carbonate. Soil profiles by pH value are alkaline (8.43-8.41). The physical clay of the soil is 44.0-26.6%, the granulometric composition is silt-silt, in the upper layer (0-9cm) there is heavy loam, in the lower layer (9-40cm) there is light loam (Figures 5, 6, 7).

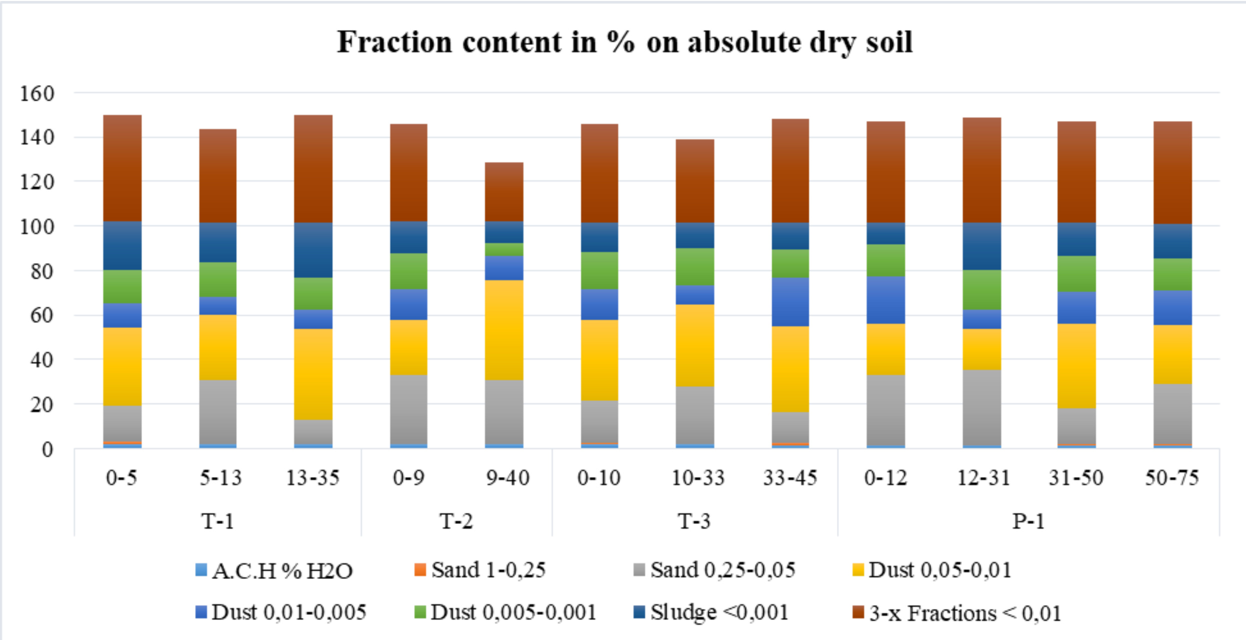

Figure 7 – Particle-size composition of the soil

Soil profile 4. The humus content from the top to the bottom layers is 2.24-0.93%. Mobile nitrogen in the upper layer (0-10cm) is high (61.6 mg/kg), in the lower layer (10-45cm) it is low (33.6 mg/kg). Available phosphorus is 8.0 mg/kg (very low provided) in all layers. Mobile potassium in the upper layers (0-10 cm) is high (330.0 mg/kg), in the layer (10-33 cm) very high (650.0 mg/kg), in the lower layer (33-45 cm) low (200.0 mg/kg). The number of absorbed bases is 16.7 -12.82 mEq / 100 g. CO2-1.28-4.15. carbonate content increases from the upper layer to the lower. Soil profiles are carbonate. Soil profiles by pH value are alkaline (8.64-8.56). The physical clay of the soil is 44.0-37.0-46.7% in granulometric composition, silty-silty, in the upper and lower layers there is heavy loam, in the middle layer there is medium loam (Figures 2, 3, 4).

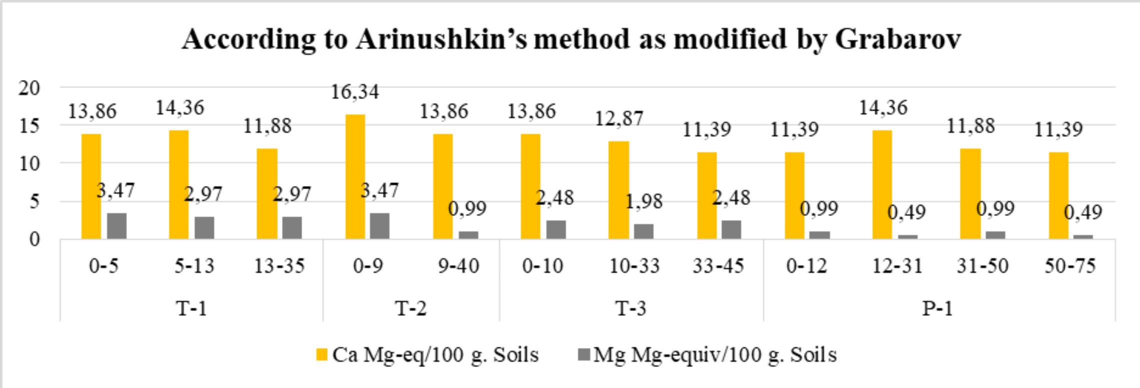

Figure 8 – According to Arinushkin's method as modified by Grabarov

In open areas with intense wind conditions, soil formation processes do not occur. Firstly, this is due to the lack of fine soil, secondly, with a tense water regime (the upper layer dries out greatly), and thirdly, it is very difficult for plant seeds to gain a foothold on such a surface. Therefore, the natural overgrowth of such land is very slow.

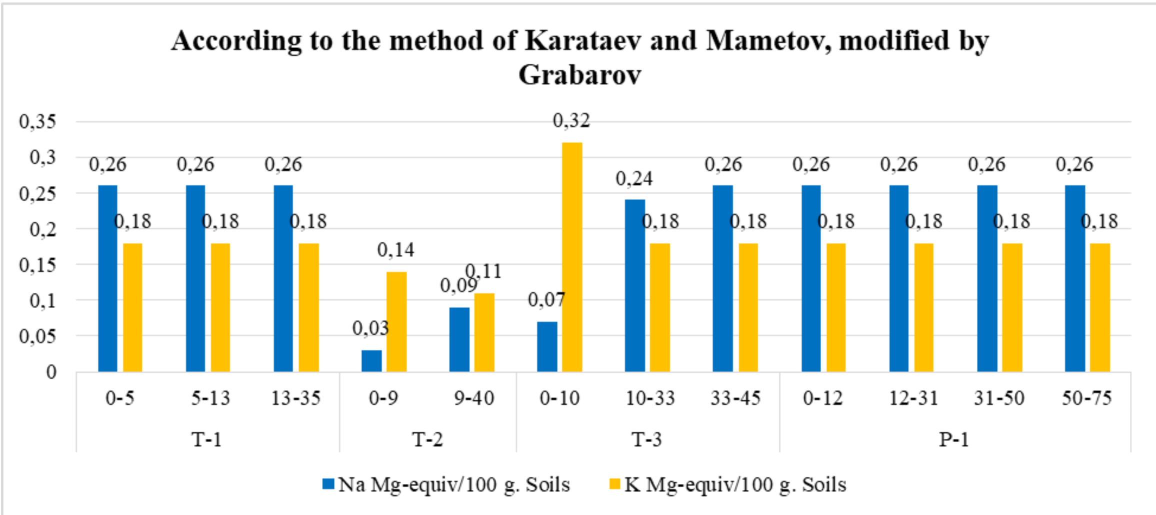

Figure 9 – According to the method of Karataev and Mametov, modified by Grabarov

Conclusion

Territory of the region Zhambyl region has a diverse soil cover. In the lower reaches of the Shu and Talas rivers, as well as in depressions of desert relief, takyr-like soils and takyrs are common. Deserts are characterized by gray-brown soils, loose-sandy and sandy gray soils, while foothills are characterized by gray soils. Landscape diversity and climatic features of the territory determine the species composition and distribution of flora and fauna. The soils in the north-northeast of the deposit are gray-chestnut xeromorphic and gray-chestnut underdeveloped on crushed eluvium and eluvium-deluvium of dense rocks. In the east there are ordinary northern xeromorphic gray soils. The soils on the southern side are ordinary northern mountain sierozems. In terms of granulometric composition, these soils are medium loamy. The southern part of the Karatau foothill plain is composed of Carboniferous rocks, which include mainly conglomerates, calcareous-gypsum rocks, underlain by red-colored arkosic sandstones, and limestones with interlayers of shale and sandstone. These rocks are covered by a thin thickness of 0.5 – 1 m of eluvial-deluvial, loamy-crushed stone quaternary formations. The eastern part of the plain is formed by alluvial-proluvial and deluvial deposits and loess-like loams. At the base of the sequence there are pebbles that come to the surface in modern alluvial fans of mountain streams. The cover suite of loess-like deposits increases in thickness with distance from the mountains. The relief at the study site is uneven, the surface of the site is cut off at different levels. The thickness of layers A+B fluctuates on average within the range of 45-50 cm. A total of 4 soil sections were laid, in which 12 soil samples were taken along the genetic horizons with a continuous strip column for soil-laboratory analyses. Heavy metals are widespread in abandoned industrial sites; in soil they can threaten human health by poisoning groundwater and affecting soil cover. Environmentally friendly and cost-effective remediation of contaminated areas is a big problem.

The analyzed soils are characterized by low and very low humus content. On these soils, it is necessary to systematically apply organic fertilizers (manure, peat compost, green manure), grass sowing, liming of acidic soils, alternation of crops (crop rotation) and proper cultivation, ensuring normal conditions of water-air and thermal regimes in the soils; in conditions of low average annual precipitation, it is recommended practice moisture and snow retention, as well as soil protection from water and wind erosion. Natural conditions must be taken into account when planning and implementing these activities Zhambyl regions and specific features of the economic territory.

Findings

1. It was revealed that the territory of the Zhambyl region has an uneven topography, the surface of the area is cut off at different levels. A variety of soil cover is observed throughout the land plot.

2. It has been established that the results of analyzes of the humusified part of the soil profile are more than 1.31% in accordance with GOST 17.5.3.06-85 and confirm the presence of a fertile soil layer.

4. According to the laboratory analyzes obtained and the description of the soil sections, the thickness of the fertile soil layers A+B is 45-50 cm.

5. We studied in comparison with P-1 undisturbed areas complete soil profiles with the surface disturbed and cut off by points P-2, P-3, P-4, where the thickness of the fertile soil layer at point P-2 is 13 cm from the day surface.

6. It was found that Phydrogen layer with a thickness of less than 40 cm of surface soil at point P-3, lags 9 cm from layer A, 31 cm from layer B. A fertile soil layer with a thickness of less than 33 cm at the surface at point P-4 lags 10 cm from layer A and 23 cm from layer B.

Financial funding

The research was carried out as part of the implementation of the IRN AP19677698 project “Assessment of the impact of man-made waste on the properties of soil covers and the development of a method for the rehabilitation of ecologically disadvantaged industrial lands”.

References

1. Vitousek, P.M., Global environmental change: An introduction: *Annual Reviews of Ecological Systems* v. 23 (1992): 1–14.
2. Rockström, J., and 28 others, planetary boundaries: Exploring the safe operating space for humanity: *Ecology and Society*, v. 14, no. 2, art. 32: http://www.ecologyandsociety.org/vol14/iss2/art32/ (2009): (last accessed 1 Oct. 2012).
3. *Toktar M., Lo Papa G., Shayakhmetova A.S., Dazzi C., Kozybayeva F.E. the primary processes of soil formation in technogenically disturbed terrains of kokzhon phosphorite deposit. Вестник Северо-Казахстанского государственного университета имени Манаша Козыбаева. № 2 (43). (2019): 7-21*
4. Bradshaw, A., Restoration of mined lands–using natural processes. *Ecol. Eng.* 8, (1997): 255–269.
5. Ma, J.J., Li, Q.F., Zhang, S.L., The correlation among soil microorganism and soil nutrient in different types of mixed stands of Hippophae Rhamnoides. J. Arid Land Resour. *Environ*. 21 (6) (2007): 163–167.
6. Huang, D., Liu, Q.S., Remote sensing monitoring and effect evaluation on ecological restoration of heidaigou coal mining area. In: International Conference on Remote Sensing, Environment and Transportation Engineering, *RSETE* (2013). http://dx.doi.org/10.2991/rsete.2013.40.
7. Coffin, D. P., and W. K. Lauenroth. Recovery of vegetation in a semiarid grassland 53 years after disturbance. *Ecological Applications* 6 (1996): 538–555.
8. Toktar M., Papa G. Lo., Kozybayeva F.E., Dazzi C. Soils and plants in an anthropogenic dump of the kokdzhon phosphorite mine (Kazakhstan) *EQA – Environmental quality / Qualité de l’Environnement / Qualità ambientale*, 26 (2017): 13-22.
9. Krolikowska K., Dunajski A., Magnuszewski P and Sieczka M. “Institutional and environmental issues in land reclamation systems maintenance,” *Environmental Science and Policy*, vol. 12, no. 8 (2009): pp. 1137–1143,

10. Yuehan W., Kazhong D., Kan W and Guangli G. "On the dynamic mechanics model of mining subsidence," *Chinese Journal of Rock Mechanics and Engineering*, vol. 22, no. 3 (2003): 352–357,

11. Ming-Gao Q. "Technological system and green mining concept" *Coal Science & Technology Magazine*, no. 4 (2003): 1–3.

12. Hao Bing-yuan and Kang Li-xun, Mine Land Reclamation and Eco-Reconstruction in Shanxi Province I: Mine Land Reclamation Mode l. *the Scientific World Journal Volume* (2014): 1-8. Article ID 483862, http://dx.doi.org/10.1155/2014/483862.

13. GOST 27593–88 (2005). POChVY. *Terminy i opredelenija*. UDK 001.4:502.3:631.6.02:004.354.

14. Ponomareva V.V., Plotnikova T. A. Gumus i pochvoobrazovanie. L.: *Nauka*, (1980): 222.

15. Aliev S. A. Uslovija nakoplenija i priroda organicheskogo veshhestva pochv AN ASSR., (1966).

16. Fadeev S. V. Jekologicheskij slovar'. SPb.: (2011): 35 s.

17. http://resources.arcgis.com/ru/help/main/10.1/0031/00310000002m000000.htm

18. Pod red. A. G. Gushhina, A. G. Chimshidova. *Atlas Kazahskoj SSR* – M.: *GUGK pri Sovete Ministrov SSSR*, (1990): 96 s.: kart.

19. Vorob'ev, A. S. Izuchenie gumusa v pahotnom sloe chernozjomov juzhnyh i tjomno-kashtanovyh pochv Erejmentauskogo rajona s pomoshh'ju programmnogo obespechenija QGIS 2.2.0-Valmiera / A. S. Vorob'ev. – Tekst: neposredstvennyj // *Molodoj uchenyj*. – № 8 (67). (2014): 374–376. – URL: https://moluch.ru/archive/67/11411/

20. E.V.Arinushkina, Methods for the determination of total humus in soils. *Book. Manual of chemical analysis of soils*. (1961): 130-139. U.D.C 781. 5(421. 8) (in Russian).

21. A.S.Radov, I.V.Pustovoy, A.B. Korol'kov, Methods for the determination of total potassium in soils. *Book. Practicum on agrochemicals*. . U.D.C. 631.8.(075. 8) (in Russian). (1965): 177-178.

22. E.D Zatula, T.I. Prozhorina Methods for the determination of total carbonates in soils. *Book. Chemical analysis*. (2008): 23-28. U.D.C. 02.2(301.7). (in Russian).

23. N.A. Chebotarev, A.N. Orlov, A.P. Pleshkova, V.M. Eroshina, E.E. Ignatieff, Methods for the determination of heavy metals in the environment Analytical Chemistry. *Book. Determination of mobile compounds of manganese by Krupsky and Alexander method modification CINAO.* (1995): 2-5. State registration № 50685-94 (in Russian).

24. A.F.Vadyunina., Z.A.Korchagina., Methods for the determination of granulometric composition in soils. *Research methods physical properties of soils*. (1986): 7-10. U.D.C 631.43(075.8) (in Russian).

Авторлар туралы мәлімет:

Есимсиитова Зура Беркутовна – биология ғылымдарының кандидаты, әл-Фараби атындағы ҚазҰУ биоалуантүрлілік және биоресурстар кафедрасының доценті (Алматы, Қазақстан, e-mail: zura1958@bk.ru)

Қонысбаева Айжан Әміржанқызы (корреспондент-автор) – әл-Фараби атындағы ҚазҰУ биоалуантүрлілік және биоресурстар кафедрасының PhD докторанты (Алматы, Қазақстан, e-mail: konysbaeva.aizhan@mail.ru)

Information about authors:

Yessimsiitova Zura Berkutovna – candidate of biological sciences, associate professor of the Department of Biodiversity and Bioresources of al-Farabi Kazakh National University (Almaty, Kazakhstan, e-mail: zura1958@bk.ru)

Konysbayeva Aizhan Amirzhankyzy (corresponding author) – PhD student of the Department of Biodiversity and Bioresources of al-Farabi Kazakh National University (Almaty, Kazakhstan, e-mail: konysbaeva.aizhan@mail.ru)

Received: December 08, 2023
Accepted: June 16, 2024