MODERN ECOLOGICAL STATE OF THE SOILS ABSHERON PENINSULA AND WAYS SOLUTIONS

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Abstract

The interaction between ecosystems and people began from the very beginning of their existence. Over time, this process began to enlarge. The development of science and the emergence of new inventions in technology have led to the further intensification and gradual sharpening of the interaction. The expansion and intensification various sectors of the economy, the constant increase in the number of people, the emergence of megacities, etc. have also had an impact on the geographical environment. It has revealed difficult to solve ecological problems for the environment surrounding us and has set before us the task of their restoration and re-circulation. The increasing scope of the various ecological problems that have arisen has made their solution inevitable, which has become one of the topical issues of our time. Currently, the development of methods for assessing anthropogenic impact is of particular importance for all components of the environment - soil, vegetation, fauna, water bodies, air, etc. Problems related to the need to monitor the real situation with anthropogenic pollution of soils necessitate the application of new approaches in the fight against the threat toxicants, in addition to chemical analysis. It is necessary to assess the integral toxicity of the soil, reflecting the impact of a complex of all factors. In terms technogenic pollution of soils in our republic, the Absheron Peninsula stands out in particular, and therefore the presented article stands out with its relevance.

Keywords: Recultivation, soil pollution, oil products, quarries, biotechnology

I. Introduction

Many factors have an impact on the deterioration of the ecological situation of the Absheron Peninsula. The unsatisfactory natural conditions of the studied area, the small number of rivers, the salty lakes, high evaporation, and the predominance of clay deposits in the geological structure have created conditions for the further aggravation of the ecological problems of the area [1, 2].

Along with natural factors, the intensification anthropogenic transformation day by day has led to the global development negative situations. In particular, the development industries such as oil, petrochemical, mechanical engineering, construction, agrarian sector, resort tourism, etc. of the peninsula has played a greater role in the pollution of the ecosystem surrounding us [3, 4]. Thus, as we have noted, both natural and human-created anthropogenic factors are significant in the pollution of the studied area.

II. Research object

The zone we are conducting research on is located in the Greater Caucasus, formed at its southeastern end, washed by the waters of a closed basin on three sides, and covering 2.46% of the territory of our republic, Baku, Absheron and surrounding villages are the oldest and most densely populated region of our country [5, 6]. The absolute altitude of the region, which consists of only 222 thousand ha, varies between -25 m and 390 m above sea level, with the highest point being Kaskes.

III. Research method

At the current stage of social development, the study of the problems arising from the negative impact of man on nature and nature on people is a rather urgent issue both at the global and individual regional levels [7, 8]. The article analyzes the pollution of the land cover of the Absheron Peninsula. At the same time, literature, fund materials, cartographic, observational, comparative, etc. methods were used, land cover changes were analyzed, and relevant scientific recommendations were given on ways to eliminate negative situations that may arise here in the future [9,10].

IV. Analysis and discussion

The development of various sectors of the Absheron Peninsula industry (oil extraction, oil refining, chemical metallurgy, mechanical engineering, electric power, building materials industry), agriculture (agriculture and livestock breeding) and economy has polluted the lands of this territory. 33.3 thousand hectares of the study area are unsuitable lands. The unfavorable natural conditions, as well as the fact that more than 70% of the industrial enterprises of our republic are located here, hinder the natural restoration of the lands [1].

According to their pollution, the soils of Baku, Absheron and surrounding villages are divided into 3 groups - weak (with waste from residential areas), medium (with the influence of agriculture) and high. According to our research and analysis of statistical data, the soils where pollution is observed are in Garadagh, Sabunchu and Khazar districts.

Most of the soils are contaminated with oil and its products. Soil pollution with this product has been recorded in Khazar, Sabunchu, Surakhani districts. An important reason for this is the oil and oil products discharged into the surrounding areas during the exploitation of the oil fields noted here. If we look at the soil profiles here, we can observe that oil has been absorbed to a depth of 100 m. The amount of oil has been determined to be between 12.5-7.8%. The oil solution migrates vertically up to a depth of 2 m in the soil.

Tar asphaltenes cover the upper part of the soil layer (0-16 cm), disrupting the air and water exchange of the soil. These substances, which are considered heavy fractions of oil, can be seen in most chemical elements. Mainly substances with a high content of hydrocarbons are absorbed into the soil to a depth of 2 m and dissolved by water. The most dangerous thing is that the pollution reaches the groundwater.

Oil pollution also causes changes in the humus, nitrogen, and physicochemical composition of these soils. Thus, in soils polluted by oil, the amount of humus in the upper layers is 1.4-1.3%, and its amount decreases to 0.8-0.6% as it moves towards the lower layers. This situation is manifested in the amount of nitrogen [1, 2, 3]. The soils spread in the mentioned areas become completely unsuitable for cultivation.

According to the research conducted by V.A.Ahmedov (2004), in the territory of the peninsula, light fractions of oil have absorbed into the soil, and the other part has evaporated [1]. Unlike light

fractions, heavy fractions of oil cover the surface of the soil. At this time, it creates an obstacle to the evaporation of the light fraction, stops the aeration process in the soil, which eventually destroys living organisms and bacteria.

Recultivation and recycling of soils contaminated with tar asphaltenes, polycyclic aromatic hydrocarbons such as naphthalene, xyrizene, pyrene, benzoperene, and fluorine is also a very difficult and time-consuming process. It migrates to a depth of 2 meters and more in the soil, and most of the hydrocarbons are water-soluble compounds. According to statistical data, during the production of 1 million tons of oil in the region, about 25 million tons of well water comes to the surface of the earth and accumulates here. This well water is rich in salts of organic acids, heavy metals, mineral salts, and radioactive substances [4]. Approximately 15-17 million tons of them contain the substances we have mentioned.

Oil production does not only pollute with hydrocarbons, tar asphaltenes, and other substances. The diversity of its own composition also affects the degree of pollution. Microelements contained in oil are divided into two groups: ecologically toxic (Y, B, Na, Mo, Se, Al, Pb, Cl, Fe, S, Mg) and non-toxic (Mn, Fe, Ca, Al, P). Non-toxic, as well as weakly toxic elements, are the main part of oil ash [6, 7].

Most of the land cover of the Absheron Peninsula has been subjected to technogenic changes as a result of anthropogenic impacts.

The area of contaminated and degraded lands here is approximately 25 thousand hectares. The degree of contamination is 20-30%, and the depth of contamination is between 2-3 meters. Here, 1285.3 ha of land is contaminated to a depth of 10 cm, and 2420.6 ha to a depth of 50 cm. The soils in the studied area have not lost their primary function, being contaminated only with oil. This is influenced by a number of other factors, and the types of such degraded soils are given in the diagram below (Figure 1.).

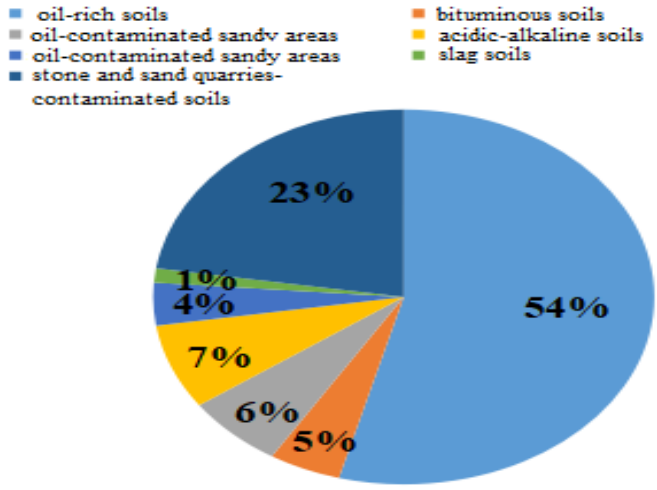

Figure 1: *Types of degraded soils (in %)*

The long-term exploitation of oil in the study area has led to the spread of large areas of soil contaminated with fuel oil. The presence of oil fields, mainly in the Sabunchu, Garachukhur and Khazar regions of the peninsula, has resulted being covered with thick fuel oil in the soil. Here, the oil absorption thickness on the soil surface varied from 50-100 cm, and the fuel oil thickness from 30-50 cm. The high amount of fuel oil has caused the humus content in the soil to fall to 18.8-35.3%, the dry residue to 0.62-3.50%, the absorbed bases to fall to 14.2-22.0 mg/eq. and the pH to 7.5-7.8. The high value of the dry residue has resulted in increased salinization in the soils. In the mentioned soils, salts are mainly accumulated in the lower layers along the soil profile. In fuel oil pollution, the

amount of carbonates is 18.0-34.7%. The granulometric composition of these soils is clayey and sandy. Minerals such as calcite, kaolinite and chlamydon prevail in their composition. Clayeyness is light and moderate [5]. The color of the soils varies from light brown to dark brown depending on the amount of humus.

Fuel oil polluted soils are most widespread in the Bina, Gala, Sabunchu, Binagadi and Bibiheybat, Mashtaga-Buzovna mines. Most of these soils, 5.5 thousand ha, are concentrated in the territories of Sabunchu, Binagadi, Garadagh districts.

Fuel oil polluted soils are also divided into 4 groups according to the degree of pollution: poor, medium, severe and very severe (table 1). The main indicators for the division of these groups are the moisture of the soil surface, the thickness of the fuel oil and the depth of absorption. As a result of the research conducted, 23% of the oil-contaminated soils spread across Baku, Absheron, and surrounding villages are classified as very severely contaminated, 26% are contaminated, 35% are severely contaminated, and the remaining portion is classified as lightly contaminated.

Table 1: *Pollution levels of fuel oil-contaminated soils*

Pollution level	Surface moisture	Thickness of the fuel oil layer, cm	Absorption depth of fuel oil, cm
Poor	Dry	0-10	0-40
Medium	Low humid	10-15	40-60
Severe	Moisture	15-25	60-80
Very severe	Soaked	>25	>80

As in the case of soils contaminated with fuel oil, soils contaminated with bitumen are divided into 4 pollution degree groups (poor, medium, severe and very severe) depending on the moisture of the soil surface, the thickness of the bitumen layer and the depth of absorption. As a result of the research we conducted on the mentioned parameters, 34% of the widespread bituminous soils of the peninsula are very severe, 28% severe, 31% high and the rest are of poor pollution degree.

The thickness of the bituminous layer, where oil products pollution occurs and over time absorbed into the soil, is 40 cm thick and in some places 70 cm. The thickness of the oil layer is 100 cm and sometimes up to 115 cm. The granulometric composition mainly consists of loamy, clayey and sandy loam. The amount of oily-tarry substances in these soils is 15-20% and in some places 7.0-8.8%. The reaction of this soil medium differs according to its alkalinity. The amount of absorbed bases in the soils varies within a wide range from 5.5 to 36.1 mg/eq, and sodium from 1.5 to 2.9 mg/eq. The amount of easily soluble salts in water (especially sodium chloride and sodium sulfate) is relatively high, 1.14 to 2.54%. In addition to absorbed bases, these soils also differ in their carbonation. The carbonation of the soils along the profile varies between 7.5 to 36.8%. The soils are light and medium clayey in granulometric composition. In the mineralogical composition, rocks such as quartz, gypsum and calcite predominate.

In the areas of oil fields that have not been used for a long time and their exploitation has been stopped, areas covered with plants have formed due to natural regeneration. The areas with bitumen on top are very few and spread in areal. The physical and chemical changes occurring in the soil have been replaced by biochemical processes over time, and the soils have partially become fertile and have been able to regenerate themselves naturally. However, despite this, the bituminous cover formed over time, due to the preservation of oil products absorbed into the soil, biochemical processes could not fully penetrate. Undecomposed oil products therefore still have their negative effects on the normal development of plants. Such contaminated areas are widespread in areas with oil deposits in the Binagadi, Girmaki and Balakhani oil fields, which ceased to be used 45-50 years ago. When analyzing statistical data, we determined that the most bituminous soils in Baku,

Absheron and surrounding villages are concentrated in the Garadagh and Sabunchu districts. We can see that in the regions there are 3600 ha and 3075 ha (Figure 2.).

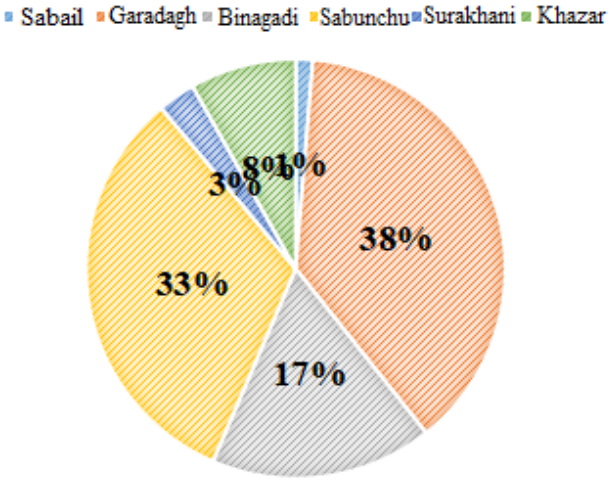

Figure 2: *Bituminous soils by region (in %)*

Soils contaminated and covered with deep-well rocks formed as a result of drilling and repair work are distinguished from oil-bearing and bituminous soils by many characteristic features. Thus, this type of soil was mainly formed during the drilling, repair and deepening of wells. The waste (cuttings) collected here are stored either in earthen dam reservoirs or in natural pits. They begin to absorb into the soil together with oil materials.

Another reason for contamination with deep-well rocks is the storage and transportation of the crude part of the oil produced in 1941-45, which was not added to any additional additives. Thus, the difficult political and economic situation during this period created problems in storing the extracted oil in favorable conditions. At that time, large-scale earthen dam reservoirs were built to store crude oil. These reservoirs and pits performed two functions. The first of these is the settling of the initial form of oil, including sedimentation, and the second is the role of large-volume tanks for storing oil. This type of reservoirs is found in the Khazar, Binagadi, Garachukhur and Surakhani districts of the Absheron Peninsula. Here, they are widespread in a wide area near oil fields. Currently, the mentioned reservoirs are filled with sediments. The granulometric composition of the sediments is oiled. The absorbed oil continues to various layers. We can see technogenic landscape complexes near the mines that have ceased operation in the Surakhani, Garachukhur, Binagadi and Khazar districts. Although a long time has passed since the formation of these landscape complexes, they are not even covered by aboriginal plants here. They are mainly sandy, sandy and partly silty in granulometric composition. In some places, they have created an aeolian (dunes) form of relief. Since most of them are oiled, their surfaces resemble takirs and are devoid of living creatures.

The main factors that disrupt the geomorphological structure and landscape of the area we are studying and replace it with completely technogenic landscapes include stone and sand quarries. Especially in recent years, the spontaneous development of this area has led to the intensification and widening of this process. Now, as a result of the exploitation of construction material quarries, more than 4,000 ha of soil cover has been destroyed. This pollution is mainly concentrated in the Sabunchu, Khazar and Garadagh districts of the peninsula. Of these districts, only Garadagh has been more damaged by both sand and stone quarries, accounting for 1,675 ha and 550 ha, respectively.

The ecological state of the soils of the studied area is in a very critical state. The fact that the soils are exposed to industrial waste, mine waters, etc., has completely destroyed the biological

activity of this zone. In this regard, the restoration, rehabilitation and re-circulation of the soils of the Absheron Peninsula contaminated with various products is one of the most urgent problems of our time. First of all, it is advisable to use biological remediation methods.

Biological recultivation consists of stages and is a long-term process. After each stage, the information obtained and their results are analyzed according to quantitative and qualitative indicators. If the result obtained is satisfactory, preparatory work is carried out for the next stage.

The important issue that we face is to increase the efficiency of cleaning oil-contaminated soils and to ensure that the environment does not face this process a second time during the cleaning process and to minimize environmental risks. For this, the specific characteristics of each area of the area we are researching should be taken into account [9]. Because the soil cover of the peninsula has a complex structure and the degree of pollution is also different. It consists of improving and evaluating complex cleaning technologies aimed at the systematic analysis of ecological risks. It creates difficulties in the partial cleaning of the lower layers of the soils where oil contamination is determined, reducing their ecological risks, and putting them into use in agriculture. It is very important to observe the following stages in recycling and rehabilitation [10].

At the first stage, the general condition of the soils contaminated with various wastes in the area we are studying is analyzed. After that, it is planned which type of bioremediation will be used and based on this, the duration of the cleaning is determined. Also, in order to determine all the optimal solutions of the technological process, all stages of cleaning work are predicted.

When carrying out bioremediation work, first of all, the indicators should be properly documented (extrapolation calculations, a base of bioremediation scheme and model should be established). Field experiments, quantitative indicators and bioremediation work are used to establish the base. It is necessary to create improved methods for monitoring field conditions. In this regard, certain works have been carried out in this area for the peninsula, which are as follows:

1. A plan of contaminated soil samples was developed and prepared on a scientific and statistical basis;

2. In the areas, fundamental measurements are carried out to determine the pollutants, given substrates, metabolites, electron acceptors, toxicity ratio, the amount (activity) of microorganisms, especially microorganisms that decompose pollutants, the amount of non-degradable substances;

3. Plant groups of the studied area have been studied.

No matter how advanced science and technology are, there is no specific model for the recultivation of lands contaminated with this natural resource in the oil-rich countries of the world. The reason for the lack of such a model is the variety of physical and geographical conditions of the areas where the main products of the fuel and energy industry are processed and exploited. Therefore, before carrying out recultivation work for the area, the level of oil contamination of the soils, the composition of the oil, the time period during which the contamination occurred, the physical-chemical and water-physical properties of the soil cover, the landscape and climatic characteristics should be taken into account.

As a result of the studies, we came to the conclusion that recently, cleaning work has been carried out in the area on the Absheron Peninsula using a large number of cleaning methods. Thus, in February-March 2000, 9 wells with a depth of 4-12 m and an area of 150x150 m were drilled in the Hovsan area. Samples were taken from various layers and their oil concentration was analyzed granulometrically.

During the analysis of known materials, we determined that in the Bibiheybet massif, an average of about 81.4 kg of oil product was obtained from 1 m^3 of oil-contaminated soil [9]. In this area, we conducted research, the soil was cleaned up to a depth of 2 m from the surface. Here, the average depth was taken into account as 1 m. The volume of land planned to be cleaned in the Bibiheybet massif was 1.37 million m^3. Another area to be cleaned is the Gala area, located 32 km northeast of Baku, around the Gala settlement.

After the cleaning work, which began in November 2008, recultivation work should be carried out and implemented over time to restore and re-circulate the soil. Evergreen plants that are suitable for the natural conditions of the Buzovna and Mashtaga areas and are resistant to salinity and drought were planted [9].

V. Conclusion

The development of various industrial sectors in the Absheron Peninsula has turned the Absheron Peninsula into a pollution object for oil, bitumen, fuel oil, stone and sand quarries in the studied region. All stages biological recultivation for the purification and recirculation of these soils were investigated and their negative and positive characteristics were analyzed separately.

In the second stage recultivation, it was determined that bioremediation is not a section biotechnology, but a method recultivation. Because purification with natural microorganisms is carried out at the main stage biological recultivation. This is one of the most important nuances of biological recultivation.

In the study area, the importance olive, common pomegranate, willow, black clover, hairless licorice, fig, wormwood and other perennial plantings for the phytoremediation oil-contaminated soils was investigated. In particular, at this stage, it was determined that ephedra (Ephedra) and thorny caper absorb toxic substances and heavy metals.

References

[1] Aghayev Sh.B., Afkerov G.Kh. "Disturbed and polluted lands of the Absheron peninsula, their distribution, recultivation problems". Baku, 2007. 33 pp. 7-27.

[2] Ahmadov V.A., Bakhshiyeva Ch.G., Gahramanova, G.V., Hekimova N.F. "Ecological problems of soil contaminated with oil in Absheron". Abstracts of the scientific-practical conference dedicated to the 95th anniversary of Academician Hasan Aliyev on the topic "Hasan Aliyev and the problems of sustainable development of the environment in Azerbaijan". Baku, 2002. pp. (198-199)

[3] Yagubov G.Sh. "Study of technogenically disturbed soils of the Republic of Azerbaijan, genetic characteristics and ways of their recultivation". Baku, "Vatan" publishing house, 2003. 206 pp. 50-59.

[4] Aliev F.Sh. Ecology and oil. Monthly analytical magazine "Capital", No. 5, 2004, 75 pp.

[5] Kerimov M.K. Radioactive zagrozenia na uchaskakh neftepromislov Absheronskogo poluostrov. Sbornik "Method proven to be of environmental monitoring". Baku, 1998, 154 pp.

[6] Kerimov S.V., Ismailov N.M., Vasenev I.I. "Ecological very modern state of technogenic polluted lands in the conditions of oil fields of the Absheron Peninsula", Reports of TSHNA.T. M. 2008. 280 p. 115-133.

[7] Safarov I.S. "Development of gardening and park construction in Baku and Absheron", Baku, 1989, 89 pp. 37-81.

[8] Pikovsky Yu.I. e others. "The problem of diagnosing and regulating soil pollution with oil and petroleum products". Soil Science, 2003, NZ, 1911 pp. 1132-1140.

[9] Hajiyeva G.N., Ibrahimova L.P. Ecological problems of technogenically disturbed lands on the Absheron Peninsula Journal Geology, Geogeography and Geoecology, 2024, 33(1), pp.70-76, doi:10.15421/112408

[10] Amanova Sh.S., Hajiyeva G.N., Najafov J.S., Ibrahimova L.P. Investigation of urban biodiversity and factors influencing it based on modern technologies, Vilnius Gediminos Technical University "Geodesy and cartography", 2024, vol.50, issue 3, pp.141-149, DOI: https://doi.org/10.3846/gac.2024.19626