Influence of gas industry waste on the ecological condition of soils

Shodi Kholikulov[1*], *Isomiddin* Bobobekov[1], *Tursunboy* Yakubov[1,2], and *Barchinoy* Botirova[2]

[1] Department of Soil Science and agrotechnologies, Samarkand State University, Samarkand, Uzbekistan
[2]Department of Natural sciences, Karshi Engineering-Economic Institute, Karshi, Uzbekistan

Abstract. The article discusses the accumulation of various harmful compounds and heavy metals in the soil as a result of the wastes of the gas processing enterprise of the "Shurtangazkimyo" complex and their negative impact on soil fertility and ecological conditions. The irrigated light serozem soils around the "Shurtangazkimyo" complex are extremely poor in humus. As a result of the impact of waste, the biological processes in the soil are weakened, and the accumulation of organic substances is reduced. The accumulation of various harmful compounds and heavy metals in the soil as a result of the activities of the "Shurtangazkimyo" complex has a negative effect on the productivity and ecological condition of the light serozem soils distributed in this area. Keywords: "Shurtangazkimyo" complex, waste, soil, heavy metals, fertility, environment, humus, nitrogen, phosphorus, potassium, nitrate, ammonium, quantity.

1 Introduction

The need for fuel and energy supply has significantly expanded as a result of the global industry's rapid development. Existing fuel and energy resources are primarily made up of natural gas and oil products. One of the most crucial elements of economic development is the mining and processing of these products. Currently, 12 billion tons of oil equivalent worth of oil, natural gas, coal, and atomic energy are used for production. Sulfur, nitrogen, and carbon oxides, as well as a number of other hazardous compounds, are released into the environment during the extraction, processing, and use of these organic resources. These gases are causing global climate change, ozone layer depletion, the "greenhouse effect," and other environmental problems. That is, the oil and gas industry is rapidly becoming one of the major polluters of the environment [4-7, 12, 19.]
That is why it is important to study the environmental condition of the areas where the oil and gas industry is located. It is known that irrigated soils occupy a leading position in the agriculture of our republic. Therefore, many studies have been conducted to study the properties and characteristics of these soils, to study the influence of various factors on their

* Corresponding author: kholikulov48@mail.ru

ecological status, especially on their fertility, and work in this direction is still ongoing. The works in this direction are mainly devoted to changes in soil fertility as a result of the implementation of erosion, mineral fertilizers, irrigation and other agrotechnical measures [5,11,14, 21]. Several studies have been conducted by domestic and foreign scientists on the effect of industrial waste on the productivity of irrigated soils.

In many researches, it has been stated that as a result of the activities of oil and gas production and processing enterprises, various toxic compounds are emitted into the atmosphere and damage the environment. For example, when one ton of natural gas is burned (in a torch), around 50-80 kg of various types of harmful waste are released. It was noted that the release of waste depends on the composition of natural gas and its physical and chemical properties. It has been mentioned that the burning of torches in gas processing industries is the main source of air pollution in the region [4]. Also, in a number of studies, various gases released into the atmosphere during the operation of gas processing industries, especially sulfur, carbon and nitrogen oxides, hydrogen sulfide, mercaptan, benz(a)pyrene (C20H12) and other wastes, affect the environment, damage the atmospheric air, soil and thereby negatively affect the development of plants [1,6, 9,10,16].

It was found out from previous studies that the effect of various wastes released as a result of the activities of industrial enterprises, including gas processing enterprises, on the ecological condition of the soil has not been studied in the conditions of our republic. Since the gas processing industry has been operating in the Republic of Uzbekistan for a short time, scientific studies on its impact on the environment have not been carried out. The main goal of the research is to study the effect of the waste of the Shu'rtangazkimyo complex on the ecological condition and productivity of irrigated light serozem soils. For this purpose, we set out to study the impact of the wastes of the "Shurtangazkimyo" complex, which is one of the largest industrial enterprises in our republic, on the ecological condition and fertility of the light serozem soils scattered around it.

2 Methods

2.1 Climate conditions of the research area

The climate of the research area is continental, the average annual air temperature is 16.4^0C, and the average temperature of the coldest seasons is -6^0C. The average air temperature of the summer seasons is $+27^0$ C, $+30^0$ C, the highest temperature is $+43^0$C, $+45^0$ C. The hot months are June-July. The climate of the region has a specific effect on the wind regime. Based on the "wind rose" diagram, the direction of the wind and the annual average return in the area are distributed as follows (in percent): North-14, North-East-10, East-8, South-East- 3, South-3, South-West-56, West-20, North-West-36 (Fig. 1). According to "Wind rose" diagram information, north-west direction winds prevail in the area [19].

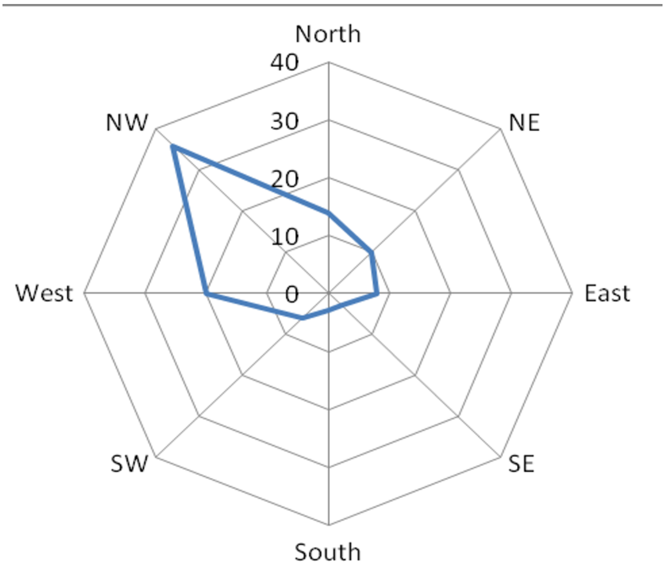

Fig. 1. "Wind rose" diagram of the area

2.2 Analytical methods

Soil humus in the study - by the method of I.V. Tyurin; Nitrogen in the form of nitrate - by the Grandwald-Lyaju method; ammonium nitrogen - using Nessler's reagent; mobile phosphorus – by the Machigin method; was determined by the Machigin-Protasov method in an alternating potassium-flame photometer. Statistical analysis of the results of the experiment was carried out according to the method of Dospekhov (1985) [8].

3 Results and discussion

The research was conducted in the irrigated light-colored serozem soils scattered around the "Shurtangazkimyo" complex located in the Guzor ecosystem [17]. "Shurtangazkimyo" complex is considered the only and one of the largest industrial enterprises in our republic, processing 3.5 billion m3 of natural gas per year, producing 125,000 tons of polyethylene granules, 100,000 tons of compressed gas, 100,000 tons of gas condensate, 2,500 tons of sulfur granules, produces 3.2 billion m3 of refined gas [19]. During its operation, the complex emits air pollutants from 53 sources. The torch (torch) coming out of the complex also emits various harmful compounds to a certain extent into the environment and has a negative impact on the stability of the ecosystem. They mainly include methane, ethane, propane, butane, pentane, hexane, heptane, nitrogen oxides, carbon oxides, sulfur oxides, hydrogen sulfide, or mercaptans, and various other chemicals [19]. As a result of the activity of the complex, lower molecular polymers that harm the environment are also released (Table 1)

Table 1. The amount of waste from the Shurtangazkimyo complex

№	Polyethylene label	Field of use	Amount of low molecular weight of polymer, (kg /100 t).
1	MF-3	Polyethylene Film production	300
2	2908	Production of boxes and barrels	250
3	59 C	Production of water bottles	750

4	38 A	Production of drainage pipes	2000
5	44 H	Conductor insulation production	900

According to the table, the least amount of waste per 100 tons of polyethylene (250 kg) is generated during the production of polyethylene products with the label 2908, which are used for making boxes and barrels. Following that is the waste product generated during the production of the MF-3 label (300 kg). The largest amount of low-molecular polymer waste is generated in the production of 38A label polyethylene, which is used in the production of drainage pipes (2000 kg). The technology of the complex is designed to produce about 150 types of high, medium and linear low-pressure polyethylene. The waste produced in the production of each brand of polyethylene is increasing year by year. This, in turn, leads to environmental pollution with various harmful compounds and heavy metals.

The results of the conducted research show that due to the waste of the "Shurtangazkimyo" complex, the soil scattered around it is contaminated with heavy metals such as lead and nickel. The maximum amount of mobile lead was 55.2 mg/kg (at 850 m on the south side of the complex), and the maximum amount of mobile nickel was 53.1 mg/kg (at 1500 m) in the southeast direction. These amounts are several times more than maximum allowed concentration. Pollution occurs mainly in a radius of 2000 meters around the complex and in the south, southwest and southeast directions of the complex along the wind direction [18]. We focus on the impact of soil pollution with heavy metals on the ecological condition and productivity of the soil of this ecosystem as a result of the waste released into the environment by the "Shurtangazkimyo" complex.

Soil fertility is known to be affected by its physical properties, chemical composition, the amount of nutrients absorbed by plants, and other factors. One of the most important variables influencing soil fertility is humus. The amount of humus relies on elements such as soil mechanical composition, soil formation conditions, location relief, type of crop, and cultivation agrotechnology. Humus tightly bonds mineral particles in the soil, giving it a granular texture. Soils with a high humus content less effort and energy are spent in mechanical processing, and the density of the soil decreases. Organic matter is of great environmental importance, it reduces the effects of many negative consequences of using mineral fertilizers, retains excess nutrients and avoids leaching, neutralizes harmful compounds. However, in recent years, the amount of humus in the serozem soils of Uzbekistan has greatly decreased due to the improper implementation of crop rotation and regular planting of inter-row crops (cotton) as a monoculture. In the next 40-50 years, the amount of humus in most irrigated soils of Uzbekistan decreased by 40-50%. The amount of humus in the average layer of 1 m of most soils that have been irrigated since ancient times does not exceed 0.8-0.9% [13,20,21].

The results of the study showed that the irrigated light serozem soils around the “Shurtangazkimyo” complex are extremely poor in humus. The amount of humus from the organic waste in the soil was also influenced in a certain sense by the various wastes released as a result of the complex's activity. As a result of the impact of waste, the biological processes in the soil are weakened, the accumulation of organic substances is reduced. Humification in the soil, that is, the process of turning organic matter into humus, has decreased. This, in turn, leads to a low accumulation of humus in this area.

As a result of the activity of the complex, as a result of the waste released into the environment, the increase of various harmful compounds and heavy metals in the soil leads to a decrease in the biomass of naturally growing plants. As a result, less organic matter accumulates in the soil. The conversion of existing organic matter into humus is reduced in unfavorable environmental conditions. As a result, the amount of humus in the soil decreases. Depletion of humus occurs at the same time as reduction of nitrogen, phosphorus and potassium. Microorganisms are crucial for the creation of ammonium and nitrate nitrogen in the soil as well as for converting phosphates that are difficult to dissolve into forms that plants can absorb. The negative impact of various harmful compounds, including heavy metals, on the activity of microorganisms in the soil is reflected in the works of a some researchers [3,15]. This leads to disruption of biological processes in the soil. It is known that accumulation of nitrogen in the form of humus, nitrate and ammonium and mobile phosphorus in the soil depends on the activity of microorganisms, that is, biological processes.

The amount of humus in the soils on the southern side of the "Shurtangazkimyo" complex is relatively low. For example, the amount of humus in the upper 0-30 cm layer soils was 0.41% in the immediate area of the complex, and it was 0.42-0.45% in this layer 100 m away from the complex (Fig. 2). The amount of humus in the soil increased with distance from the complex. According to the conducted studies, the amount of humus in the upper 0-30 cm layer of the soil increased from 0.41% to 0.91% at up to 10,000 m from the territory of the complex. At 1000-1500 m from the complex, the amount of humus was less than 0.70-0.75% in all directions. The lowest amount of humus was recorded mainly in the soils of the south and south-east side, where the level of pollution is high (Fig. 2).

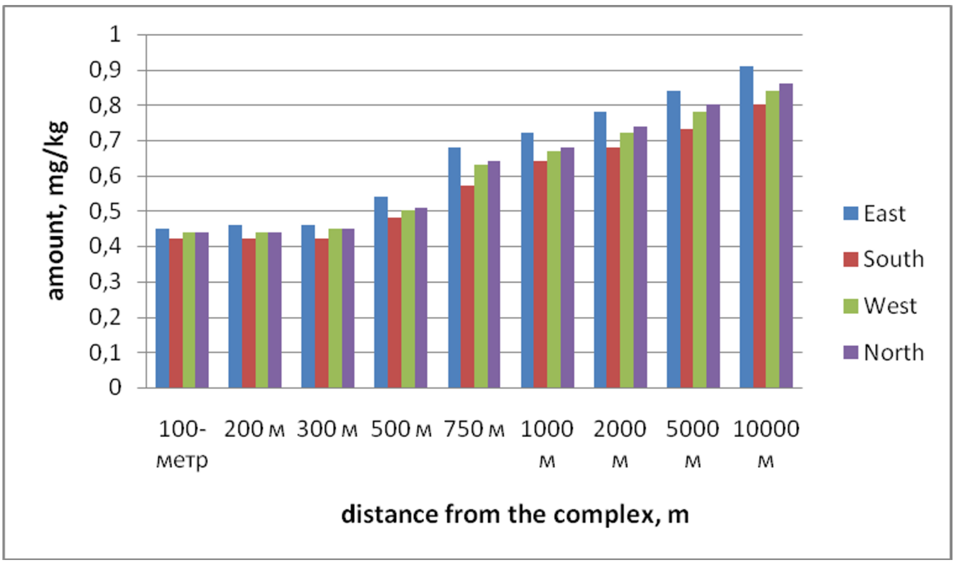

Fig. 2. The amount of humus in the soils around the"Shurtangazkimyo" complex

The waste released as a result of the "Shurtangazkimyo" complex has a negative effect on the amount of nitrate and ammonium forms of nitrogen, mobile phosphorus and exchangeable potassium in the irrigated light serozem soils scattered around it (Figures 3-4). The amount of nitrogen in the form of nitrate (N-NO3) in the soil near the building of the "Shurtangazkimyo" complex is 3.2 mg/kg, nitrogen in the form of ammonium (N-NH4) is 3.4 mg/kg, mobile phosphorus (P2O5) is 6, 5 mg/kg, and exchangeable potassium (K2O) was -148 mg/kg.

The amount of nitrogen in the form of nitrate and ammonium was 3.5-3.7 mg/kg, and the amount of mobile phosphorus was 6.5-6.8 mg/kg in all directions studied at 100 meters from the territory of the complex. The amount of exchangeable potassium at this distance was found to be 152-154 mg/kg.

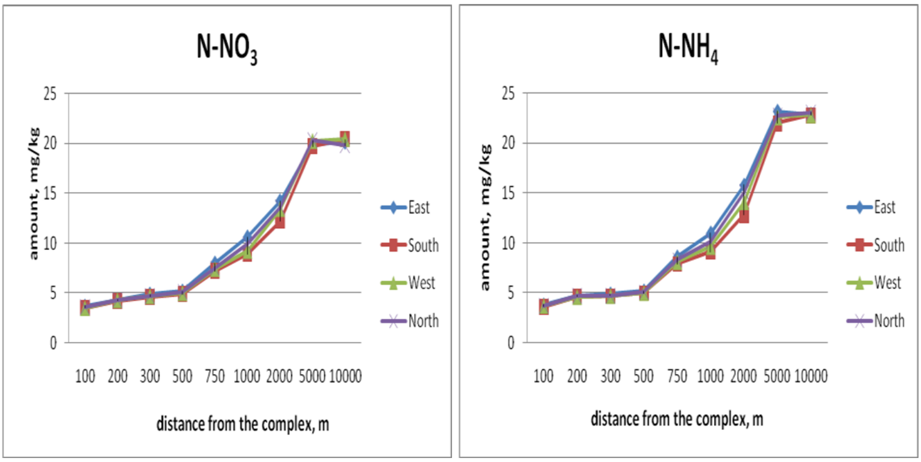

Fig. 3. The effect of the wastes of the Shurtangazkimyo complex on the amount of nitrogen in the form of nitrate and ammonium in the soil

The amount of mobile nutrients in the irrigated pale serozem soils increased as the negative impact of waste decreased with distance from the complex (Figures 3-4). For example, at 200 meters from the complex in all directions, the amount of nitrogen in nitrate form was 4.2-4.3 mg/kg, and at 500 meters it was 4.9-5.2 mg/kg. At these distances, the amount of nitrogen in ammonium form was 4.6-4.7 mg/kg and 5.0-5.2 m/kg, respectively. The amount of mobile phosphorus was found to be 7.8-7.9 mg/kg in all directions at 300 meters, and 8.0-8.4 mg/kg at 500 meters. The lowest amounts of these elements were mainly observed in the south, south-east and south-west directions of the complex. From the distance of 1500-2000 meters from the complex, the amounts of mineral nitrogen and mobile phosphorus increased significantly.

Complex wastes also reduced the amount of exchangeable potassium in soils. However, unlike nitrogen and phosphorus elements, it did not have a significant effect on the reduction of potassium content.

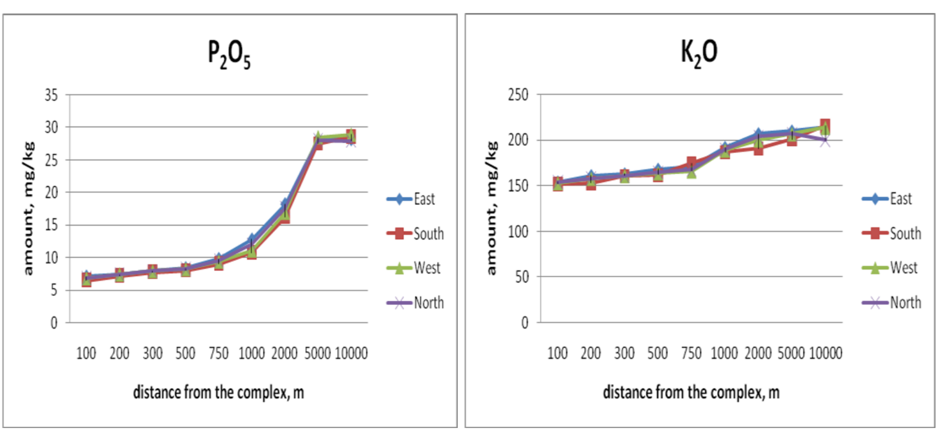

Fig. 4. Amount of mobile phosphorus and exchangeable potassium in the soils around the Shurtangazkimyo complex

This situation can be explained by the fact that potassium is mainly contained in mineral compounds in the soil, and that the wastes of the complex mainly affect the biological processes in the soil.

4 Conclusion

Accumulation of various harmful compounds and heavy metals in the soil as a result of the activities of the "Shurtangazkimyo" complex has a negative effect on the productivity and ecological condition of the light serozem soils distributed in this area. The effect of complex wastes is a significant decrease in the amount of humus in the soil and nutrients necessary for plants, that is, nitrogen in the form of nitrate and ammonium, as well as mobile phosphorus. The waste of the complex does not significantly affect the amount of exchangeable potassium in the soil.

References

1. V.A. Chernikov, Agroecology (M.: Kolos, 2000)
2. I. Bobokhojaev, P. Uzakov, Soil composition, properties and analysis (T.: 1990)
3. T.V. Bagaeva, N.E. Ionova, G.V. Nadeeva, Microbiological remediation of natural systems from heavy metals (Kazan: Kazan University, 2013)
4. A.A. Vasiliev, et.al. Ecological technologies of oil producing companies in Western Siberia / A.A. Vasiliev, N.I. Matveev, V.B. Lukinykh // EKiP **5**, 16-17 (2004)
5. O. V. Gazizova, A. R. Galeeva, *Environmental safety as a priority for the development of the oil and gas industry in the context of the need for the integrated use of hydrocarbon raw materials.* Bulletin of Kazan University. Energy and rational nature management, p.14-18 (2013)
6. M.Kh. Diyorova, "Effects of gas industry sulfur compound wastes on soil properties and trees of arid regions and ways to improve them" biological sciences (PhD) dissertation. (Tashkent-2017)
7. T.A. Demina, Ecology, nature management, environmental protection: a manual for senior students of educational institutions (M.: Aspect Press, 1997)
8. B.A. Armor, Methods of field experience. (M.: Agropromizdat, 1985)
9. T.G. Dobrovolskaya, D.G. Zvyagintsev, I.Yu. Chernov, et.al. The role of microorganisms in the ecological functions of soils. Eurasian Soil Science **48**, 1087–1096 (2015)
10. D.V. Ladonin, O.V. Plyaskina, Collection of articles of the Ivanovo State Agricultural Academy **4,** 184-197 (2001)
11. Yu.N. Yeldyshev. When will the torches in the oil fields go out. Ecology and life **10**, 58-61 (2007)
12. A.A. Zhakisheva. Ways to prevent the impact of oil and gas production on the environment. Bulletin of the Chelyabinsk State University **32 (247)** 34, 142-149 (2011)
13. T.K. Ortikov. The current state of irrigated soils in Uzbekistan and ways to improve them. Improving the productivity of irrigated serozem soils and its environmental challenges: Proceedings of a conference. Part 1. (Samarkand, 2002)
14. Overview of the problem of cadmium, lead and mercury pollution of the environment in Russia and Ukraine. (Moscow, 2008)

15. E. V. Pleshakova, Ecological and functional aspects of microbial remediation of oil-contaminated soils. Abstract of the dissertation for the degree of Doctor of Biological Sciences (Saratov – 2010)
16. V.S. Petrosyan, Gas plumes of vehicles. Priroda **12**, 11-16 (2001)
17. Atlas soil of the Republic of Uzbekistan (2010)
18. Sh.T. Khalikulov, T.B. Yakubov. Effect of wastes of Shu'rtangazkimyo complex on the amount of some mobile heavy metals in pale serozem soils. Bulletin of Gulistan State University, Series of Natural and Agricultural Sciences **3**, 39-45 (2021)
19. Sh. Kholikulov, T. Yakubov, I. Bobobekov, The Effect of Gas Industry Waste on Heavy Metals in Soil. Journal of Ecological Engineering **22(9),** 255–262 (2021). DOI:10.12911/22998993/141365
20. Sh. Kholikulov, T. Goziev, *Change of Temperature and Humidity of Soil at its Regulation*. Proceedings 20th World Congress of Soil Science 2014. Jeju-do South Korea. p.694 (2014)
21. Sh. Kholikulov, S. Pardaev, Influence of Organo-Mineral Composts on Agrochemical Properties Serozem Soils of Uzbekistan. Proceedings 20th World Congress of Soil Science. Jeju-do South Korea. p.689 (2014)