PAPER • **OPEN ACCESS**

Transformation of the chemical properties of soils in the zone of influence of the asphalt concrete plant

To cite this article: Zh M Gumarova *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **979** 012159

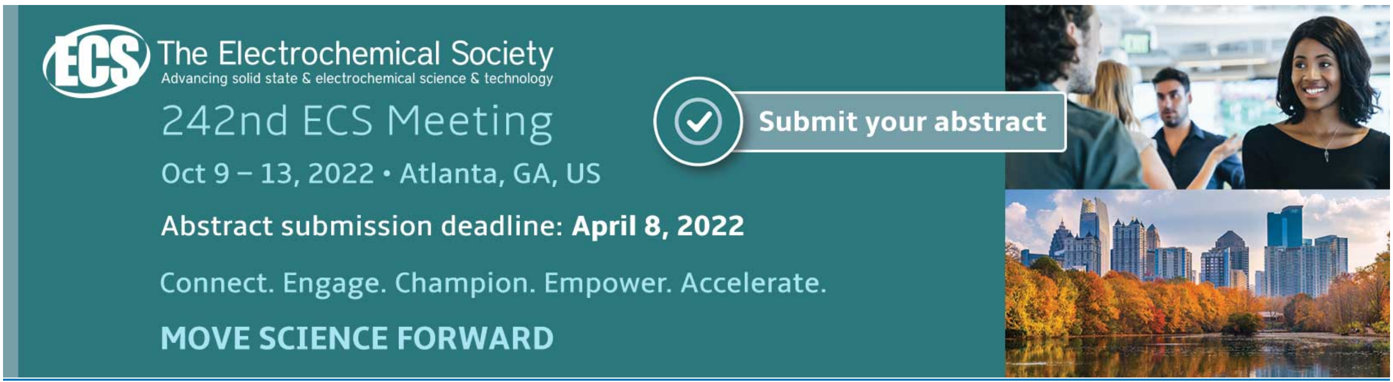
View the article online for updates and enhancements.

You may also like

- Regional approach to soil pollution assessment and ecological sustainability of the town soils of Kursk region
N Nevedrov and G Smitskaya

- Soil-agrochemical analysis of the fertile soil layer from the Erunakovskiy field of the Taldinskiy coal mine
M A Yakovchenko, E A Izmulkina, N A Stenina et al.

- Ecogeochemical evaluation of soils under conditions of technogenesis
G I Sarapulova



This content was downloaded from IP address 89.218.221.115 on 11/03/2022 at 09:59

Transformation of the chemical properties of soils in the zone of influence of the asphalt concrete plant

Zh M Gumarova, A M Nurgaliyev, R Sh Japarov, S Sungatkyzy and E K Akkereyeva

Zhangir Khan West Kazakhstan Agrarian Technical University, 51, Zhangir khan street, Uralsk city, 090009, Republic of Kazakhstan

E-mail: aina_zhg@mail.ru

Abstract. The article presents the results of studies of technogenically contaminated soils in the territory of an asphalt concrete plant. Toxic dust generated by the operation of the enterprise pollutes the air and settles on the surface of the soil. This anthropogenic impact is visually manifested in a decrease in the projective cover of the vegetation cover in the Baiterek region of the West Kazakhstan region. The studies represent the study of such parameters as wind direction, soil composition for readily soluble salts, heavy metals and oil products. In the analysis of soils for heavy metals and oil products, spectral and fluorescent methods were used. Easily soluble salts in an aqueous extract were determined by electrochemical, gravimetric, and direct titration methods. The dynamics of the accumulation of pollutants in the soil corresponded to the winds operating in the zone of the plant. In the northern and western directions from the plant, the analysis of soils for lead and cobalt showed that the permissible norms were exceeded by 5.8 and 6.1 times. The dynamics of petroleum products in the plant's soils also revealed that the approximate permissible norms were exceeded. Analysis of the salt content in the technogenic sediment showed an average salinity within the entire production site. As a result of the research carried out, we found out that the functionality of the plant, represented by the welding, boiler, asphalt mixture production units and the vehicle fleet, really exerts a technogenic load on the soil and vegetation cover. The authors recommend excluding the construction of residential buildings and livestock grazing in the northern and western directions from the design.

1. Introduction

As a result of industrial production in the areas where various enterprises are located and in places of mining, as well as often near settlements, foci of an industrial desert arise. In such areas, the soil is so damaged that it loses its fertility [1]. The soil, accumulating the incoming pollutants, inevitably affects the adjacent environments, acting as a source of secondary pollution of atmospheric air, natural waters, biotic complex [2]. Technogenic air pollution in cities is caused by emissions of pollutants, both as a result of the activities of vehicles and industrial enterprises [3]. However, the demand for asphalt mix in the region sometimes exceeds the production capacity of both stationary and mobile asphalt-concrete plants. At the same time, the high cost of transporting raw materials and finished products, as well as the need for a large number of workers, are increasingly forcing industrial enterprises producing construction materials to locate their facilities within settlements or in their immediate vicinity [4]. Polluting components in the form of dust settle on the soil surface, penetrate

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

through the thickness into deeper horizons, leading to a decrease (30-40% coverage) of the projective vegetation cover. Performing the functions of geochemical barriers and possessing the ability to extract heavy metals from landscape cycles, soils are one of the main indicators of the well-being of the territory [5]. The accumulation of heavy metals negatively affects the biological and enzymatic activity, leads to general soil degradation. But the most dangerous factor for plants and other living organisms is the degree of accessibility, which is determined by the mobility of chemical elements [6]. Heavy metals (HM) in soil are one of the most serious pollutants due to their toxicity and non-biodegradability [7]. Heavy metals are involved in biological circulation, are transferred along food chains and cause a number of negative consequences. With the maximum chemical pollution, there is a decrease in the capacity of soils for biological self-purification, loss of productivity and further complete destruction of the ecosystem.

The development of human society and the satisfaction of its needs occurs with the constant extraction and further use of natural resources. The result is a significant generation and accumulation of industrial waste [8]. At present, oil pollution is mainly concentrated on facilities bearing a high technogenic load [9]. It was found that about twenty environmental aspects identified in the departments of technical inspection and repair and maintenance have a negative impact on the environment [10].

The purpose of our research work was to assess the ecological state of soils on the territory of an asphalt concrete plant in terms of soil contamination with heavy metals, oil products, as well as the content of readily soluble salts.

2. Materials and methods

Spot samples of soils for the determination of oil products, heavy metals and readily soluble salts were obtained from a layer of 0-5 and 5-20 cm with a mass of 200 grams. Contamination indicators for heavy metals were determined by cadmium, copper, lead and cobalt (accumulated in the soil due to traffic). Heavy metals were determined using an atomic absorption spectrometer (model AA140). Determination of mobile forms of heavy metals in a soil sample was carried out by extraction of metals using acids. The mass fraction of oil products in soil samples was measured using a Fluorat-02-2M liquid analyzer. A sample of soil for the determination of oil products was prepared depending on the degree of contamination in a standard way. Total alkalinity (or alkalinity from bicarbonates) was determined by potentiometric, chloride ions by argentometric method (Mohr's method), sulfate ions by gravimetric methods, and calcium and magnesium cations by titrimetric methods. Sodium cations in the aqueous extract were determined using a selective sodium electrode on an I-160 ionomer.

To assess the quality of the study area, soil samples were taken from the northern, southern, western and eastern directions from the asphalt concrete plant. The process of studying the parameters of pollution of the objects under study was correlated with the direction of the winds.

3. Results

As the data of the wind rose in figure 1 show, the prevailing winds were from the north and west directions.

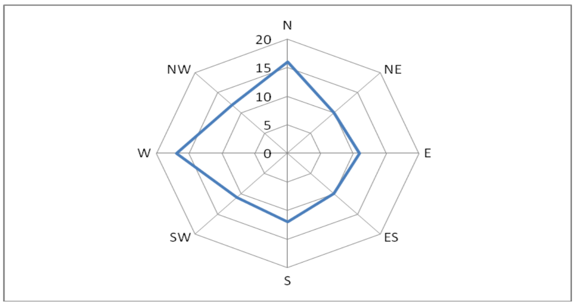


Figure 1. The wind rose in the Baiterek region.

The results of the analysis showed the following (table 1): soil samples obtained in the northern direction at a distance of 50 m from the pollution source contain Co 1.3 times more than the established MAC, and Pb - 1.12 times. At the same time, the copper content at a distance of 50 and 100 m from the source of pollution exceeded the established value by three times.

Table 1. Dynamics of heavy metals in soil samples (mg / kg) northward from the ABZ.

Sampling points	Cu	Pb	Co	Cd
50m	3.1	5.6	6.5	0.001
100m	3	5.4	6.0	0.001
200m	2.8	4.9	5.1	0

Soil samples taken southward from the asphalt concrete plant showed (table 2) the excess of the MAC for lead, copper and cobalt by 1.26 times for Pb and Co by 1.42 times. The results of the analysis of soil samples for heavy metals, obtained at a distance of 200 m southward from the production site, showed that the content of metals Cu, Pb, Co and Cd does not exceed the maximum permissible concentrations. And the amount of cadmium at all distances did not exceed the norm.

Table 2. Dynamics of heavy metals in soil samples (mg / kg) southward from the ABZ.

Sampling points	Cu	Pb	Co	Cd
50m	3.6	6.3	7.1	0.001
100m	3.2	6.0	6.6	0.001
200m	3.0	5.2	5.1	0

In the western direction (table 3), the concentration of cadmium metal was 0.105-0.206 mg / kg. And the content of lead and cobalt showed significant excess in terms of MAC (5.8 and 6.1). The highest cobalt value was observed in a soil sample taken at a distance of 50 m. In this direction, traffic is observed, operating mainly on diesel fuel: asphalt pavers, loaders, bulldozers, etc. The excess in lead can be attributed to the combustion of fuels that previously contained leaded gasoline.

Table 3. Dynamics of heavy metals in soil samples westward from the ABZ.

Sampling points	Cu	Pb	Co	Cd
50m	3.6	6.2	7.7	0.001
100m	3.3	5.8	6.1	0.001
200m	3.0	5.1	4.8	Traces

In the dynamics of soil samples taken from the eastern direction (table 4), exceeding the maximum permissible concentrations was not found. In this direction, there are branches from highways and warehouses.

Table 4. Dynamics of heavy metals in soil samples east of the ABZ.

Sampling points	Cu	Pb	Co	Cd
50m	3.2	6.1	6.9	6.9
100m	2.8	5.2	6	6
200m	2.1	4.1	4.8	4.8

It was found that the share of oil products (table 5) In the composition of samples taken from the ABZ in the northern and western directions is approximately 1.5 times higher than the approximate permissible concentration (OPC = 300 mg / kg).

Table 5. The share of oil products in the soil, mg / kg (OPC = 300 mg / kg).

Sampling points	50m	100m	200m
Northern	450	401	328
Southern	305	236	110
West	465	380	345
Oriental	449	296	115

The transformation of technogenically altered soils in the zone of influence of the asphalt concrete plant in terms of the content of readily soluble salts (table 6) showed medium and weak salinity throughout the adjacent territory.

Table 6. Transformation of technogenically altered soils in the zone of influence of an asphalt concrete plant in terms of the content of readily soluble salts.

Soil, plot	Anions,%,milligram-equivalent/ 100g soil			Cations,%,milligram-equivalent/100g soil			Salinity type	Salinity
	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+		
On technogenic sediment, 50 m	0.0262	0.0547	0.0195	0.0148	0.0062	0.0242	Chloride	Medium salted
On technogenic sediment, 100 m	0.0254	0.0512	0.0182	0.0104	0.0152	0.0215	Chloride	Medium salted
On technogenic sediment, 200 m	0.0102	0.0408	0.0078	0.0036	0.0018	0.0118	Chloride	Medium salted

The results of the water extract show a chloride type of salinity. The soils of the territory adjacent to the plant are characterized by an average degree of salinity.

4. Discussion

Analysis of soil samples taken in the northern direction from the plant showed a high level of pollution, expressed in exceeding the maximum permissible concentrations associated with the technogenic impact of the railway and access roads. The excess observed to the south from the plant can be explained by the close location of the highway, while the contamination of cobalt and lead is localized to the west. We see that the transformation of the soil environment in terms of cobalt and lead is caused by heavy traffic, combustion of hydrocarbon fuel containing cobalt. Frequent metal welding and operation of asphalt mixing plants, flue gases and aerosol particles emitted into the air in large volumes also contribute to intensive pollution of the territory. Studies of heavy metals in soil samples from a distance of 200 m in the eastern direction did not reveal any excess. The data obtained are comparable with the directions of the prevailing winds. Unloading of bitumen, storage pits, as well as the spill of fuels and lubricants apparently contributed to the high level of pollution of the territory of the asphalt concrete plant with oil products. In places where vehicles are parked, the share of oil products in the soil is determined in critical volumes. Within the radius of the asphalt concrete plant, an increase in readily soluble salts was observed in the soil. Chloride type of salinization indicates that industrial salt is still used to combat the ice cover.

5. Conclusion

In conclusion, the results of the study are described:

- It has been established that the anthropogenic load on the soils of the territory is directly dependent on the direction of the operating winds and the proximity of the source of pollution.
- The content of heavy metals and oil products in soil samples exceeds the MAC, which, in turn, has a negative impact on vegetation and biota.
- The oppression of vegetation in the zone of influence of the asphalt concrete plant can be associated with the poisonous effect of water-soluble salts, mainly chloride.
- The studies carried out indicate the need to ensure environmental safety by installing air purification systems, planting trees around the perimeter of the plant, and in order to avoid harmful effects, it is necessary to prevent the construction of residential buildings and grazing in the northern and western directions.

References

[1] Dzhumelia E and Pohrebennyk V 2021 Methods of Soils Pollution Spread Analysis: Case Study of Mining and Chemical Enterprise in Lviv Region Ukraine. *Ecological Engineering & Environmental Technology* **22(4)** 39-44

[2] Ushakova E S, Karavaeva T I and Belkin P A 2020 Ecological Condition of soils in industrial areas (as in the case of berezniki, perm region): Comparison of Russian and foreign methods of assessment. *Bulletin of the Tomsk Polytechnic University, Geo Assets Engineering* **331(10)** 58-70

[3] Martsev A and Selivanov O 2019 Ecological and hygienic assessment of environment in the town with glass packaging production. *E3S WebofConferences* **135** 1044

[4] Strizhenok A V and Ivanov A V 2017 Ecological assessment of the current state of environmental components on the territory of the impact of cement production industry. *Journal of Ecological Engineering* **18(6)** 160-5

[5] Sambu A D, Mezhekey A M, Okculuk A O and K-KhDadar A 2021 Ecological state of the soil cover of coal deposits in the Republic of Tyva. *Earth and Environmental Science* **723** 42045

[6] Gorbov S, Bezuglova O, Plakhov G and Ivolgina V 2019 Accamulation and migration of mobile forms of lead and copper in urban soils of the rostov agglomeration. *International Multidisciplinary Scientific Geo Conference Surveying Geology and Mining Ecology Management, SGEM* **19(3.2)** 3-8

[7] Xu Y, Shi H, Fei Y, Wang C, Mo L and Shu M 2021 Identification of Soil Heavy Metal Sources in a Large-Scale Area Affected by Industry. *Sustainability* **13** 511

[8] Brolla A T and Howe C 2015 Soil contamination in landfill. *McGraw-Hill* 82

[9] Lifshits S, Glyaznetsova Y, Erofeevskaya L, Chalaya O and Zueva I 2021 Effect of oil pollution on the ecological condition of soils and bottom sediments of the arctic region. *Environmental Pollution* **288** 117680

[10] Anpilova Y, Lukianova V and Trofymchuk O 2020 Environmental Safety of Motor Transport Enterprises within Urban Areas. *Journal Ecol. Eng* **21(4)** 231–6