

Technogenic systems of Pavlodar region

Abstract. Technogenesis is a process of environmental transformation under the influence of various types of technical human activity. Technogenesis - this transformation of the earth's crust occurs during the extraction and processing of mineral resources, engineering and geological activities. One of the technogenically transformed areas is the Pavlodar region of Kazakhstan.

This scientific article presents the main sources of technogenic impact in the Pavlodar region. The research gives a description of the two main technogenic systems. There have been determined the main chemical contaminants of the components of the natural environment. The authors have calculated using modern methods of GIS technologies, the area of sludge collectors. The article describes a promising method for solving such non-trivial problems as identifying the spatial distribution of ecological risk zones, or the spatial display of the concentration distribution of pollutants. The article gives a description of the main industrial facilities of the Pavlodar region, the number of emissions, and also characterizes the climatic factors of the study area.

Key words: technogenesis, geosystem, sludge collector, waste.

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Introduction

A special place among the manifestations of technogenic impact on the environment of industrial centers belongs to contamination with heavy metals. It is because of the rapid self-cleaning of components of the natural environment from metal contamination to the level required for reasons of hygiene and ecological safety is difficult to reach, and in many cases it is practically impossible [1].

Industrial urbanization plays a special role in the pollution of the natural environment. Talking about an ecologically safe situation in industrial centers is possible only when science considers its problems the perspective of human life support and from the standpoint of the rational relationship "human-nature" [2].

Research methods

The issues of assessing the impact on the environment, environmental risks, ecological and economic degradation, and the search for a way to minimize negative impact on the environment are complex tasks that stand in front of every production facility and organizations exercising environmental control at the state level as well. These questions currently do not have a general standardized solution, mainly due to the difficulty of estimating the volumes of emissions and waste. Thus, the trend of using modern methods of computer modeling and visualization, such as neural networks and GIS, has significant advances in solving such non-trivial general tasks as identifying the spatial distribution of environmental risk zones, or the spatial mapping of the concentration distribution of pollutants. The application of the proposed approaches will make it possible to develop a methodology that applies not only to industrial territories of Kazakhstan, but also to any other technogenic objects without reference to location. Thus, the proposed project is extraterritorial and is aimed at solving production and environmental problems both in the territory of Kazakhstan and within the limits [3].

Research area

Ash and sludge collector of the Aksu ferroalloy plant.

The industrial site of the plant is located in the north-west of the industrial zone of Aksu, Pavlodar region, on the left bank of the Irtysh River, 22 km upstream from the regional center, the city of Pavlodar. Aksu is located 50 km south from the city of Pavlodar on the left bank of the Irtysh River. The population of the city is 70,124 inhabitants as part of the urban district (city akimat) with subordinate rural settlements, including 41,625 people of the city itself (2019). The Aksu ferroalloy plant, together with the Aksu state district power station, is a city-forming enterprise responsible for the production of the city's infrastructure (Figure 1).

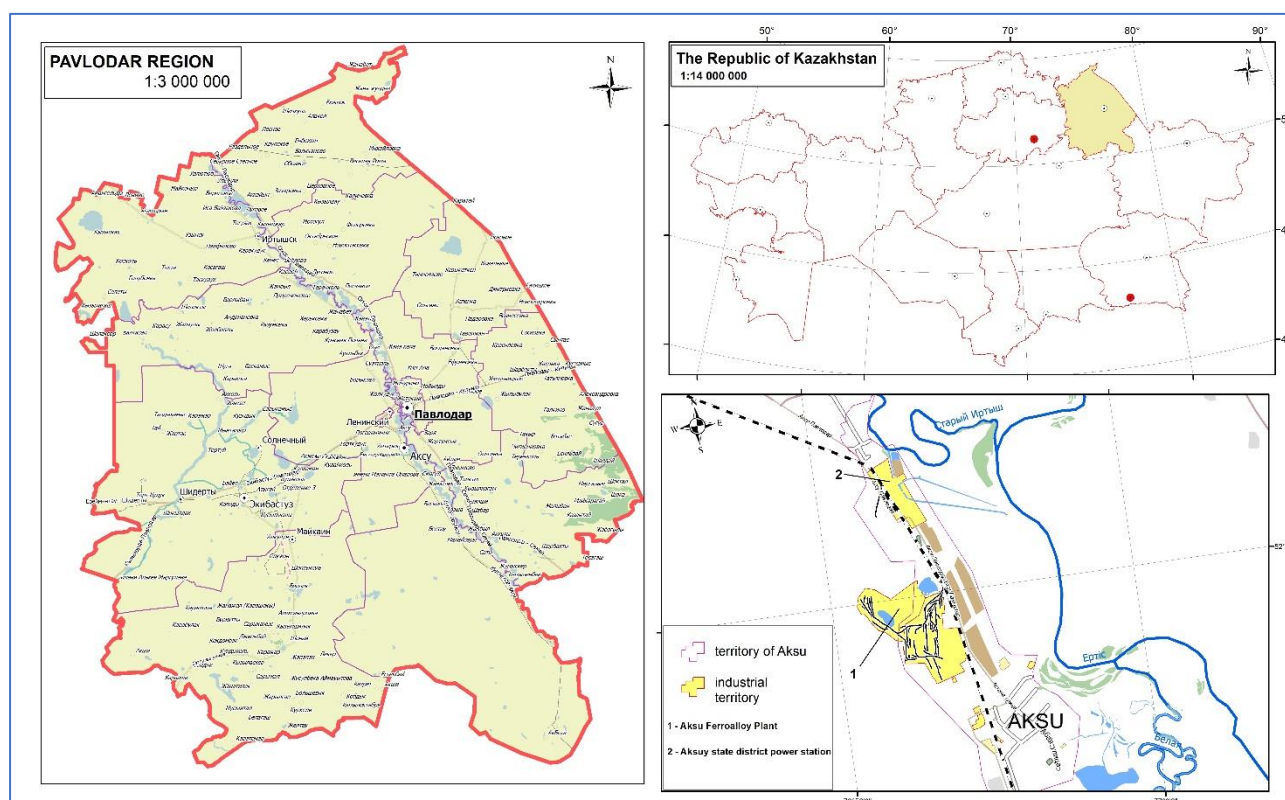


Figure 1. Technogenic system of Aksu city

The climate of the region is sharply continental. It is characterized by an insufficient and unstable amount of atmospheric precipitation with a summer maximum, low air temperatures in winter with strong winds and insufficiently thick snow cover, late spring and early autumn frosts, significant fluctuations in temperature during the year.

The wind regime is continental. Winds prevail in the western, southwestern and southern directions. The seasonal change of prevailing winds to the opposite directions is one of the main features of the climate.

The average wind speed is 4.5 m/s. The highest wind speed is observed in the spring (up to 6.0 m/s). Wind force often exceeds 15-20 m/s.

Ash and sludge collector of the Pavlodar aluminum smelter

Pavlodar aluminum smelter was built in the 60s (September of 1955)

In 1964, the first echelon of products was sent from Pavlodar to the Novokuznetskiy aluminum plant. In 1995, the enterprise was transformed into JSC "Aluminum of Kazakhstan".

The enterprise is located in the East industrial region of Pavlodar. To the east of the industrial site, there is an ash disposal area of a thermal power plant and a waste storage facility of aluminum plant. From the south and west, there are lands occupied by collective gardens and a forest nursery (Figure 2).

The area of the object's location lays in a zone with a sharp continental climate with dry hot summers and prolonged low winters.

The average annual amount of precipitation according to multiyear observations is 260 mm per year, of which 76% falls during the warm period from April to October. The hot month is July with an average monthly maximum air temperature of +27.9° C. The coldest month is January with an average monthly minimum air temperature of 22.2° C below 0. The prevailing direction of the wind is the west and south. The average annual wind speed is 3.7 m/s.

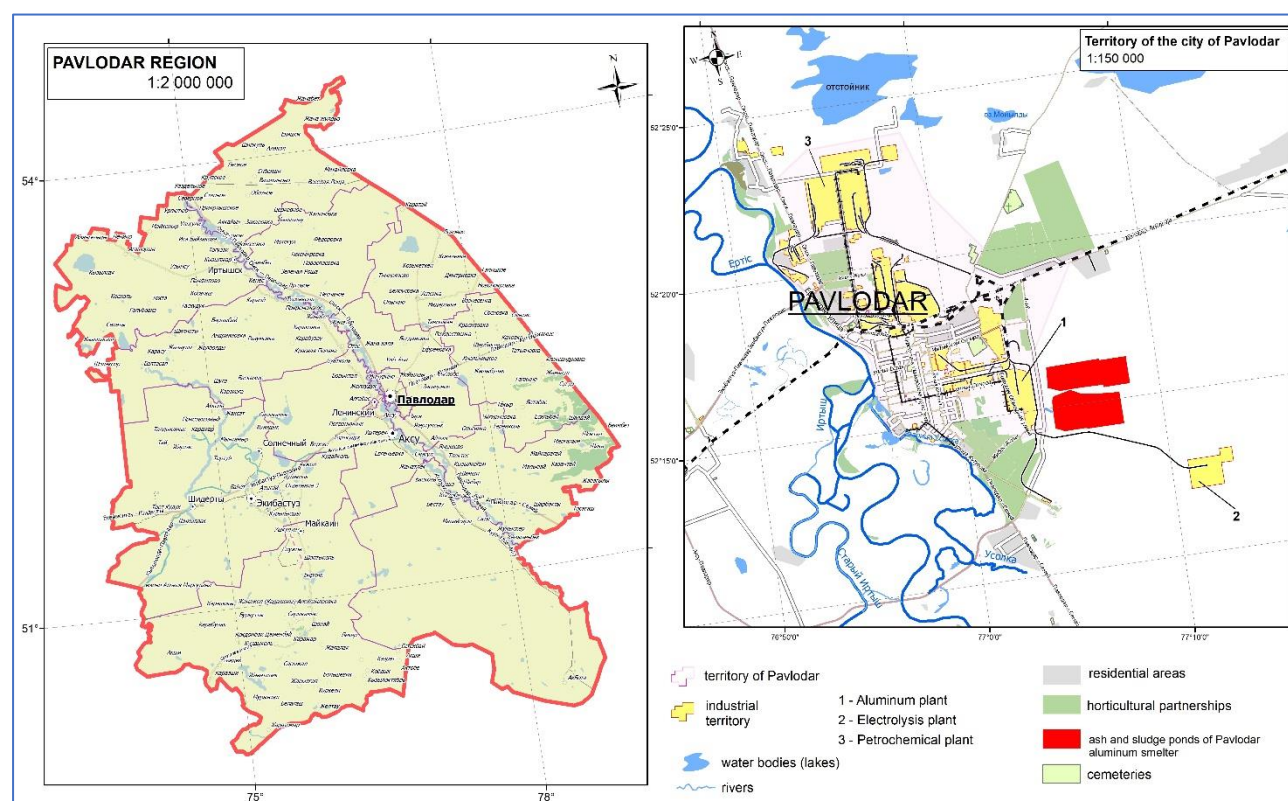


Figure 2. Technogenic system's location map in Pavlodar city

Analysis and discussion.

The Aksu Ferroalloy Plant is a branch of the JSC "Transnational Company "Kazkhrom" and is the part of the Eurasian Natural Resources Corporation (ENRC). AFP is a leading metallurgical company in the world for the production of chromium, siliceous and manganese alloys. The production capacity is one million two hundred thousand tons of ferrous alloys per year. The number of employees at the enterprise is more than 6,000 people. The plant includes 4 smelting shops, 26 electric furnaces with a capacity of 16.5 to 63 MVA, 2 charge preparation shops, a slag processing shop, a block of mechanical repair shops, an automobile shop, a railway shop, and 42 divisions. The annual production of chromium, manganese and silicon alloys is more than 1 million tons.

The power station of the Eurasian Energy Corporation JSC is located 4.5 km northeast of the Aksu ferroalloy plant, on the western side, at a distance of 2.5 km, there is HWM-3 of AFP. Pavlodar-Semey railway runs from the east from plant.

The nearest settlement zone (Aksu) is located at a distance of 3.5 km southeast of the AFP. According to the sanitary classification of production facilities, the Aksu Ferroalloy Plant belongs to the

“I” hazard class [4]. Environmental Code of the Republic of Kazakhstan assigned the plant the 1st category [5]. In physical and geographic terms, the industrial site of the Aksu ferroalloy plant is located in the lower part of the Irtysh left coastal flat dry-stepped area of the Pavlodar region. Two large elements can be distinguished in the relief: the lowland accumulative plain, which belongs to the Irtysh depression, and the floodplain of the Irtysh River.

The region of the location of the industrial site of AFP lays on the steppe or dry-steppe type of landscapes on chestnut soils, characterized by patchiness of the soil cover (and vegetation) associated with the relief and underlying substrate. Climate plays an important role here, especially the amount of precipitation, which directly affects the processes of soil formation and the intensity of the vegetation cover.

Groundwater is confined to sandy sediments. The direction of the groundwater flow is towards the Irtysh River.

During the production of ferrosilicon at the plant, the production wastes such as ferroalloy gas, slug, sludge from wet gas purifiers of closed ovens, dust of dry gas purification of open ovens are formed. A large share of waste is stored on the territory of three ash and sludge collectors. Thus, the sources of disturbance on the components of the environment include the generation of waste, as well as the places of collection and temporary storage of waste. Gas purification sludge is formed in the “tea pot” devices of the projected dust of the purification equipment. The amount of generated sludge is more than 28000 ton per year. According to its physical state, the sludge is paste-like, according to its physical properties; it is insoluble in water, not flammable, not explosive. According to its chemical properties, it does not have reactivity; the main components of waste are oxides of silicon, iron, chromium (VI). According to the hazard level, the sludge from the gas purification plant belongs to “Amber” level and has the index AD140. Ash and sludge collector of Aksu ferroalloy plant covers 633 304 m² (Figure 3).

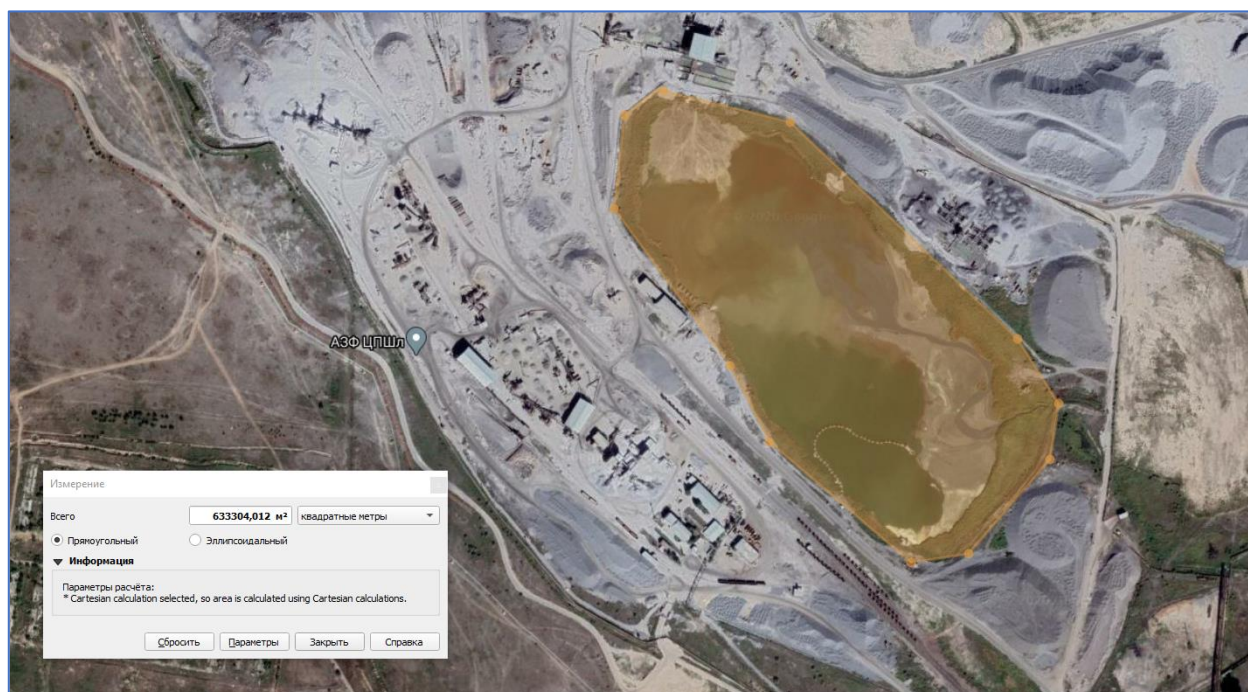


Figure 3. Area of object №1 Ash and sludge collector of Aksu ferroalloy plant

The Aluminum of Kazakhstan Joint Stock Company, the former Pavlodar aluminum smelter (PAZ), is one of the enterprises of Kazakhstan. Activities and main products: production and sale of alumina, as well as extraction, processing and sale of bauxite, limestone, refractory clays, crushed stone, production and sale of gallium, aluminum sulfate, aluminum alloys in the form of ingots and other goods

and services. Aluminum of Kazakhstan is one of the ten leading alumina producers in the world.

The purpose of the Pavlodar Aluminum smelter is the processing of bauxite, associated raw materials additives and the production of commercial alumina, which is a raw material for the production of aluminum. The aluminum plant occupies a land plot of 759.3858 hectares. The main part of the territory is built up with industrial buildings, warehouses and auxiliary and service facilities, including roads and railways. The territory of the plant is landscaped and maintained.

Aluminum of Kazakhstan JSC has developed and is implementing an environmental policy, the main goal of which is to prevent environmental pollution. Annual expenditures for environmental protection measures amount to about 350-450 million tenge. Thanks to their implementation, the enterprise has achieved a reduction in atmospheric emissions with an increase in production volumes. In particular, in the period from 2010 to 2014, with an increase in alumina production by 17%, the volume of atmospheric emissions at the enterprise decreased by 7%. The specific weight of emissions into the atmosphere per one ton of alumina was 0.048 tons in 2004 against 0.057 in 2010. The plans include further step-by-step reconstruction of gas cleaning units (electrostatic precipitators for sintering and calcination furnaces, ash collection units for boiler units of CHPPs) to increase the cleaning efficiency and reduce emissions. The company also performs a set of works to reduce the impact on soil and groundwater. In 1998, a second sludge collector card with an anti-seepage curtain "wall in the ground" was put into operation, which protects groundwater from pollution. In 2001, the reconstruction of the ash storage began. To date, more than 4 million tenge have already been invested in the reconstruction. The restructuring is carried out in the framework of the implementation of the obligations of JSC "Aluminum of Kazakhstan" according to the Memorandum on Mutual Understanding and Interaction signed by the Ministry of Environmental Protection and akim of Pavlodar region and users of natural resources. Within the framework of the dust suppression program, an area of 4.5 hectares was planted with bushes and reeds at the ash dump, and an area of 80 hectares was washed with sludge. JSC "Aluminum of Kazakhstan" conducts industrial monitoring of the environment (control over the air condition on the territory of the enterprise and in its sanitary protection zone and over the efficient operation of gas treatment plants, analysis of waste water, analysis of the chemical composition of groundwater from the network of observation wells on the territory of the enterprise and around waste storage, analysis of soil samples around waste storage). Facility No. 2 includes 4 ash and sludge collector and occupies an area of 42,524,356 m² (Figure 4).

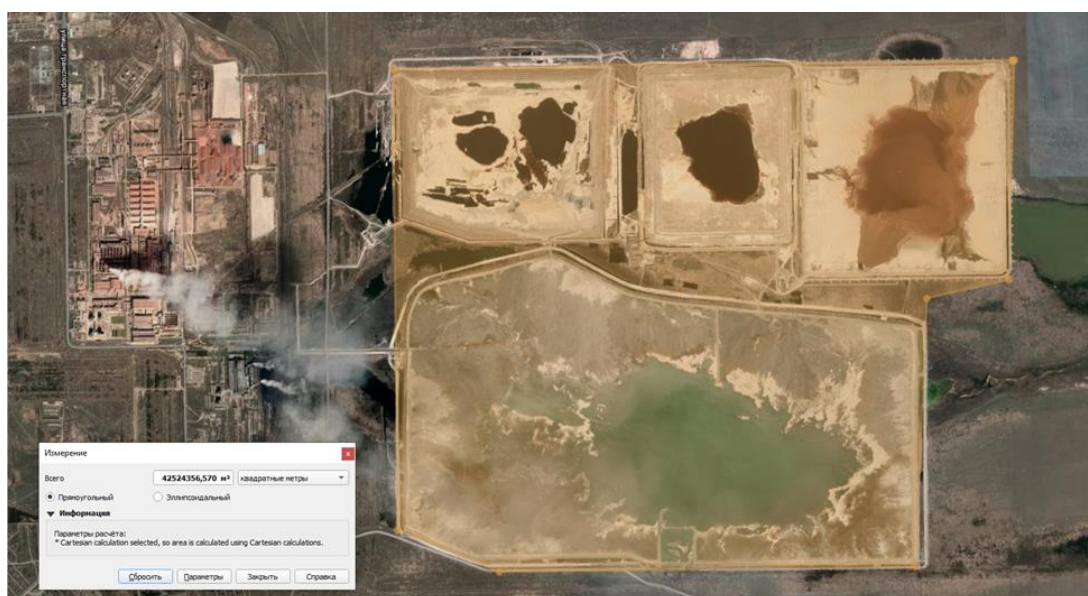


Figure 4. Area of object №2 Ash and sludge collector of Pavlodar aluminum smelter

Conclusion

Two large industrial facilities (Aksu ferroalloy plant, Pavlodar aluminum smelter) and systems that discharging waste have a direct technogenic impact on the environment.

The natural components of the study area are directly affected to the atmosphere air, biota and soil cover, underground and water surfaces, lithological basement, and the relief. Especially significant changes in natural complexes occur as a result of technogenic transformations of the relief, which always leads to the removal or burial of vegetation and soil cover.

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Павлодар облысының техногендік жүйелері

Аңдатпа. Техногенез - бұл адамның әртүрлі техникалық іс-әрекеттерінің әсерінен қоршаған ортаның өзгеру процесі. Техногенез - жер қыртысының бұл өзгеруі минералды шикізатты өндіру және өңдеу, инженерлік-геологиялық жұмыстар кезінде орын алады. Павлодар облысы – Қазақстандағы технологиялық тұрғыдан өзгерген аудандардың бірі. Сондықтан бұл ғылыми мақалада Павлодар аймағындағы антропогендік әсердің негізгі көздері көрсетілген. Негізгі екі техногендік жүйенің сипаттамасы келтірілген. Табиғи орта компоненттерінің негізгі химиялық ластанушылары анықталды және заманауи әдістермен шлам жинағыштардың ауданы есептелінді. Жұмыста экологиялық қауіпті аймақтардың кеңістіктік таралуын анықтау немесе ластанушы заттардың концентрациясының таралуын кеңістіктік көрсету сияқты маңызды мәселелерді шешудің перспективалы әдісі сипатталған.

Мақалада Павлодар облысының негізгі өндірістік нысандарына, шығарындылардың мөлшеріне сипаттама берілген, сонымен қатар зерттелетін аймақтың климаттық факторлары сипатталған.

Түйін сөздер: техногенез, геожүйе, шлам тоғаны, қалдықтар.

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Техногенные системы Павлодарской области

Абстракт. Техногенез – это процесс трансформации окружающей среды под воздействием различных видов технической деятельности человека, преобразование земной коры при добыче и переработке минеральных ресурсов, инженерно-геологической деятельности. Одним из техногенно преобразованных участков является Павлодарская область Казахстана. В данной научной статье приведены основные источники техногенного воздействия в Павлодарской области. Дано описание двух основных техногенных систем. Определены основные химические загрязнители компонентов природной среды и рассчитана площадь шламонакопителей современными методами ГИС-технологий. Описан перспективный метод в решении таких нетривиальных задач, как выявление пространственного распределения зон экологического риска либо пространственного отображения концентрационного распределения загрязнителей. Также приведены описания основных промышленных объектов Павлодарской области, количество выбросов, а также характеристика климатических факторов исследуемой территории.

Ключевые слова: техногенез, геосистема, шламонакопитель, отходы.

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