On the state of the environment and natural environment of the East Kazakhstan region

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Abstract. The article analyzes the state of the environment in the East Kazakhstan region. The authors, having analyzed official sources, showed that as a result of the restoration of production volumes at non-ferrous metallurgy and thermal power enterprises, there is an increase in emissions of hazardous waste by individual enterprises in this industry into the environment. In the atmospheric air of large industrial cities and towns in the region, maximum permissible concentrations of lead, sulfur dioxide, nitrogen oxides, phenol, formaldehyde and other components are observed to be exceeded. The authors emphasize that mining enterprises have a negative impact on the state of water resources and the unsatisfactory technical condition of sewer networks and treatment facilities, which leads to bacterial contamination of water sources, including sources of drinking water supply. The authors also discuss the state of forest resources and wildlife in the region. The conclusion that was done by the authors – there is a real threat of environmental pollution from waste from non-ferrous metallurgy and mining enterprises in the region and at the present moment.

1 Introduction

Issues about the state of the environment in the East Kazakhstan region (EKR) are currently among the most discussed in the Republic of Kazakhstan and require an increased attention [1–3]. For East Kazakhstan region, the state of the environment is undoubtedly the most important [4-5]. The East Kazakhstan region (EKR) within its existing borders occupies an area of 282.3 thousand square kilometers. Of the total area of the land fund, the share of agriculture is 51.4%; industry and transport – 0.8%; populated areas – 10.25%; lands for environmental purposes – 0.5%; forest fund lands – 11.7%; water fund lands – 1.95%; reserve lands – 23.4%.

The population of the East Kazakhstan region is 1660.6 thousand people, including the urban population – 951.6 thousand people and the rural population – 709 thousand people. There are 8 natural and climatic zones on the territory of the region – from alpine, mountain, forest, steppe to desert. The climate of the region is sharply continental.

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The volume of industrial products (works, services) in current prices amounted to 82.6 billion tenge. In the structure of the national economic complex of the region, the share of industry is 62%, agriculture – 4%, transport – 6.9%, construction – 4.5%, service sector – 12.8%, other industries – 9.8%.

There are 21,036 business entities registered in the region, 84.2% of them are working in the private sector of the economy. The share of production volume in the non-state sector is 98.5%.

The region is characterized by a developed river network with the main transboundary artery – the Irtysh River, the surface flow of which accounts for up to 30% of the total flow of the Republic. The eastern region is one of the most water-supplied; water resources are used to generate electricity. 50% of the republic's forest reserves are concentrated in the region.

The structure of the regional economic complex is represented mostly by industry (62%) [6-7]. The basic sector of the economy is the mining industry and non-ferrous metallurgy (Figure 1).

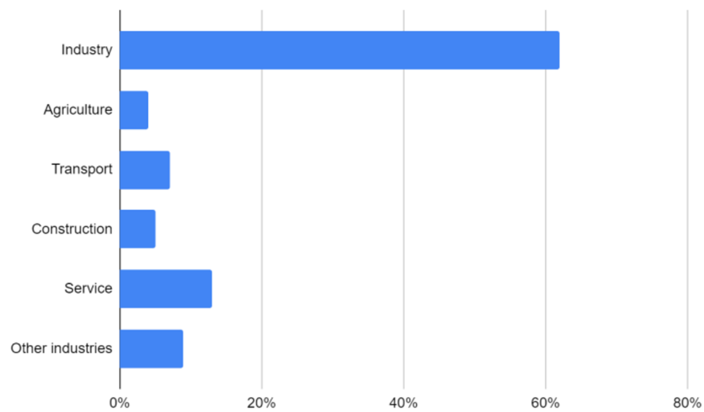

Fig. 1. Economic complex of the East Kazakhstan region.

2 Materials and methods

Interdisciplinary methods were used in this research. The authors used official data from the Ministry of Natural Resources and Environmental Protection of the Republic of Kazakhstan. In the process of working on the article, scientific methods of various scientific disciplines were used: ecology, meteorology and hydroecology.

3 Discussion of the results

3.1 Air basin conditions

As a result of the resumption of production volumes at non-ferrous metallurgy and thermal power enterprises, there is a slight increase in emissions from individual enterprises in this industry within the limits of maximum permitted emissions (MPE) [8].

The most unfavorable city in the Republic according to the air pollution index (API_5) is the city of Leninogorsk, and the city of Ust-Kamenogorsk is in fourth place. There is an excess of maximum permitted concentrations (MPC) for suspended substances, lead, sulfur

 https://doi.org/10.1051/e3sconf/202453901004

dioxide, nitrogen oxides, phenol, formaldehyde and other components in the atmospheric air of industrial cities and towns in the region. Gross emissions of pollutants tended to decrease [9] (Figure 2).

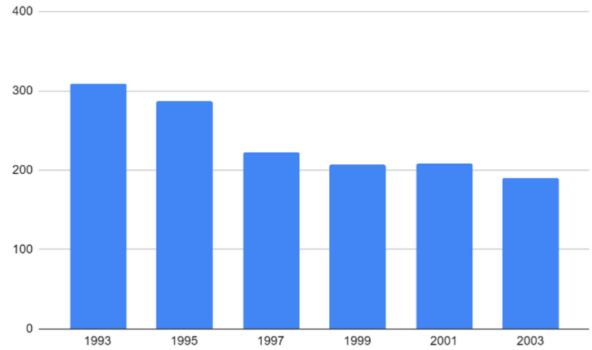

Fig. 2. Dynamics of gross emissions into the atmosphere in the East Kazakhstan region.

Cities in the region influence on the formation of atmospheric air in the region negatively. See table. 1.

Table 1. Change of API_5 by cities of East Kazakhstan region.

Cities	1993 year	1994 year	1995 year	1997 year
Ust-Kamenogorsk	13	9	8.6	13
Leninogorsk	20.1	26.8	16.4	22
Semipalatinsk	4.6	4.9	4.8	4.9
Zyryanovsk	9.8	7.8	5.1	11

The table shows that the atmosphere of such cities as Leninogorsk, Ust-Kamenogorsk, Zyryanovsk is more susceptible to pollution. The contribution of urban industrial enterprises to total air pollution is presented in Figure 3.

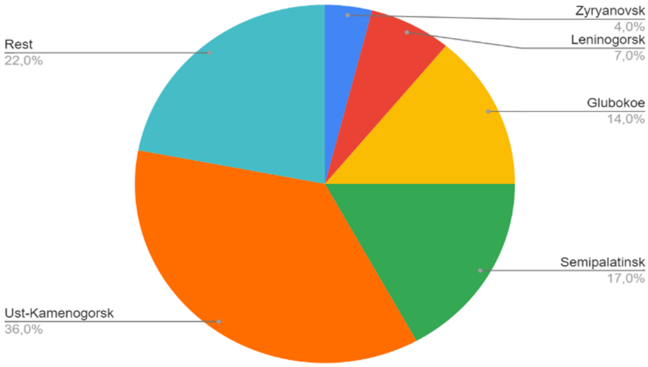

Fig. 3. Contribution of cities to air pollution in East Kazakhstan region.

In the city of Ust-Kamenogorsk the main contribution to air pollution comes from the metallurgical complex of OJSC “Kazzinc” (Figure 4).

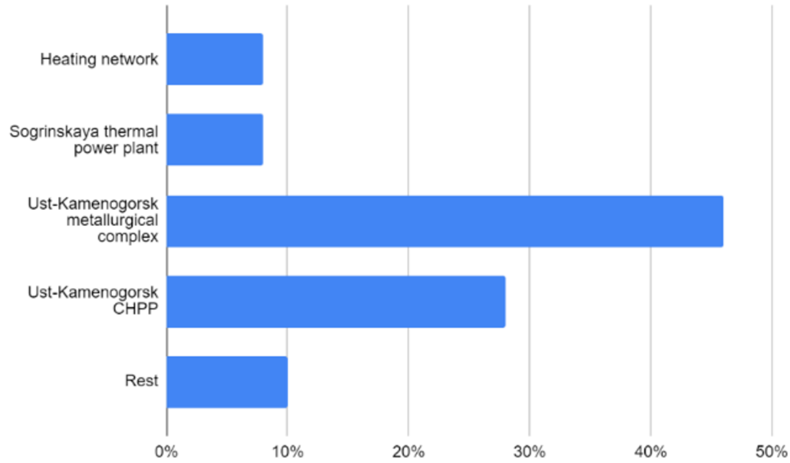

Fig. 4. Contribution of major enterprises to air pollution in the city of Ust-Kamenogorsk.

According to the observations of the Center for Hydrometeorology for the I–III quarter of 2005, there was an excess of MPC by 1.5–4.5 times for suspended substances, sulfur dioxide, nitrogen oxides, phenol in the cities of Ust-Kamenogorsk and Leninogorsk. In 2006, the Center for Hydrometeorology did not determine the content of toxic components in the air of cities: arsenic, lead, selenium, cadmium and others, while 90 tons of lead and 3.7 tons of arsenic were released into the atmosphere of Ust-Kamenogorsk by OJSC "Kazzinc", into the atmosphere of the village of Glubokoe – 33.9 tons of lead and 7 tons of arsenic respectively.

An analysis of the implementation of air protection measures by non-ferrous metallurgy and heat power enterprises for 2001 in the city of Ust-Kamenogorsk showed that with a planned cost of 31 million tenge, measures worth 18 million tenge were actually completed, which made it possible to reduce emissions from these enterprises by only 102 tons from the planned 240 tons

3.2 State of water resources

Water use in the East Kazakhstan region is presented in Figure 5.

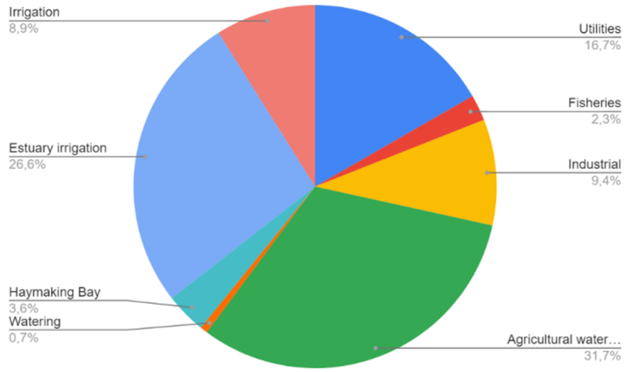

Fig. 5. Use of water resources in the East Kazakhstan region in 2000 (million cubic meters).

The rivers in the zone of influence of other mining enterprises in the region remain polluted: r. Breksa (influence of mine and drainage waters of the Shubinsky mine, Talovsky tailings dump, Ridder-Sokolnoy mines), r. Ulba (drainage waters of the rock dump of the Tishinsky mine of the Leninogorsk Mining and Processing Plant), r. Glubochanka (in the zone of influence of the Beloussovsky mine), r. Bukhtarma (Maleevsky mine), r. Uba (Chekmar mine, Nikolaevsky quarry, Snegirikhinsky mine, etc.) [10]. The average concentrations of pollutants in these reservoirs under the influence of mining and non-ferrous metallurgy enterprises were: copper from 1 to 43 MPC, zinc from 4 to 40 MPC, phenols from 2 to 7 MPC.

The sources of pollution in the Irtysh basin remain insufficiently treated wastewater from the cities of Semipalatinsk (14.5 million m^3/year) and Ust-Kamenogorsk (61.9 million m^3/year) due to the insufficient capacity of treatment facilities. Sewage networks and treatment facilities in towns and cities in the region are in unsatisfactory technical condition, which leads to bacterial contamination of water sources, including sources of drinking water supply. The technical condition of the sewer siphon across the river Irtysh in Semipalatinsk is critical, which creates a threat of a siphon break and the discharge of untreated domestic wastewater into the river Irtysh.

The main sources of domestic water supply to the population of the region are underground waters of aquifers of alluvial sediments of river valleys, and therefore, the protection of bacterial and chemical pollution of surface waters can ensure the required quality of drinking water intakes and prevent the impact of poor-quality water on public health. Sources of groundwater pollution in the city of Ust-Kamenogorsk are industrial sewerage networks draining industrial waste storage tanks of thermal power and metallurgy enterprises: “AES Altai-Power”, Ust-Kamenogorsk Metallurgical Complex, Ulba Metallurgical Plant, JSC “Titanium-Magnesium Plant” [11].

Near the mountains in Semipalatinsk, large foci of groundwater contamination with jet kerosene have been identified, which are located near the river Irtysh. The source of contamination is the airport, which was previously used to service the Semipalatinsk nuclear test site.

The deterioration of the state of water resources in the East Kazakhstan region is associated with the restructuring of the economy, a change in forms of ownership at mining enterprises, when the environmental obligations of the new owners are not regulated, economic audits are not carried out during liquidation, bankruptcy, and there is no clear mechanism for implementing the requirements of Articles 52 and 53 of the Law of the Republic of Kazakhstan “On Environmental Protection”, the sources and methods of financing environmental protection measures during liquidation and bankruptcy are not defined.

3.3 State of land resources

The peculiarities of the climatic and natural conditions of the Eastern Kazakhstan region, as well as the high technogenic load, determine the high potential susceptibility of soil to destruction and pollution [12] (Figure 6).

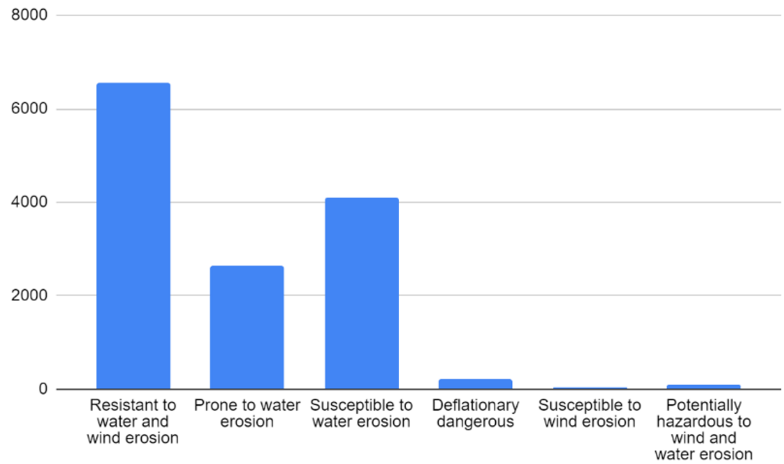

Fig. 6. Erosion state of soils (thousand ha).

Losses of humus as a result of erosion on average in the region reach 1% per year and have amounted to 20–25% over the past 20 years; soil fertility is declining. An analysis of the practice of reforming land relations and land management in the agricultural sector shows that in the management and economic decisions, the responsibilities of new land owners to preserve fertility and prevent soil degradation, are not taken into account.

In the balance of agricultural land use for 2005, there was a transfer of arable land without grass to the category of fallow land.

Uncultivated arable lands become sources of weeds, reserves of harmful insects and diseases that spread to agricultural crops, which subsequently requires the use of pesticides [13].

3.4 Industrial waste

Every year, about 30 million tons of waste are added to the region without recycling process of secondary raw materials [14]. As a result of the activities of the mining and metallurgical industries in the region, an area of 976.5 hectares was accumulated with 1329.9 million tons of toxic industrial waste at the beginning of the 2000s.

Most of the toxic waste is disposed of in landfills that do not meet sanitary and environmental requirements. These include ash dumps with expired service life of the Ust-Kamenogorsk and Sogrinskaya TPP of the “AES Altai-Power” system, tailings dumps and dumps of rocks and industrial waste of enterprises of OJSC “Kazzinc” system (Leninogorsk mining and processing complex, Zyryanovsky MPP, JSC “Ust-Kamenogorsk metallurgical complex”).

At the beginning of the 2000s the region has accumulated 16 million tons of municipal solid waste (MSW) (Table 2).

Table 2. Soil pollution from solid waste dumps.

Names of cities, towns	Year of opening of the landfill	Distance from populated areas, km	Volume of garbage in 1999 (thousand tons)	Garbage accumulation in 2000 (million tons)
Ust-Kamenogorsk	1957	1.5	126.0	6.0
Shemonaikha	1976	1.5	27.0	0.54
Bolshenarymskoe	1995	1.0	3.5	0.07
Zyryanovsk	1953	3	12.0	0.5
Samarskoe	1993	1	3.6	0.01
Glubokoe	1986	10	3.0	0.03
Serebryansk	1975	3	6.0	0.15
Tavricheskoe	No data available	No data available	2.25	No data available
Zaysan	1980	3	2.7	0.05
Katon-Karagai	No data available	No data available	0.6	No data available
Akzhar	1992	2.5	4.0	0.02
Lininigorsk	1963	2.0	10.0	0.3

There was no system for recycling household waste in the region. In order to prevent the spread of outbreaks of plant diseases and harmful insects (locusts and others), monitoring of land use and timely adoption of measures was carried out at the regional level.

3.5 The situation in East Kazakhstan region with waste containing radioactive substances

In the East Kazakhstan region there are about 100 enterprises and organizations working with radioactive substances, using more than 10,000 sources of ionizing radiation. More than 2,000 of them are a subject to write-off and burial [15].

At the enterprises of the former Semipalatinsk region, 16,772 tons of radioactive waste with a total activity of 15.89 curies are located in the form of mine dumps. At the enterprises of East Kazakhstan region more than 6.6 million tons of radioactive waste with a total activity of 21 thousand curies are located in the form of mine dumps in: Zhanasemeysky, Zaysansky, Zyryanovsky, Tarbagataysky, Ulansky, Shemonaikha districts, Zyryanovsk, Ust-Kamenogorsk, Leninogorsk, “Ulba Metallurgical Plant” and the mothballed storage facility of NGO “Luch” in Semipalatinsk.

Radiohydrolithochemical work confirmed the high degree of contamination of the northern part of the East Kazakhstan region with lead. Lead anomalies in bottom sediments cover the territory of the Shemonaikha, Glubokovsky and Zyryanovsky districts. The total area of the territory with a lead content of more than 1 MPC (20 mg/kg) reaches 30 thousand square meters. m. Maximum contents tend to industrial centers (Leninogorsk, Ust-Kamenogorsk, Zyryanovsk, Glubokoe, Belousovka).

Fluctuations in the gamma background in the region are insignificant and do not exceed the average background level – 14–17 microroentgens/hour. At the same time, there are pockets of radioactive contamination in the region.

3.6 State of biological resources

The territory of the state forest fund has an area of 3.37 million hectares. The increase in area by 4.2 thousand hectares occurred due to the inclusion of shelterbelt forest belts, previously owned by Agroprom, on the balance sheet. The forests of the region, mainly mountainous, perform important soil-protective, water-regulating, climate-forming functions and belong to forests of I and II groups [16].

Fires are a huge environmental problem. In total for the period of the early 2000s fires covered 183.6 thousand hectares of territory, including 121.2 thousand hectares covered with forest. Reforestation work was carried out on an area of 2.9 thousand hectares, including tree planting – 2.5 thousand hectares.

At the current rate of reforestation work, it will take 40 years to restore forest lands damaged by fire. At the same time, the loss of coniferous forests, which have a regulating effect on the gas composition of the atmosphere, leads to aggravation of the problems of the “greenhouse” effect, and therefore the primary task of forest protection organizations is to prevent forest fires and increase the pace of reforestation work.

At the beginning of the 2000s the stock of fishery reservoirs controlled by the Zaisanirtishrybokhrana management is presented in a diagram (Figure 7).

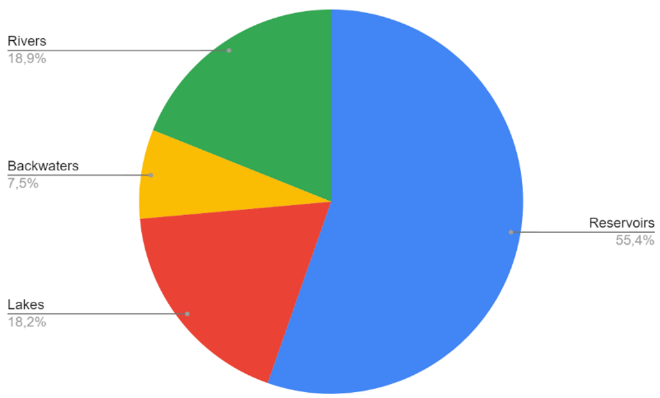

Fig. 7. East Kazakhstan Fisheries Reservoirs Fund.

At the beginning of the 2000s. The catch of fish from fishery reservoirs developed by the fishery amounted to 5783 tons, of which 97.2% of the catch falls on the Bukhtarma Reservoir [17].

The reproduction of fish stocks at the Bukhtarma Reservoir is carried out by the spawning and rearing farm. In 2003, 44 million carp larvae were obtained and 5 million fingerlings were released into the reservoir. There are no data on fish catching and reproduction of the most valuable fish species, including whitefish.

Significant damage to fish stocks is caused by hydraulic structures that impede fish migration routes and excessive water discharges through hydroelectric power plant turbines. In connection with the critical situation in the Turanga Bay of the Bukhtarma Reservoir, associated with its disconnection from the main reservoir as a result of a decrease in the reservoir level, work was carried out to prevent fish kills.

The strategy for the conservation and rational use of ichthyofauna in the region's water bodies requires taking the necessary measures to increase the capacity of small rivers (cleaning river beds, creating protective strips along rivers), preventing pollution of water bodies (discharge of untreated wastewater, compliance with water protection strips), expanding the network of fish farms that provide increasing the productivity of reservoirs, improving the protection of fish stocks from poaching.

The fauna of East Kazakhstan region is unique and diverse. The region is rich in game animals, both in species and in quantity. In the Republic, 12 species of ungulates are classified as commercial, of which 7 species of wild ungulates (elk, roe deer, deer, mountain goat, etc.) live in Eastern Kazakhstan. 49 species of birds, the most popular in sport and amateur hunting, nest here. However, in the region there are insufficient biotechnical measures for the rational use of hunting resources and their protection. For example, for these reasons alone, the number of moose in Eastern Kazakhstan decreased from 3.5 thousand individuals in the late 1990s to 1.0 thousand individuals in 2003. Thus, only the implementation of basic biotechnical and conservation measures will allow them to be restored, and for certain species of ungulates to increase them number in the region [17].

In the region there are two state reserves – Markakolsky and Western Altaisky, two zoological reserves - Kuludzhunsky and Tarbagataisky. The maintenance of the reserve fund remains low due to unsatisfactory funding. According to the census of the main species of animals, the number of most animals and birds is at the lower limit of the level that is optimal for the conditions of the habitat. It is required to complete the formation of a scheme for the development and placement of the region's natural reserve fund, including the organization of the Katon-Karagai Natural Park, as well as the further development of a network of protected natural areas.

4 Conclusion

In conclusion, the authors came to the conclusion that the unfavorable environmental situation in the region is associated with the activities of mining and non-ferrous metallurgy enterprises, the legacy of the Semipalatinsk nuclear test site and has a significant impact on the health of the population. The region has the highest incidence rate of neoplasms in Kazakhstan, and the downward trend in natural population growth continues. An important problem remains the issue of preserving the ecosystem of the river Irtysh, which has a system-forming effect on the surrounding areas. The authors emphasize that the region and at present moment has a real threat of environmental pollution from waste from non-ferrous metallurgy and mining enterprises.

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