On the issue of ensuring environmental safety of anthropogenic systems in cross-border areas of the Novosibirsk Region

E Malgin, E Shemetova and I Bochkarev

1 Siberian University of Consumer Cooperation, 26 Karla Markska prosp., 630087 Russia

E-mail: malgin1954@mail.ru

Abstract. This article explores the concept of a cross-border region and analyzes sources contributing to environmental pollution. More than that, the authors focus on the features of monitoring and ensuring environmental safety of the cross-border region of Novosibirsk (Russian Federation) and Pavlodar Regions (Republic of Kazakhstan). As a result, measures and algorithms to optimize their sustainable development are suggested.

1. Introduction

The relevance of our study is determined by the practical importance of the topic related to the role played by cross-border (formed by interactions of administrative-territorial and municipal entities and their subjects) regions in the processes of cooperation and security. Globalization, on the one hand, and national identity, on the other, create contradictions that are clearly manifested in the implementation of the concept of sustainable development and environmental security in cross-border regions.

With respect to their operation, the border areas are divided into geopolitical “buffers,” border “clamp regions,” frontier regions, and “cross-border regions.” At the present stage of research, the concept of “cross-border region” is commonly used. The concept of a “cross-border region” implies mutual border crossing and various forms of cooperation [3, 4, 5, 8, 13, 17]. V. A. Kolosov introduced this concept into scientific circulation [6, 7]. According to V. S. Korneevets, this is a “specific form of organization of society” [8, 9].

Of course, there is a problem of categorical design of the concept depending on research aspects [3, 10]. O. E. Brednikova argues that contemporary space oversteps and ignores borders, but it is formed due to the existence of the border itself [2, p. 492-497]. P. Ya. Baklanov and M. Yu. Shinkovsky believe that a cross-border strip defines a part of the territory linking different sectors of a region, and a contact zone indicates areas where interaction is most successful. These parts are necessary to understand certain characteristics of the formation of a cross-border region. [1, p. 16]. According to the definition of T. N. Kuchinskaya, “A transboundary region is a potential region: it is divided by the sovereignty of neighboring states, it has a complex of national, regional, and zonal elements with their own characteristics, it reflects their historical and cultural identity, interacts between adjacent border regions to preserve the management and development of their “living space,” it is formatted by the state administrative-territorial border” [10]. According to A. N. Demyanenko, terminological
vagueness (and even entanglement) has a very definite character, an extremely complex object of study [5].

How to combine the concept of sustainable development and ecologization of a cross-border region? For the first time, the term sustainable development was used (1987) in the report “Our Common Future” by the UN World Commission on Environment and Development as a development model based on the need to balance the solution of social, economic problems in favor of the environment. How to ensure this balance, environmental safety in specific cross-border regions, taking into account different legal and organizational conditions of border areas management? Is sustainable development relevant in general to cross-border regions? In contemporary publications on cross-border interaction, according to V. S. Molotov and other researchers, assessing the response of cross-border geosystems to different types and intensity of economic impact did not receive sufficient coverage [11].

2. Materials and Methods

Our research methods include (1) analysis of publications on this issue (conducting a literature review); (2) identifying sources of chemical pollution of ecosystems in the Pavlodar region (Kazakhstan); (3) statistical reporting: environmental conditions, an integrated assessment of the state of air, water, and soil according to the results of chemical monitoring.

The studied transboundary Novosibirsk-Pavlodar region borders with the Omsk region in the north, with the Novosibirsk region in the northeast, and with the Altai region in the southeast. It is the largest industrial region of Kazakhstan. 7.3% of the country’s total industrial production is concentrated in the region. “Kazdata marketing technologies” informs about 18 large enterprises in Pavlodar and its surrounding region [16].

The concept of border cooperation of the Novosibirsk and Pavlodar regions until 2025 provides an analysis of the area and unresolved problems associated with a low level of investment cooperation, common interests in environmental protection, veterinary and sanitary well-being, mutual information on the transfer of hazardous waste by land, air and water flows, with the implementation of environmental monitoring, prevention and assistance in eliminating natural and man-made emergencies [12].

The portal “Energy.Media” and the information bulletin of RSE “Kazhydromet” On the State of the Environment of Pavlodar Region for the Period 2014-2018 [15] noted a high level of air pollution in sulfur dioxide (2.4%) and nitrogen dioxide (14.6%); an increased level of suspended particles of PM-10, carbon monoxide, nitrogen dioxide, nitrogen oxide, ozone, hydrogen sulfide, phenol, hydrogen chloride; and a low level of nitrogen oxide and ozone. In the region, the volume of industrial emissions into the atmosphere has grown by 46% over the past 10 years. The reason behind such an increase is the growing electricity generation (by 40-60%) and a simultaneous increase in emissions to 58.2 tons only at the following enterprises: CHP-1, Aluminum Kazakhstan JSC, Ekibastuz SDES-1 (state district electric station). The “Kazgidromet” has only 7 environmental posts in the region, which are designed to measure only 9 components. Since 2017, air monitoring has been carried out on 15 pollutants (suspended particles PM-10, suspended particles PM-2.5, sulfur dioxide, sulfates, carbon monoxide, nitrogen dioxide, hydrogen sulfide, ozone, phenol, chlorine, hydrogen chloride, the sum of hydrocarbons, ammonia, methane). At the same time, large industrial enterprises emit more than 130 harmful substances. How does this affect the Novosibirsk region? Let’s review the repeatability of various wind directions (Table 1).
Table 1. Repeatability of various wind directions, %.

| Directions  | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Year |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| North       | 3   | 5   | 8   | 11  | 12  | 17  | 21  | 18  | 11  | 7   | 5   | 3   | 10  |
| Northeast   | 4   | 6   | 8   | 11  | 8   | 13  | 12  | 11  | 7   | 5   | 5   | 2   | 8   |
| East        | 8   | 8   | 8   | 10  | 10  | 10  | 10  | 10  | 9   | 7   | 7   | 6   | 8   |
| Southeast   | 13  | 11  | 10  | 9   | 7   | 5   | 5   | 5   | 7   | 10  | 11  | 11  | 8   |
| South       | 27  | 25  | 19  | 12  | 15  | 14  | 12  | 13  | 17  | 20  | 21  | 28  | 19  |
| Southwest   | 22  | 21  | 15  | 13  | 13  | 13  | 13  | 8   | 13  | 20  | 21  | 22  | 16  |
| West        | 19  | 20  | 25  | 21  | 20  | 15  | 13  | 17  | 21  | 22  | 23  | 22  | 20  |
| Northwest   | 4   | 4   | 7   | 13  | 15  | 16  | 16  | 18  | 15  | 9   | 7   | 6   | 11  |
| Calm        | 5   | 4   | 3   | 2   | 4   | 5   | 6   | 6   | 5   | 4   | 3   | 3   | 4   |

Figure 1. An average rate of wind direction for the year [16].

The contact area of the Bagansky, Karasuk, Kupinsky, Chistoozerny districts of the Novosibirsk and Pavlodar regions is 200-250 km, and the distance from the enterprises to the border of the Novosibirsk region is 150 km. An average indicator of wind direction for the year is 36% to the north and east, and these are the areas of the Omsk and Novosibirsk regions, which means that the likelihood of pollution remains. In 2018, the FGUZ Center for Hygiene and Epidemiology in the Novosibirsk Region measured a content of zinc in the soil of the Chistoozerny District, in which pollution can be characterized as dangerous [14]. On October 25, 2018, the Government of Kazakhstan made a decision on installing automated stations of atmospheric air, 14 complexes of high-precision measuring instruments of operational response, determining the content of hydrogen sulfide, mercury, radiation in the Pavlodar region. They are to be located at a distance of 3 meters from the source, where the air flow is uniform and there is no inversion. In 2015, 8 enterprises were subject to environmental analysis, but their number increased to 19 in 2019 [15].

3. Research Results
Annualy, the following is emitted into the atmosphere in Kazakhstan:

1. 4.5 million tons of harmful substances;
2. 25% of this amount falls in the Pavlodar region;
3. 98% is formed on the territory of three cities – Pavlodar, Ekibastuz and Aksu (Kazakhstan), the main sources are the ferroalloy plant, “Ksp Steel,” and “Aluminum of Kazakhstan”;
4. The problem of air and water pollution remains relevant: violations in operation of ash dumps are made by the Eurasian Energy Corporation (EEC);
5. Water samples in the Irtysh River observe an excess of the maximum allowable concentrations of copper, zinc, manganese, and petroleum products from 1.5 to 2.5 times; the flow of the Irtysh river has decreased three times in the last 30 years; the river grows shallow; floodplain meadows suffer;

6. Eco-bioprotection technology is not actively implemented, installation of automatic monitoring systems at enterprises is at the decision stage;

7. More than 30% of the air masses per year is directed to the territory of the border regions of the Novosibirsk Region, in which an automatic system for a comprehensive assessment of the environmental situation has not yet been created. At the same time, the Pavlodar region is the only one in the republic that is exploring the target indicators of environmental quality (the second stage in 2020, and the third stage in 2023) [18].

Modernization of the wastewater treatment systems of enterprises includes installation of electrostatic precipitators of the new generation (ZUU) and boilers at power units; eco-bioprotection technology (scrubbers, emulsifiers, gas ducts). Modernization of sewage treatment plants of enterprises will give flue gas cleaning efficiency up to 99.38%. So, to ensure environmental safety of anthropogenic systems in the cross-border region of the Novosibirsk Region, we need to apply the dual purpose of V. S. Molotov: (1) Ensuring the quality of environmental conditions; (2) creating an economy with ecological industries. They can be implemented through “optimization of environmental management,” on the one hand, or “optimization of anthropogenic impacts on the environment”, on the other [11]. The first one does the following: (1) improving an environmental management system; rationalizing a territorial distribution of economic activity (b) developing a “basin” approach. The second implies: (1) technological modernization of production; (2) environmental safety engineering; (3) environmental regulation and control.

4. Discussion
On October 25, 2018 in the Government of Kazakhstan, the hearings were held with the presence of the public and experts on environmental issues existing in the Pavlodar region, which ranked first in the country in terms of harmful emissions. According to the revealed facts of exceeding the threshold limit value (TLV) at the borders of sanitary zones at the “Maikuben-West” LLP, “EEC” JSC, and “Kazchrome” JSC, large fines were imposed on them. According to the results of these hearings, the decision was made on the installation of automated stations that would determine the content of hydrogen sulfide, mercury in ambient air, and radiological contamination at the enterprises of the region [18]. According to the results of our study, the West Siberian Administration for Hydrometeorology and Environmental Monitoring intends to improve monitoring over the cross-border environment, focusing on the Bagansky, Karasuk, Kupinsky, Chistoozerny districts of Novosibirsk and Pavlodar regions.

5. Conclusion
The problem of ensuring environmental safety of anthropogenic systems in cross-border areas remains unresolved. The basis for its implementation is to address those causes affecting the environment in the Novosibirsk-Pavlodar transboundary region, including the following: (1) a weak interregional environmental regulatory framework; (2) lacking financial resources; (3) irrational ecology of production, etc. The following tools should be applied: (1) improving the interregional environmental legislation; (2) geographical justification used in anthropogenic loads regulation; (3) a cartographic analysis of environmental management; (4) developing and applying a cross-border system of environmental quality indicators, a forecast scheme and environmental risk reduction measures; (5) providing a comprehensive automated control of environmental impact.

Thus, the activities to ensure environmental safety of cross-border territories are the implementation of means and methods of interstate regulation regarding the negative impact of economic activities on the environment, requiring a coordinated environmental policy of
environmental management of cross-border territories and development of institutional mechanisms for cross-border cooperation.

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