Environmental assessment of the Akmola region territories relative to the exposure to diseases of the population by the sigmal deviation method

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Abstract. This paper presents the statistical indicators of the population's sickness in various districts of Akmola region. The object of the work is to conduct an environmental assessment of Akmola region’s districts on the relative risk of morbidity. The following morbidity indicators were studied: blood, blood-forming organs and individual disorders involving the immune mechanism; respiratory organs; oncopathology; digestive organs and general morbidity. The sigmal deviation method was used to find out environmental assessment and ranking of territories. The conclusion is made about the importance of risk assessment for environmentally related diseases for ranking territories, identifying crisis zones and ensuring the well-being of the population. It was revealed that the territory of Akmola region has an uneven anthropogenic impact. It is shown that in areas with a high level of atmospheric pollution and adverse water supply conditions, the medical and environmental situation is extreme or critical. The necessity of constant monitoring of the incidence rate for environmentally caused diseases and the adoption of environmental measures in the identified crisis areas is substantiated. The methods for assessing the risks of morbidity considered in the article can be used to improve the activities of the executive branch of Kazakhstan.

1. Introduction
The transition of the Republic of Kazakhstan to sustainable development is an urgent need because the country needs development that meets the requirements of the present generation and does not constrain the ability of future generations to meet their needs. Economic growth due to the exploitation of natural resources can occur only at a certain stage. In modern conditions, more progressive mechanisms are required for growth and development [1 - 2].

In all Kazakhstan settlements, especially in large cities, the problem of collection, storage and processing of increasing volumes of municipal waste is acute. The main method of waste management today is the placement of waste in landfills. At the same time, the operation of most landfills and municipal waste dumps in Kazakhstan does not meet regulatory requirements. About 90 % of the existing landfills in the country do not meet the requirements of environmental and sanitary legislation...
[3 - 4]. Only a part of settlements of the Republic is covered by services of the specialized enterprises on collecting and export of waste, and others are left without service.

2. Materials and methods
The starting materials to study the health indicators were the reporting documents of the Department of Health of Akmola region for ten years. The medical and environmental situation in various territories of Akmola region was evaluated by the method of signal deviations based on methodological recommendations for a comprehensive hygienic assessment of the degree of tension in different territories [5].

The data was subjected to statistical processing using the Excel software package. Districts and cities of Akmola region have different anthropogenic impact. The basic sources of air pollution are located in the cities of Kokshetau and Stepnogorsk. There are very high levels of air pollution on their territory [6]. A 10-year massive analysis of annual data of statistical reports on the diseases extent according to primary circulation, taking into account the influence of local living conditions were studied by determining the relative risk (the ratio of the frequency of diseases in the study area to the frequency of the same diseases in the background (or control) territory). The indicators of health disorders in the region having the lowest indicators of health disorders were in the quality of background indicators.

The medical and environmental situation was assessed according to one of 5 categories: 1 - satisfactory environmental situation (SES 1 -1.5); 2 - relatively tense environmental situation (RTES 1.5 -2); 3 - significantly tense environmental situation (STES 2.1 - 2.5); 4 - critical or emergency environmental situation (CEES 2.6-3.5); 5 - catastrophic or environmental disaster situation (CEDS more than 3.5) [7-8].

3. Findings
Assessing the state of the territories according to changes in the incidence of blood, blood-forming organs and individual disorders involving the immune mechanism, we revealed: in five districts of the region, the ecological state is satisfactory; relatively tense situation in four areas. A significantly tense environmental situation was observed in 5 districts. In the city of Kokshetau and 4 districts (Korgalzhinsky, Sandyktau, Tselinogradsky and Burabaysky) the ecological situation is extreme or critical (Table 1) [9].

The medical and environmental situation regarding respiratory diseases is satisfactory only in two districts of the region; the situation is relatively strengthening in Korgaldzhinsky district. A critical situation has developed in eight districts of the region, and in many districts of the region, the situation is at the level of environmental disaster.

There are three districts at a satisfactory level in the oncology. Relatively tense situation in seven districts of the region, significantly tense situation in other 6 districts of the region. A critical environmental situation has developed in the Tselinograd region, and in the cities of Stepnogorsk and Kokshetau.

The morbidity of the digestive organs, satisfactory revealed the situation in the Sandyktausky district, in Tselinograd - relatively tense. The situation in the Bulandinsky and Enbekshildersky districts are substantially tense, and in 11 districts and 2 cities of the region, the situation is critical. The situation in the Akkol and Yereimentau districts is catastrophic for this type of incidence.

An analysis of the overall incidence in three districts of the region revealed a satisfactory situation, in nine regions it was relatively tense. In three districts, it is significantly tense, in four districts it is critical and catastrophic in the city of Kokshetau, where the highest level of general incidence was revealed.

A general analysis of the medical and ecological situation in the territories of Akmola region using the signal deviation method showed that the most disadvantaged areas are Arshali, Atbasarsky, Egindykolsky, Burabaysky districts, Stepnogorsk and Kokshetau (Table 2). They are characterized by
a high level of air pollution, inadequate provision of cultural and children's institutions, and adverse water supply and treatment conditions.

**Table 1.** The state of the territories according to changes in the incidence rates for individual classes by the sigmal deviation method

| Name of cities and areas | Territory status according to changes in the incidence rate for individual classes |
|--------------------------|---------------------------------------------------------------------------------|
|                          | Blood diseases | Disease of respiratory system | Oncology | Disease of digestive system | Overall incidence |
| Akkolsky                 | SES            | CEES                        | STES      | CEES                        | RTES              |
| Arshalinsky              | STES           | CEDS                        | RTES      | CEDS                        | RTES              |
| Astrakhan                | STES           | CEES                        | RTES      | CEDS                        | RTES              |
| Atbasar                  | SES            | CEDS                        | STES      | CEDS                        | RTES              |
| Bulandinsky              | SES            | CEES                        | STES      | STES                        | SES               |
| Eginidykolsky            | RTES           | CEDS                        | STES      | CEDS                        | RTES              |
| Enbekshildersky          | SES            | CEES                        | RTES      | STES                        | RTES              |
| Yereimentau              | RTES           | SES                         | RTES      | CEDS                        | RTES              |
| Esilsky                  | STES           | CEDS                        | SES       | CEDS                        | RTES              |
| Zhalaksynsky             | STES           | CEDS                        | STES      | CEDS                        | RTES              |
| Zherkainsky              | SES            | CEES                        | RTES      | CEDS                        | RTES              |
| Zerendinsky              | RTES           | CEDS                        | RTES      | CEDS                        | RTES              |
| Korgalzhyn               | CEES           | RTES                        | STES      | CEDS                        | SES               |
| Sadyktau                 | CEES           | SES                         | SES       | SES                         | SES               |
| Tselinogradsky           | CEES           | CEDS                        | CEES      | RTES                        | RTES              |
| Shortandinsky            | STES           | CEDS                        | SES       | CEDS                        | RTES              |
| Burabay                  | CEES           | CEDS                        | RTES      | CEDS                        | CEES              |
| Stepnogorsk              | RTES           | CEDS                        | CEES      | CEDS                        | STES              |
| Kokshetau                | CEES           | CEDS                        | CEES      | CEDS                        | CEES              |

The Akkol, Astrakhan, Enbekshilders, Zhalaksynsky, Zherkainsky, Tselinogradsky districts have significant shortcomings in these sections. The most prosperous regions according to the total assessment are Sandyktau, Yereimentau, Korgalzhyn, Bulandinsky, Esilsky, Zerendinsky and Shortandinsky districts.

**Table 2.** Ecological situation in the territories of Akmola region with respect to the relative risk of morbidity by the method of sigmal deviations

| Ecological situation of the territory | Territory |
|-------------------------------------|-----------|
| satisfactory                        | Sandyktau |
| relatively tense                    | Yereimentau, Korgalzhyn |
| substantially tense                 | Bulandinsky, Esilsky, Zerendinsky, Shortandinsky |
| critical or emergency               | Akkolsky, Astrakhan, Enbekshildersky, Zhalaksynsky, Zherkainsky, Tselinogradsky (water) |
| catastrophic or environmental       | Arshalinsky, Atbasarsky, Eginidykolsky |
| disaster situation                  | Stepnogorsk, Kokshetau |

**4. Conclusion**

The work by the example of Akmola region over a ten-year period allowed us to assess the environmental risks associated with environmental pollution and analyze the incidence rates in the regions. The integrated environmental assessment used by the sigmal deviation method allowed ranking the territory of Akmola region and identifying crisis zones requiring constant monitoring and
additional environmental decisions that would reduce the risk of population morbidity. High incidence rates for diseases caused by environmental risks (respiratory diseases, oncopathologies, etc.) prove the increased influence of environmental factors on the health of the population in Akmola region. This circumstance indicates the need for a more detailed study of the ecological state of the environment in the region.

In Akmola region, the number of existing air condition monitoring is insufficient for an objective assessment of the quality of atmospheric air. Poor technical and instrumentation of the posts does not permit monitoring of all hazardous pollutants present in the air basin. An increase in the number of observation posts in the region is required; it is necessary to re-equip existing posts in order to more effectively assess the quality of atmospheric air.

For more effective risk management, it is necessary to implement a centralized information program for processing and analyzing a large amount of data on the state of the environment and public health and identifying cause-effect relationships in the "environment - public health" system for risk analysis.

Environmental pollution as a risk factor for health is an extremely urgent problem. The application of the assessment principles and risk management allow more efficient use of financial resources for environmental improvement, ensuring the sanitary-epidemiological and environmental well-being of the population. At the same time, it is important to consider the occurring negative changes in the habitat using new methods and assessment technologies. Health risk assessment is an internationally recognized scientific tool for developing optimal solutions for managing environmental quality and public health.

5. Acknowledgments

The article was prepared in the framework of the project: "Enhancing competences of sustainable waste management in Russian and Kazakh HEIs / EduEnvi" with the financial support of the program "Erasmus+".

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*Monthly informational and analytical magazine*