Formation of Depressive Areas in the Area of Quarries and Mines on the Example of the City of Bakal

Valentina Kurochkina(✉)

Moscow State University of Civil Engineering, 26 Yaroslavskoye Shosse, 129337 Moscow, Russia
kurochkina@mgsu.ru

Abstract. The paper deals with the problem of Russian cities that have the properties of depressive areas. Depressive areas are spaces in which there is a long-term decline in environmental quality indicators. In this paper, the attention is drawn to this environmental issue. The reasons giving rise to such depressed territories can be very diverse. Gradually, unclaimed abandoned buildings appear in depressed areas, which, at the same time, may have historical value, and there is also a long-term decline in environmental quality indicators. Today many monotowns possess such properties of depression, especially those specializing in the extraction of some type of exhaustible natural resources. These cities also include the city of Bakal, to which this paper is devoted. Depressed areas have a negative impact on the environment. High level of unemployment and low level of economic development have an impact on the quality of life and health of people.

Keywords: Depressive areas · Quarries · Mines · Ecology · Satellite towns · Small towns · Open public spaces

1 Introduction

This paper examines the reasons for the formation of a depressed area covering the city of Bakal (Chelyabinsk region) and the adjacent territories.

Nowadays, the city of Bakal in the Chelyabinsk region is a city with all the signs of a depressed area. A decrease in environmental quality indicators is manifested in a decrease in jobs, since once it was mines and quarries that were sources of income and prosperity for the city. After their depletion, a process of degradation began in the city.

The reasons giving rise to disproportions in the development of the territory can be varied [1]: natural and climatic; availability of natural resources; location, degree of urbanization, etc. (Fig. 1).

In Russia, several stages of the formation of depressed territories can be distinguished. First, these are the territories where crisis processes began to manifest themselves in the era of the USSR, and they only began to intensify after the collapse of the country. Secondly, the territories that acquired features of depression after the collapse of the USSR [2].

A. Beskopylny et al. (Eds.): INTERAGROMASH 2022, LNNS 575, pp. 1–12, 2023.
https://doi.org/10.1007/978-3-031-21219-2_1

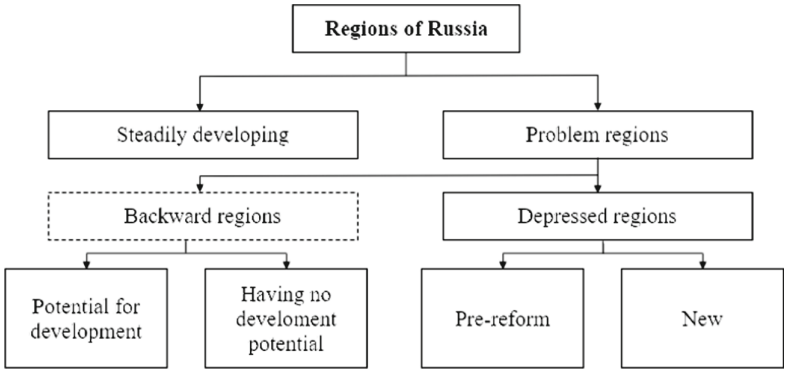

Fig. 1. Regions of Russia.

2 Methods

When carrying out research in this work, various literary sources, reports and factual materials received from the residents of this city were used.

The ancient Ural Mountains are an inexhaustible source of rocks necessary for man. Iron and copper ores, coal, asbestos, nickel, marble and many other minerals are mined in the Urals. Hence the huge number of quarries that are found almost everywhere in our country.

The city of Bakal is located in the western part of the Chelyabinsk region (228 km from Ufa) (Fig. 2). The main activity of the city was the extraction of brown iron ore and siderite. It is here that the oldest mines in Russia are located. Their development began in 1757. The city is the administrative center of the Bakal urban settlement with a population of 18,706 people as of 2020.

This city was the first in the region to receive the PSEDA (Priority Social and Economic Development Area) status in 2017. This means that this economic zone has preferential tax conditions, simplified administrative procedures and other privileges created to attract investment, accelerate economic development, and improve the life of the population. Do not forget that already in 2014, the city was included in the list of single-industry towns in which there are risks of worsening the economic situation.

That is, in principle, the problem has already been identified, at least its approach, but the applied forces were not enough to save the city from degradation. To assess the scale of this environmental problem affecting the city, let us turn to its history. This small town with an area of 50 square kilometers is located between the Suley and Bolshoy Suk ridges of the Southern Urals, 258 km from the center.

In 1757, on the place of the modern city, a settlement was founded at the Bakalskoye iron ore deposit. In 1818, active mining of iron ore began at the Vagonnaya Yama mine, and in 1901—at the StaryBakal open pit mine. These mines produced high-quality low-phosphorous ores, which were used as raw materials by the Satka and Zlatoust metallurgical plants. In 1928, the settlement received the status of an urban-type settlement. In 1929, a mining school was opened in Bakal, which trained operators of drilling rigs, assistants to locomotive drivers, excavator operators.

Fig. 2. Bakal city on the map of Chelyabinsk region.

During the Great Patriotic War, the Bakal mines worked at full capacity, producing 760 thousand tons of ore annually (Fig. 3). In the postwar years, the following mines were put into operation: Vostochny Aleksandrovsky, Ivanovsky, Okhryany, Zapadnypod Shishkoy, Novo-Bakalsky, Shuydinsky.

Fig. 3. Bakal mine during the war.

In 1951, several mining villages were merged into the city of Bakal. By 1970, the Palace of Culture, 4 clubs, 2 cinemas, 28 libraries, a branch of the institute, a mining technical school, 3 METS, 3 secondary schools, 2 baths, 13 catering canteens were already functioning in Bakal, i.e. the city was actively developing and, one might say, flourished (Fig. 4).

Fig. 4. The city of Bakal during its heyday.

But already in 2014, it was included in the list of single-industry towns in which there are high risks of worsening the economic situation in the future (Fig. 5).

From history we see that the city showed great hopes and a bright future, but we should not forget that the resources in the depths of our planet are not endless. The attached photographs show beautiful views of the quarries, which, unfortunately, are currently poisoning the territory and the population (Fig. 6).

Fig. 5. The city of Bakal today.

For a clearer idea of the geological structure of the deposit, let us consider a schematic section of the Bakal ore field [3] (Fig. 7).

It is clear from the figure that the overburden rocks, collapsing, pollute the underground and surface waters, as well as the atmospheric air. Let me remind you that a

Fig. 6. Open-pit mines (quarries).

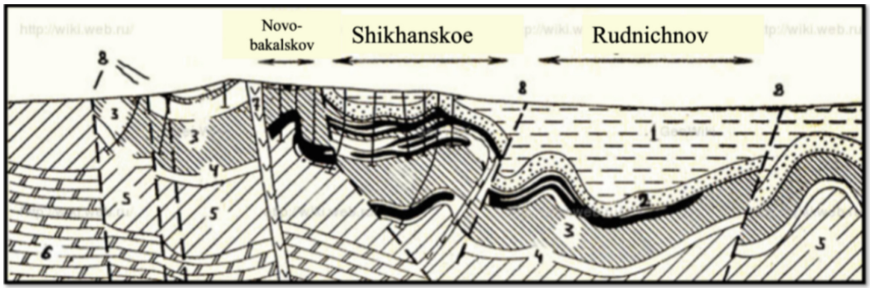

Fig. 7. Geological section: 1 - shales of the Zigazino-Komarovskaya suite; 2 - quartzites of the Zigal'gasuite; 3 - shales of the Bakalsuite; 4 - limestones and dolomites of the Bakal suite; 5 - shales of the Bakalsuite; 6 - limestones and dolomites of the Satka suite; 7 - dolerites; 8 - tectonic faults. Black - iron ore [3].

depressive area is a space in which there is a long-term decline in environmental quality indicators [4, 5]. These include industrial, disturbed, empty territories, degrading riverine areas of the zone with dilapidated housing stock, etc. The accumulation of negative factors over time leads to a qualitative change in the territory.

The characteristic features of the formation of depressive areas are:

- strong and stable lag behind other territories in terms of the main socio-economic indicators (it is also considered here in terms of development rates, which are characterized by a low level of economic development and a high level of unemployment);
- lack of opportunities for the formation of a new economic specialization and the exit of the territory from the crisis with its own internal resources
- transition of the production and resource base into a phase of stable decline.

According to A.G. Granberg [5], the typification of depressive territories is based on two methods: the first method delimits depressive areas on the basis of general external factors that cause a disproportion in the development of the region. The second one is based on the identification of depressed territories based on external factors that determine their formation (Table 1).

Table 1. Typification of depressed territories [7].

Typing	Description of the territory	Type of impact	Effects
Based on external factors	Territories affected as a result of natural or technical disasters, socio-political conflicts	The destruction of the accumulated economic potential, the significant size of the forced emigration of the population	Social and political deformations (sometimes irreversible)
Based on internal factors	The territory is distinguished by the fundamental composition of the branches of production, internal problems of the region's development	Violation of economic, demographic, ethnic, geopolitical and other nature	Depending on the type of territory

Signs of "depression" include:

- The presence on the territory of abandoned, destroyed or dilapidated structures with varying degrees of wear and tear (Fig. 8), as well as empty areas and unauthorized dumps.
- Long-term decline in environmental quality indicators.
- Lack of conditions for independent resolution of the current crisis situation without outside influence.

The duration and depth of the territorial depression are largely determined by the composition of the industries, the crisis in which became the main reason for the spread

Fig. 8. First Bakalsky pond.

of the depression to the entire economy of the region. There are several types of depressed regions based on internal factors:

- Agricultural and industrial;
- mining (focal)
- old industrial.

The type of mining depressed regions includes localized resource-producing territories (mainly mining and timber) located in sparsely populated areas. This type does not include regions of old development of mineral deposits (for example, regions for the development of coal deposits).

Regions where old industrial zones, factories and production areas are not used for their intended purpose, are poorly used, or not used at all belong to the old industrial type. Depressive agrarian and industrial territories are territories in which the agrarian sector was previously of great socio-economic importance, but today it has noticeably reduced the rate of its development [8]. The scale of depressive spaces can vary significantly. On this basis, they can be divided into several types: 1. Regional – individual cities, territories, regions or republics; 2. District – areas of cities, settlements or parts of urbanized areas; 3. Local – detached buildings or a complex of buildings, structures

and areas around them. To identify the scale of depressed areas, localize the zones of their influence and conduct their comparative characteristics, it is important to select indicators that characterize this process [9]. The city of Bakal can be attributed to the type of mining monocities. Single-industry towns are towns with one specific function. As a rule, they arise at a town-forming enterprise in order to provide production with labor resources. According to statistics, most of these towns belong to the "red" zone - the towns with the most difficult situation.

In 10 constituent entities of the Russian Federation (see Table 2), the situation with the state and development of single-industry towns is of particular importance, since in these regions, the share of the population living in single-industry towns exceeds 20% (with the national average of about 9%). In the Chelyabinsk region, the share of the population is 32.3%.

Table 2. Information about single-industry towns in the constituent entities of the Russian Federation, where more than 20% of the population lives in single-industry towns [10].

	Region	Population of single-industry towns, thous. people	Share of population in monotowns, %	Number of monotowns	In points «Red zone»	«Yellow»	«Green»
1	Kemerovo region	1636	60.2	24	8	12	4
2	Chelyabin region	1130	32.3	16	7	5	4
3	Volgograd region	365	30.7	4	3	1	0
4	Republic of Khakassia	157	29.2	6	1	5	0
5	Sverdlovsk region	1253	28.9	17	5	6	6
6	Republic of Tatarstan	1034	26.7	7	2	4	1
7	Arkhangelsk region	298	25.3	7	2	3	2
8	Samara Region	786	24.5	2	0	1	1
9	Republic Karelia	143	22.7	11	6	5	0
10	Amur region	173	21.4	4	2	2	0

The criteria proposed by the authors have something in common with the list of criteria for the crisis of single-industry towns approved by the Ministry of Economic Development, according to which their condition is assessed:

- Rates of economic growth;
- Demographic indicators;
- Employment indicators;
- Indicators of trade, turnover of small and medium enterprises;
- Indicators based on the assessment of the housing stock;
- Amount of support from the federal budget;
- Assessment of the situation in the city by the population.

3 Results

According to the Ministry of Economic Development of Russia, Verkhny Ufaley and Bakal topped the list of the most crisis-ridden single-industry towns in Russia in 2019 (Fig. 9).

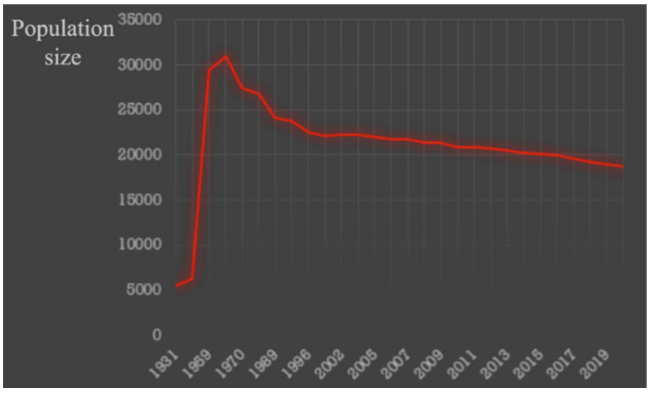

Fig. 9. Bakal population trend.

Figure 10 shows the change in the population of the city of Bakal since 1931. Of course, just by looking, you can immediately draw conclusions about the situation in the city.

- Since 1967, the size of the city has been constantly decreasing, which contributes to the formation of depressed areas.
- Among the main reasons for the decline in numbers: unemployment and economic decline in the territory.
- The outflow of the active working-age population from depressed cities led to an inevitable reduction in their labor resources.

And let's consider this problem a little more from the point of view of geology. Since the creation of large open pits is accompanied by the activation of various engineering-geological and physical-chemical processes (Fig. 10):

- there are deformations of the pit walls, landslides, mudslides;
- there is a subsidence of the earth's surface over the developed mine fields. In rocks, it can reach tens of millimeters, in weak sedimentary rocks - tens of centimeters and even meters;
- the processes of soil erosion and ravine formation are intensified on areas adjacent to mine workings;
- weathering processes are activated many times in mine workings and dumps; there is an intensive oxidation of ore minerals and their leaching; the migration of chemical elements is many times faster than in nature [11];
- within a radius of several hundred meters, and sometimes kilometers, soil is contaminated with heavy metals during transportation, wind and water dispersal (as a result, suffer water bodies of adjacent territories [12–16]), soils are also contaminated with oil products, construction and industrial debris. Ultimately, a wasteland is created around large mine workings, where vegetation does not survive.

Fig. 10. Bacal city quarries.

Today, near the town of Bakal, there are abandoned 10m open pits with a maximum depth of up to 200 m, as well as dumps up to 50–70 m high. The Sideritovaya mine named after the 15th Congress of the All-Union Leninist Young Communist League was no exception (Fig. 11).

Depressive territories, as backward ones, are referred to problem regions. But depressed regions are fundamentally different from backward ones in that, with modern socio-economic indicators lower than the national average, these regions were developed in the past, and in some industries, they occupied leading positions in the country. Therefore, depressed territories have sufficient economic potential, but as a result of the structural crisis, characterized by a steady decline in production and real incomes of the population, growing unemployment, and a decrease in the population size, they do not have the conditions to independently resolve the current crisis situation.

Fig. 11. Mine "Sideritovaya" named after the XV Congress of the All-Union Leninist Young Communist League (left), the head building of the shaft "Auxiliary No. 1" (right)

4 Conclusion

Summing up from the work done, it can be concluded that the formation of depressed areas is, in fact, an ecological problem, not solving which entails consequences. Using the example of the city of Bakal, one can be convinced that the abandoned depressed territories not only do not bring profit, but also cause a significant outflow of the population, which leads to an economic recession and, in principle, to the "abandonment" of the city as a whole.

The only help that can "revive" the city is financial aid. Because, even if we do not take into account that the resources there are renewable, then it is worth paying attention to the fact that there are still incompletely depleted open pits and mines that can bring profit to the country.

That is why this research was done, and this paper was written to draw your attention to such degrading, simply "sinking" cities that cannot cope without outside help. After all, a city like Bakal is not the only one in Russia.

After collecting and processing information, we came to the conclusion that this territory cannot improve the situation on its own. It needs, for example, financial assistance, a new concept for the development of the city and labor force, so that the city can get back on its feet.

References

1. Mansurov, P.M., Mansurova, G.I.: Depressive region: essence, criteria of attribution, main problems. Bas. Res. **6**, 506–510 (2012)
2. Granberg, A.G.: About the program of fundamental research of the spatial development of Russia. Reg.: Ec. and Soc. **2**, 166–178 (2009)
3. Nedra: Ore Deposits of the USSR, p. 496. Nedra, Moscow (1978)
4. Kurochkina, V.A.: Urban water bodies as the basis for functioning of public spaces. E3S Web Conf. **217**, 02004 (2020). https://doi.org/10.1051/e3sconf/202021702005
5. Kurochkina, V.A., Khlebnikov, S.K., Melnikova, M.D., Smetanin, I.A.: Impact of urban water bodies on the structure of open public spaces. Euras. Sci. J. **13**, 18NZVN521 (2021). https://esj.today/PDF/18NZVN521.pdf

6. Granberg, A.G.: Fundamentals of Regional Economics: A Textbook for Universities, p. 495. SU HSE, Moscow (2000)
7. Kurochkina, V.A.: The impact of long-term construction subjects and industrial areas on the geoecology ofcities and development of depressed urban spaces. Eur. Sci. J. **5**. https://doi.org/10.15862/36NZVN620
8. Surkova, S.A., Shusharina, V.V.: Depressive regions: typological features and mechanisms for overcoming depression. Reg. Ec.: Ec. Manag. **1**, 25–37 (2009)
9. Nikonov, A.G.: Strategic directions of development of depressive rural areas in modern conditions. Agr. Eur.-Nor.-East **5**, 76–80 (2013)
10. Institute for Integrated Strategic Studies: Review of Russian Single-Industry Towns Moscow. Institute for Integrated Strategic Studies (2022). https://icss.ru/images/pdf/research_pdf/MONOTOWNS.pdf. Accessed 14 May 2022
11. Krinochkina, O.K.: On the problem of waste from mining enterprises. Sci. Prac. Conf. "Student Science" students' research work "Days of Student Science", pp. 60–62 (2017)
12. Kurochkina, V.A.: Impact of urbanization on the state of water bodies and adjacent territories. E3S Web Conf. **217**, 02004 (2020). https://doi.org/10.1051/e3sconf/202021702004
13. Borovkov, V.S., Blazi, S., Kurochkina, V.A.: Complex ecological safety of water bodies in urbanized territories. Ecol. Urbanized Territories **1**, 45–49 (2012)
14. Kurochkina, V.A., Bogomolova, T.G.: Scientific rationale for technology concepts of environmental safety in water bodies at urban areas. Ecol. Urban Areas **1**, 19–22 (2015)
15. Telichenko, V.I., Kurochkina, V.A., Kirov, B.L.: Environmental safety, use and protection of water bodies in urbanized areas. Urbanized Territories **3**, 32–39.
16. Kurochkina, V.A., Bogomolova, T.G., Kirov, B.L.: Anthropogenic load on rivers in urbanized areas. Vestnik of MGSU **8**, 100–109 (2016)