Pathways to sustainable development of urban areas in the Southern Urals

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Abstract. The paper considers retrospective development of the mountain region in the Southern Urals as a special industrial and natural landscape monument of Russia. Following global trends, the authors are aware of both high significance and great vulnerability of mountain areas. The Southern Urals is considered as the region with a tendency to stagnation. The historical background of the problems is highlighted, and ecological status and risks of the region are analyzed on the example of a network of small and medium-sized cities of Zlatoust district, which contributes to solution of the problems. The cities are united by modern specialization, infrastructure, socio-economic situation and natural heritage typical of the entire Ural region, which enables generalization of the principles for both the Urals and other mountain areas. Their special environmental features require complex measures aimed to restore the integrity and the value paradigm. It is proposed to create a cluster based on the potentials, which offers specific directions for the development of a group settlement and functional autonomy. In this regard, it seems necessary to eliminate past ecological damage and to minimize adverse factors that violate environmental conditions. The urban ecology strategy is proposed to resolve contradictions in the development of resource-rich and historically identical areas of the Southern Urals.

1. Introduction

The ecosystem of our planet has come to the bifurcation point of its development, when people’s need for all types of resources, including natural, recreational and cultural, significantly exceeds the capacity and capabilities of natural and anthropogenic systems. In 1992, the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro adopted Program 21, the 13th chapter of which is devoted to preservation and rational use of mountain areas that belong to fragile ecosystems [1]. Being one of the main sources of fuel and organic resources, and tourist activity, mountain areas are under tremendous pressure. This situation is particularly relevant for one of the largest and most developed regions of mining industry – the Southern Urals, which currently faces serious development contradictions.

The study aims to consider the prospects for the balanced development of mountain areas through the example of small cities in Zlatoust mountain region of the Southern Urals in Russia.

Objectives of the study are to:

- identify the features of historical development of the Southern Urals;
- assess and characterize the current status of the Ural region in terms of environmental, cultural and social aspects;
- identify and assess the resource potential of the Southern Urals;
suggest prospects for sustainable development of mountain areas through the example of Zlatoust region, including such cities as Karabash, Miass, Zlatoust, Kusa, Satka, Chebarkul, Ozersk, and Kyshtym.

2. Retrospective of the development of mountain areas in the Southern Urals

In the 18th century, resource-rich mountain regions were attractive for development and urbanization when the state was particularly in need of mining and industrial production. Ural region and its eastern and southern regions were first to develop. New cities were founded around factories built by such entrepreneurs and industrialists as A.N. Demidov, V.N. Tatishchev, V.I. Gennin, and the Stroganovs [2]. The Stroganovs contributed greatly to the formation of metallurgical production and built 14 factories that formed a resettlement framework. In 1734, which is indicated by L.E. Joffe as one of the turning points in the history of development of the Urals, the region amounted to 40 factories. By 1767, the number of factories had increased to a hundred [3]. The enterprises became the basis for cities-factories, which exhibited a high level of socio-economic development and comfort. As a rule, the main square with the temple forms the central urban space between the working settlement and the factory. The unity of the city ensemble was achieved by a common style of buildings [3]. Therefore, until now the historical center of the cities of the Southern Urals is of great historical and cultural significance.

The introduction of advanced technologies resulted in a variety of industries, and different types of resources provision and transport accessibility, which formed a dense frame of settlements. However, settlements still used vast amounts of available natural resources. The surrounding forests played a special role in the factory functioning. The use of forests for construction and fuel supply often led to devastating fires, so that in the 19th century forests were taken under protection and became the basis for creation of subsequently protected areas (specially protected natural areas).

The Urals started to develop again during the Second World War, when 667 factories of the European part of Russia were evacuated to this region, as well as 18 million people, who settled mainly in mining settlements. Thus, eleven of these settlements were granted city status [3]. Until 1990, the population of the Urals grew steadily in all major cities and settlements, which increased production and its impact on the environment.

2.1 Zlatoust district

Zlatoust mountain district located at the foot of the Bolshoy Taganay ridge, the area abundant in lakes and small rivers, plays an important role in terms of a special symbiosis of natural areas and increased industrial activity. The city of Zlatoust was founded in 1754 at the foot of the Kosotour mountain, at the confluence of the Ai and Tesma rivers. In the early 19th century the city became the center of Zlatoust mountain district, including the Zlatoust, Satka, Kusinsk, Artinsk and Miass factories. The city occupied the intermountain valley and extended more than 17 km from west to east [Figure 1 (a)]. Zlatoust was focused mainly on ferrous metallurgy and iron smelting, which factories were located on flat areas, whereas settlements occupied less-polluted mountain areas. To date, the city has retained a production function supported by educational activities (the branch of Chelyabinsk Technical University is located in Zlatoust). The city exhibits an ensemble of factories of the first half of the 19th century, and monuments of religious architecture and civil engineering. Zlatoust is adjacent to the protected nature monuments such as the Akhmatov Mineral Lance and the Taganai National Park (Response Ridge).

The city of Kusa, the regional center of Chelyabinsk region, is located on the western slope of the Southern Urals, 244 km west of Chelyabinsk on the Kusa river, not far from its confluence with the Ay river [Figure 1 (b)]. The city’s foundation was directly related to the construction of ironworks that produced cast iron shells and high-quality art castings [4]. In 1943, Kusa was granted city status, and now it focuses on mechanical engineering and production of precision technical stones. Logging, iron ore and marble are underway in the area.

Satka is a city of regional subordination, the regional center of Chelyabinsk region. Satka is located on the slope of the Southern Urals to the west of Chelyabinsk. The city’s foundation in 1785 was due to the Troitsk-Satka ironworks built by S.G. and A.S. Stroganovs [Figure 1 (c)]. Satka was granted city
status in 1937 [5]. Preserved low-rise wooden and stone buildings, as well as a regional museum can be found in the eastern part of the city that is higher in elevation. At the same time, a modern center with cultural institutions is located in the western part, lower in elevation. Currently, Satka is a center for mining and processing of magnesia. There are factories for the production of refractory products and cast iron. The branch of Magnitogorsk Institute of Mining and Metallurgy is located in the city.

The city of Miass is located in the Southern Urals at the foot of the Ilmen mountains, on the Miass river. The area is rich in copper, so the city’s foundation in 1773 was associated with the construction of copper factory. In 1797, the richest gold mines were discovered near Miass, where about 40 pounds of gold were mined annually [6]. In 1926, Miass acquired city status. Further development was due to the automobile factory evacuated from Moscow, which contributed to the increased production of electronics and equipment [7]. Chelyabinsk State Technical University also played a significant role in the industrial development of the city. The historical and cultural potential of Miass is determined by the historical regular planning of the old part of the city, numerous wooden buildings of the 19th–early 20th centuries. A unique resource of the environment is the neighborhood with the Ilmensky Reserve, which includes a mineralogical museum.

![Historic photos of cities of Zlatoust district](image1.png)  
(a) Zlatoust; (b) Kusa; (c) Satka

**Figure 1.** Historic photos of cities of Zlatoust district (a) Zlatoust; (b) Kusa; (c) Satka

The historical framework of Zlatoust district is complemented by nineteenth-century cities founded on the basis of fortresses: Karabash, Chebarkul, Kyshtym, as well as by the autonomous territorial entity – the cities of Ozersk, Chelyabinsk-40 and Chelyabinsk-65. In particular, Karabash founded in 1822 as a settlement of gold miners included settlements of three factories, of which only copper factory has been operating to date [8]. The city has preserved the heritage of industrial architecture, has a regional museum and is adjacent to the scenic areas of Karabash Mountain and a network of lakes. The city of Chebarkul founded in 1736 as an outpost of the South Ural Cossacks comprises a unique landscape monument of the Krutik Peninsula, as well as resort areas (including Yelovoye), sanatoriums, recreation centers and the Kisegach mud resort.

### 2.2 Resource potential of Zlatoust district

To date, the considered cities occupy an economically advantageous position near railways, highways, and waterways (federal highway M-5–E-30) in the vicinity of the regional center. The development of cities is ensured by the orientation towards the production and mining complex and the existing infrastructure, which in some cases has been added by new residential areas and public service enterprises, including those in the recreational sector. The branches of technical universities located in the cities show a focus on innovative technologies. The increased attention paid to the heritage is supported by museums with their numerous collections.

On the other hand, the development of urban areas is closely related to the formation of specially protected natural areas. In Chelyabinsk region, Zyuratkul (86700 ha) and Taganai (56400 hectares) National Parks established between 1991 and 1993 are of high significance. In 1920, Ilmensky reserve was created near Miass (34380 hectares). The filtration and health-improving function of forests should be considered in conditions of high pollution of the Urals.
However, all these cities are single-industry [10]. The population number has been decreasing since 1990 [Table 1], which indicates negative trends in urban development. Manufacturing in small and medium-sized cities is not able to compete with that in large urban centers (Chelyabinsk), which means that cities become vulnerable and can lose their identity. The situation is aggravated by a worsening ecological situation, urban areas extended towards natural territories, and outdated production technologies, which represent a huge load on the environment.

### Table 1. Dynamics of the population of cities in the South Ural

| City       | 1931 | 1979 | 1992 | 2017 |
|------------|------|------|------|------|
| Zlatoust   | 75 000 | 197 660 | 207 800 | 167 978 |
| Miass      | 20 100 | 150 179 | 172 400 | 151 856 |
| Satka      | 16 900 | 46 191 | 51 000 | 42 214 |
| Chebarkul  | 3 700 | 45 845 | 51 400 | 39 914 |
| Kyshtym    | 26 700 | 39 830 | 42 700 | 37 480 |
| Kusa       | 13 300 | 21 926 | 22 800 | 17 368 |
| Karabash   | 8 300 | 17 619 | 16 400 | 11 718 |
| Ozersk     | – | – | 89 200 | 79 265 |

*Data of the People’s Encyclopedia of Cities and Regions of Russia My City [Electronic resource] URL: http://www.mojgorod.ru/cheljab_obl/index.html (Appeal Date 03/24/2019)

b Data from the 1979 All-Union Population Census. Urban population of the RSFSR, its territorial units, urban settlements and urban areas by gender Demoscope Weekly [Electronic resource] URL: http://www.demoscope.ru/weekly/ssp/rus79_reg2.php (Date applications 24.03.2019)

c Data of the Cities of Russia: encyclopedia / Ch. ed. Gm Lappo. M: Great Russian Encyclopedia, 1994–559 pp.

d Data of the Federal State Statistics Service ROSSTAT Population of the Russian Federation by municipalities as of January 1, 2017 [Electronic resource] URL: www.gks.ru/free_doc/doc_2017/bul_dr/mun_obr2017.rar (Date of circulation 24.03.2019)

e Data obtained in 1996

Thus, we can argue about a special position of the small cities of Zlatoust district. The similarity of potentials and proximity reveal common problems, including the systematic disturbance of natural ecosystems.

### 3. Current ecological status of the Southern Urals

The retrospective of the development of the Southern Urals reveals underlying causes of the current situation. Natural resources of mountain areas and their natural potential became the basis for the establishment of unique mining and metallurgical settlements but led to a total disruption of the natural ecosystem. Thus, the above-described areas exhibit an excessive mining complex as a result of regional specialization. In this system, the lack of local structures and common regional unity forces preservation of single-type production in a great number of cities, that provides meager economic effect and causes extensive damage to the environment. Distributed production belongs to the dirtiest production: metallurgy, oil production and mining. Energy generation requires burning of fossil fuel without by-product filtration, usage of hydropower including damming, installation of dams and hydraulic structures, which leads to the imbalanced hydrographic system. Suffering small rivers are of fundamental importance for the general condition of the hydrographic system and the biocenotic integrity of the region. The condition of small rivers has a direct impact on groundwater and cleanliness of large rivers and lakes.

The current situation virtually excludes the cultural and recreational potential of the region, since it undermines its foundation – the landscape environment. The mechanical destruction of soil cover and the formation of disturbed lands take place in the region, that is, the loss of the initial soil integrity and
the formation of man-made relief [10]. According to Rosreestr (Federal Service for State Registration, Cadastre and Cartography) as of January 1, 2016, in 2015 the area of disturbed lands was 1037 hectares, and for the first time in six years it dropped below 20800 hectares. The greatest violations can be observed in mining, exploration and construction areas [11]. The spread of cities towards natural territories reduces the most important ecological resource of the forest. For example, in Miass, part of the forest was preserved between the constructions of a new multi-storey complex in order to implement some pseudo-ecological ideas. As a result, these areas separated from the general system and deprived of proper care seem deplorable.

Disturbance and pollution of natural ecosystems significantly worsen environmental conditions, affecting, among other things, people's health. According to the Ecological Atlas of Russia, diseases of the respiratory tract, nervous system and cancer are more often recorded in mountain areas. In addition, people living in mountain areas have lower life expectancy compared to average.

According to experts, ecosystems are capable of self-healing, but this will require hundreds and thousands of years of anthropogenic non-interference [11]. Nevertheless, the authors argue that the possible solutions to the problems of the region do not imply the withdrawal of industry – the main town-forming component of the Southern Urals. These are the strategies for eco-city development, including the formation of local agglomerations of mixed specialization.

Thus, it can be concluded that the adverse effect of industry on the surrounding landscape and, accordingly, on the health of people living in these areas is so great that it requires "transition from the ecological paradigm based on pollution and environmental control to the paradigm based on foresight, assessment and prevention of ecological damage" [11]. "Land restoration as an integral part of measures on nature conservation, in particular, on minimization of the destructive effects of industry on the surrounding landscape is needed to compensate for ecological damage" [11]. The environmental rehabilitation technologies are developed by foreign experts. It is in foreign practice that the concept of past ecological damage is applied, which is still at the stage of scientific study and development in Russia.

4. Ways to solve social and environmental problems

The problem of restoration of contaminated areas has state status in all countries of the world. In Russia, the "Program-Target Approach to the Formation and Implementation of State Environmental Policy" has been implemented since 2003, including at the regional level. At the same time, it should consider not only the possibility of restoration of contaminated areas and disturbed landscapes, but also the improved regulation of the development of single-industry cities and settlements as sources for creating environmental problems. Since natural ecosystems, especially mountain areas, do not follow the administrative division of regions, it is impossible to solve the problems of sustainable development at the city level. The cities of Zlatoust district are considered as a group of regions similar in types of industry, historical and cultural potentials, and related to one mountain ecosystem and a single set of problems.
Satka, Miass, Kusu, Karabash, Chebarkul, Ozersk and Kyshtym can be considered as a local agglomeration with its center in the city of Zlatoust. Urban development is proposed to be carried out according to cluster type, which allows reducing the load on individual urban and natural territories, and increasing the socio-economic efficiency of the group as a whole [Figure 2]. The development of the district should be ensured not by the increased use of environmental resources, especially in conditions of increased susceptibility and vulnerability of mountain ecosystems, but by the improvement of existing production structures and the development of their cooperation. In accordance with the problems considered and the tasks set for the development of mountain areas of the Southern Urals, the following recommendations for future development can be formulated:

- Preservation of the production complex with a significant modernization of the technological process as the most important factor in improving the ecological state of the environment, which includes:
  - system application of energy-saving and environmentally friendly technologies in the production, sewage treatment;
  - search and development of biosphere-rehabilitation and environmentally compatible construction methods [12];
  - the use of advanced technologies, as shown by the historical development of the territory, plays a huge role in the production efficiency and safety. In early 1970, the Artinsk ironworks located in Zlatoust district transferred to the manufacture of braids by rolling, which is still a unique technological know-how.
- Increase in the share of recreational areas in the urban and mountain natural environment and the regional settlement system:
  - reforestation;
  - defining of the boundaries of protected areas and creation of buffer recreational zones between protected areas and settlements;
  - possibility of reserving territories as links for the green frame;
  - restriction of uncontrolled anthropogenic extension towards natural territories [13];
  - integrated management of tourist activity [14].
- Strengthening of educational and cultural potential through the creation of a local multifunctional cluster:
creation of local forms of settlement (agglomerations) in order to streamline the existing regional structures;
use of proximity of large urban formations while maintaining the agglomeration autonomy intracluster division of specializations of production activities;
restoration and restructuring of free industrial territories and buildings.
formation of the security status of former industrial areas as landmarks, their valorization
• Microstructural urban planning to ensure the internal integrity of each of the cities of the agglomeration.

5. Conclusion
Thus, the global problem of the environmental management and the development of mountain areas are particularly relevant to the Southern Urals. This is due to an active role of the industrial and mining function with its three-century history of development.

The modern economic paradigm of Russia still recognizes mining and metallurgical production as the main production of the Southern Urals. However, the imperfection of technologies and the excessive industry have a devastating effect on natural ecosystems and, as a result, on people's health.

The example of Zlatoust district shows that mountain areas are rich not only in mineral resources. In addition, the mixture of functions and the creation of integral local agglomerations contribute to the stable economic and social development of small historical cities and to the comprehensive restoration of disturbed natural areas and elimination of subsequent adverse effects.

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