Environmental safety as an element of single-industry towns’ sustainable development in the Arctic region

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Abstract. Maintaining a certain level of environmental safety is one of the most important goals in exploring the Arctic region, taking into account its intensified industrial development. This study offers an approach to achieving environmental safety of industrial single-industry towns of the Arctic region of Russia. In order to implement an environmental safety strategy in single-industry towns (with the Murmansk Region discussed as an example) and tailor it to the changing conditions, we have proposed a system of indicators reflecting the goals of preserving and restoring the ecosystem of single-industry towns of the Murmansk Region, taking into account the severe conditions and high vulnerability of the Arctic nature. The indicators were determined using the Balanced Scorecard system which components were adapted in accordance with the goals and objectives of the Strategy of Ecological Security of the Russian Federation in view of the unique features that Arctic single-industry towns have. When choosing the methodology of the study, we have found and analyzed the indicators of sustainable development, including environmental safety, proposed by international communities or organizations, such as UN Commission, World Bank, OECD European Commission, World Wildlife Fund, etc. The strategic map we have constructed allows to reconcile the interests of different stakeholders and can be used as a basis for decision-making at various levels of governance (industrial enterprises, regional and municipal authorities, local communities, and others).

1. Introduction
The issue in creating and implementing programs for industrial development of territories is in reaching certain physical limits of an ecosystem’s capacity for self-sustaining. This problem is particularly urgent for the Arctic ecosystem, which is very vulnerable and has little capacity for self-healing. The goal in this region is in reconciling the conflict between economic growth and maintaining a safe environment. It is no accident that international organizations pay great attention to environmental issues, as well as to methods of organizing economic activities aimed at improving people’s well-being while significantly reducing environmental risks through using innovative technologies, modernization and increasing production efficiency. This is why analysis of the problems of achieving environmental safety of single-industry towns (SITs) in the Arctic region is an important topic for research.

2. Environmental safety and sustainable development of territories
Both Russian and foreign authors define sustainable development as the balance between economic well-being, social equality and healthy environment; achieving this balance is one of the most important tasks of sustainability [1, 2].

The concept of sustainable development was first formulated in the Brundtland Report (also known as Our Common Future) for the World Commission on Environment and Development, published in 1987 [3]. The report defines sustainable development as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs [4].

The program of sustainable development in the 21st century until year 2030 is described in the Resolution adopted by the UN General Assembly on September 25, 2015 (Transforming our world: the 2030 Agenda for Sustainable development) [5]. According to this document, sustainable development should be based on green economy, which is a complex construction that includes improving energy efficiency via renewable energy sources (RES). The 2009 Human Development Report of the Russian Federation mentioned improving energy efficiency as one of the most important trends of sustainable development [6, 7]. Improving energy efficiency could not only reduce greenhouse gas emissions and energy costs but also slow down the depletion of mineral resources and prevent various environmental threats associated with the extraction of these resources [8]. The UN Resolution states that the goals and objectives of the world’s sustainable development are a global challenge, universally applicable for all countries. The 17 sustainable development goals and 169 targets are the proof of the new agenda’s scale and relevance, continuing the effort already made to protect and restore terrestrial ecosystems, ensure rational use of water resources, provide universal access to reliable and modern energy sources, promote sustainable infrastructure, industrialization and innovation, and so on [6, 9].

Achieving the goals of sustainable development entails strengthening the global partnership. Sustainable development goals are regarded as an additional tool together with international law, treaties and conventions, stimulating the interaction of countries and mobilizing stakeholders to take action [10, 11]. The UN has established six criteria of successful sustainable development [12]:

1. People. Ensure healthy lives, promote well-being for everybody at all ages, ensure quality education and inclusion for women and children.
2. Decent living standards. Eradicate extreme poverty and reduce inequality.
3. Prosperity. Promote sustained, inclusive and transparent economic growth.
4. Planet. Protect, restore and promote sustainable use of ecosystems following the interests of all countries and the future generations.
5. Partnerships. Promote global solidarity in the interests of sustainable development.
6. Justice. Promote peaceful and inclusive societies and build effective, accountable and inclusive institutions at all levels.

To quantify the achievement of these goals, the 1992 United Nations Conference on Environment and Development in 1992 raised the issue of indicators for sustainable development [5, 13, 14]. The original list included 134 indicators; calculation of these indicators complicated the work and analysis at the national level. Later, in 2001, core indicators were determined within the “theme/sub-theme/indicator” framework. The Economic category included two main themes: the economic structure and the production/consumption patterns. The first consisted of three sub-themes: economy, finance and trade. The second consisted of four sub-themes: consumption of material resources and energy, transport, education, waste management.

OECD’s (Organization for Economic Cooperation and Development) system of environmental indicators is another well-known set of indicators. The OECD member countries have been working on a program of environmental indicators since 1990, adhering to special selection criteria: 1. Relevance. 2. Scope of application. 3. Availability for regular use in statistical analysis. The system is based on the “pressure-state-response” (PSR) framework, describing the causal correlation between economic, social and environmental components, which is used to formulate the policy to solve real problems. The OECD indicator system was used as a basis for the system of indicators developed by the World Bank in cooperation with the United Nations Environment Programme and the International Center for Tropical Agriculture in order to improve environmental management. Its distinctive feature is that the indicators
are presented in the form of a geographic information system, which facilitates planning and decision-making.

Constructing indicators for sustainable development has been the subject of numerous studies recently. One of the new systems is the SGD Index for monitoring the progress on Sustainable Development Goals, developed by experts from Bertelsmann Stiftung and the UN Sustainable Development Solutions Network (SDSN) at the national level, based on different indices for each specific goal [15].

Various rankings are used in addition to indices and indicators for assessing sustainable development, for example, the regional energy efficiency ranking composed by the Ministry of Energy of the Russian Federation, the ranking for assessment of performance of regional executive authorities composed by the Government of the Russian Federation, regional rankings on fundamental and environmental performance of business (Interfax-ERA), Ecological Footprint of the Russian Regions (WWF), and others. According to the Paris Agreement, due to differing conditions in different countries, absolute emission reduction targets across the economy serve as the key sustainable development indicators in developed countries, while limited or reduced emissions across the economy serve as such in developing countries [16].

According to [17], the global community should be guided by a common strategy while achieving global goals of sustainable development. Neither possession of wealth, nor over-consumption of material goods, but rather indicators of personal merit and social significance should be the key priorities for the future generations; this consideration should be the focal point of such strategies. This will entail changes in political systems, international relations and state mechanisms. It is noted in [18] that regional stability is characterized by a system of indicators, because any given region within the country is a natural and socio-economic systems. The general stability of the region acts as a function of economic, social and environmental sustainability of the region within this approach.

Even though much research has been dedicated to achieving sustainable development [19] and there is general consensus among scholars that consumption of natural goods should not exceed the natural limitations engendered by the parameters of the natural environment of the planet, to date, the value aspects of sustainable development concept have not been studied in sufficient detail, and the mechanisms of achieving the goal have not been determined. The issues of regional differentiation of the sustainable development process (that are especially important for analysis of economic performance in such a unique region as the Arctic) have not been fully considered either.

As evident from the agenda detailed in Our Common Future report of the Brundtland Commission discussed at the 42nd session of the UN General Assembly in April 1987, there has been an emerging understanding that the ecology and economy are integrated in the real world, and that practical economic decisions are made without paying attention to natural resources and other environmental limitations [20]. Even though sustainable development issues are a constant focus of the UN’s attention and the organization consistently promotes comprehensive proposals aimed at achieving sustainable development, the principles of sustainable development voiced by the UN are not supported from a theoretical or scientific standpoint or complemented by scientific technologies, methods and systems [21]. The entirety of the links between various natural structures, social institutions and human activity structures should be thoroughly studied, understood and described in order to make a comprehensive transition to sustainable development in the ecology-society-economy system [22]. Sustainable development can be achieved through developing the scientific method, based on the general laws within the nature-society-man system compiling natural, social and spiritual processes.

Let us assess the readiness of the society for interaction on environmental issues, with Russia as an example. The term “green economy” was first introduced about 30 years ago by British economists in their study “Blueprint for a green economy” [23]. In 2010, UNEP produced a general definition of this concept [24]: the green economy can be defined as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. Russian Federation has been implementing a “green” policy based on the Constitution, the principles and norms of international law, international treaties signed by the Russian Federation, and on additional laws,
orders and decrees issued by the state authorities [25]. In recent years, the Government of the Russian Federation has set many goals based on the principles of the green economy: introducing ecoinnovations and improving sustainable energy development in Russia, among others [26]. The Federal Laws aimed at strengthening the system of environmental monitoring standards and carrying out measures to stimulate the Russian economy were amended in late 2017 [27, 28]. Decree of the President of the Russian Federation No. 176 of April 19, 2017 set out the Strategy for Ecological Security of the Russian Federation up to 2025, establishing the goals of the state environmental policy: preserving and restoring the natural environment, ensuring the quality of the environment necessary for human well-being and sustainable economic development, eliminating the accumulated environmental damage due to intensified economic and industrial activity as well as global climate change. The Strategy also established the following main targets, priorities and indicators for environmental impact assessment [29].

Complying with the principles of green economy, such as energy efficiency and energy conservation (in the energy sector), environmental sustainability of agriculture, “green” construction, “green finance”, etc. contributes to sustained and sustainable development of territories. [30].

The draft of the National Public Standard “Arctic Region: Environmental Safety” recommends that, in order to ensure sustained and sustainable development of the Arctic, each region of the Russian Federation develops, approves and implements a socio-economic development strategy, which must include a section on developing the infrastructure for environmental management of the region. The strategy should describe the target programs and separate projects and measures sharing common goals, objectives, schedules and resources, ensuring the development of the environmental safety system in the region of the Russian Federation. The action plan for ensuring the environmental safety of the region (roadmap) can be adopted either as a separate document or as a section of a more general document describing the strategy for regional development, and should be approved in the manner set out in the general document. A separate section of this document should be dedicated to motivating enterprises to implement standardization policies [31].

Sustainable development is the only possible path for the Arctic region due to a number of geopolitical and geo-economic characteristics, as well as to the specific goals established for the region. The effort being made to organize a continuous and timely supply of resources, on the one hand, and the scope of the global interconnected problems arising during the technological development of the Arctic, on the other hand, are the reasons behind the world community’s commitment towards ensuring environmental safety during the development of the territories of the Russian Arctic.

Environmentally safe technologies must be adopted in developing the Arctic territories due to the following factors:
- growing interest of the world community in the problems of environmental safety in the Arctic and rapid development of international environmental law;
- increasing demand for environmentally friendly technologies actively used by other countries;
- depletion of traditional energy resources increasing their costs;
- the need for reducing the risks of climate change;
- the need for reducing the risks of large-scale man-made disasters;

At the regional level, the environmental safety of the Arctic territories is governed by the existing techno-social and natural system. Industrial production is a source of harmful factors determining the territorial indicators associated with the actual and standard levels of man-made impact. [32] Therefore, from the standpoint of achieving environmental safety, man-made impact of the regional industry acts an “internal” hazard. The following steps should be taken to assess and develop a set of measures ensuring the environmental safety of the territories with the goal of achieving sustainable development of the region as a territorial techno-social and natural system:

1. Carrying out comprehensive analysis of regional environmental safety;
2. Assessment of the environmental safety level investigating the main sources of man-made impact, as well as the main enterprises posing risks of negative impact.
3. Carrying out a forecast of the changes in the main parameters of man-made impact on environmental safety, taking into account the planned changes in the structure of industrial production and territorial characteristics of the region that are unavoidable in the integrated development of the Arctic.

4. Confirmation that the obtained data are used when implementing the regional development strategy (including tax, credit and financing policies, social policies, etc.).

The above-given factors pose the problem of selecting a system of indicators for comprehensive assessment of the region’s environmental safety, for coordinating different aspects of regional governance, as well as for reconciling the conflicting interests of different stakeholders (industrial enterprises, regional and municipal authorities, the local community, and others). In our opinion, the balanced scorecard system (BSC) should serve as a methodological basis for solving this problem. The strategic maps developed by the cascading method (balanced scorecards for individual levels of management, such as regional and municipal levels) make it possible to coordinate the competing interests in devising and implementing a territories’ sustainable development strategy. We generated a BSC for each level of the organizational unit keeping in mind that, unlike commercial companies, the authorities have to focus on the stakeholder (or customer in the classical version of the BSC) component, instead of the financial one [33].

3. Single-industry towns and the problem of environmental safety control

The problem of maintaining environmental safety along with sustainable development of territories is especially important for Arctic SITs, where the town-forming enterprises are mainly those of the mining industry. We have used the approach described in [34], with the general stability of the Arctic region regarded as a derivative of certain activities in the region (economic, social, environmental). This paper, which is a part of a more general study, focuses on achieving environmental safety of SITs while ensuring sustainable development of the region.

The socio-economic situation in Arctic SITs is particularly severe, with the population steadily declining. A set of measures aimed at achieving a strategy for maintaining the environmental safety of SITs should take into account the specifics of the development of the territories, including a strong direct dependence of all the factors affecting the population’s quality of life on the performance of the town-forming enterprise.

The solution traditionally proposed for ensuring sustainable development of SITs is in reducing the SIT’s dependence on the town-forming enterprise, diversifying economic activity and developing small business. Not denying the need for infrastructural development and diversification, we consider it equally important to reconcile the interests of the three main participants in the economic activity of a SIT, i.e., the municipal government, the town-forming enterprise and the local community, and to form a sustainable, mutually beneficial partnership. This is facilitated by:

- relative geographical isolation of SITs of the Arctic region which means that the interests of the inhabitants are more or less similar, and the variance of their needs is low.
- the town-forming enterprise and municipal authorities heavily depend on each other, making interaction especially important.
- the number of subjects with competing interests is relatively small, as is the number of priority goals.

Achieving environmental safety is a special activity sphere that has all the conditions and opportunities for reconciling the interests of stakeholders, since there is a sufficiently well-constructed and evolving system of laws regulating the environmental activities. It is possible to obtain a quantitative environmental assessment of industrial emissions; there are scientific methods offering sets of indicators for comprehensive analysis of environmental issues in the region, while regional and federal authorities are concerned about this problem. This means that reconciling the interests in the environmental sphere should be easier than, for example, in solving the problems of the social sphere. Effective partnerships should be based on balancing the interests of stakeholders taking into account the demands of each
participant (the municipal government, the town-forming enterprise and the local community) in matters of environmental safety.

Analysis of business activity in SITs of the Russian Arctic has revealed that small business is rather poorly developed, unstructured and cannot be regarded as a key stakeholder at present [35]. However, in generating a map for achieving environmental safety, we have taken into account the issues of providing support for small business, making it possible to include small business as the fourth element of the system of participants.

4. Environmental safety map (with single-industry towns of the Murmansk Region of the Russian Federation as an example)

The Murmansk Region was chosen as the study object because of its high percentage of SITs situated in the Arctic region. Arctic SITs of the Murmansk Region also have common traits and development issues, and their town-forming enterprises are mostly those of the mining industry. The common problems shared across the region allowed to form a strategic map for ensuring environmental safety with the goal of achieving sustainable development of SITs of the Murmansk region (see Fig. 1). The goal is to ensure the required level of environmental safety of SITs of the Murmansk Region, i.e., such a level of the system’s development that satisfies the following conditions:
- enforces the currently existing environmental standards for the main sources of man-made impact;
- corresponds to the goals and objectives determined by the current regional strategy of sustainable development;
- ensures that the long-term goals and objectives are achieved in accordance with the regional strategy of sustainable development for the future.

Thus, the issue is not only and not so much in preserving the region’s resources, but in improving the well-being of its population, with the environmental component as a contributing factor. This is the reason why improving the well-being of the stakeholders is at the top level of the strategic map.

The map is based on the following priority goals important for SITs of the Murmansk Region:
- preserving and improving the labor resources of the SIT;
- using innovative environmentally efficient technologies;
- developing the small business sector and increasing the stability of the SIT’s economy;
- searching for funding sources for environmental safety projects and substantiating their attractiveness.

"Finance and budget” is the component acting as a source of development and as the basic level of the strategic map. We have deliberately elected not to use the traditional framework prescribed by the methodology, since searching for sources of funding for environmental projects is the most urgent task for SITs, where the severe socio-economic situation prevents the towns from becoming the sources of financing for the projects. On the other hand, as the town-forming enterprises are participants of larger industrial associations, they do not fully control their financial resources. In this case, the state has to take steps to support environmental monitoring (i.e., compliance with norms and standards) and to create the most favorable conditions motivating the town-forming enterprises to invest in green technologies reducing the anthropogenic pressure on the environment.

We should note that introducing innovative technologies can have a high multiplier effect, providing employment for the population, increasing business activity in other sectors of the economy, stimulating innovation, making it possible to effectively develop resources and territories even given that the infrastructure of the Arctic SITs is rather underdeveloped. Thus, achieving environmental safety should not be just a cost-based project, but on the contrary, combine the goals of environmental protection with boosting the competitiveness of the town economy, improving the quality of life of the population, achieving both environmental and economic security.
Achieving the required level of environmental safety in MR SIT

Developing a comprehensive program to maintain environmental safety (environmental system of development) in MR SIT

Forming the institutional conditions for development (compliance with norms and standards) in MR SIT

**Stakeholders**
- Monitoring the population’s health
- Minimizing the damage for the population caused by man-made
- Improving the quality of the environment
- Improving the legal regulation of environmental monitoring and control
- Providing the population with access to eco-friendly products

**Industry and entrepreneurship**
- Improving the quality of natural resources (distribution and use)
- Rational waste disposal (recycling)
- Reducing industrial emissions
- Land reclamation

**Skills and workforce**
- Developing programs for improving the environmental awareness of the population
- Personnel upgrading and training when introducing environmentally clean technologies
- Personnel training in environmental management and protection

**Finance and budget**
- Economic regulation and financing of environmental management and protection activities
- Supporting environmentally friendly technologies and environmentally clean materials
- Supporting energy efficient technologies
- Organizing an environmental control system
- Supporting programs for small business support in environmental management and protection
- Supporting programs for reducing negative environmental impacts on the population’s health

**Figure 1.** Strategic map of environmental safety of single-industry towns in the Murmansk Region

Abbreviations: SIT stands for single-industry towns, MR stands for Murmansk Region
5. Directions for future research and discussion

This study presents a strategic map for reconciling the interests in achieving the required level of environmental safety for the Murmansk Region of the Arctic zone of the Russian Federation. While the map discussed in this study was constructed taking into account the specifics of the Murmansk Region as a whole, similar maps should be developed in the future for each of the region’s single-industry towns, taking into account the specifics of these towns, their priority goals and objectives, and the extent to which the town-forming enterprises are ready for cooperation.

A separate issue is choosing the specific indicators characterizing the goals and problems in achieving sustainable development, taking into account the tasks of preserving and restoring the Arctic ecosystem in view of its severe environmental conditions and high vulnerability.

The National Public Standard “Arctic Region: Environmental Safety” that is currently under development combines the best international and Russian practices in the field of public participation in environmental control and can serve as a basis for selecting such indicators. However, the standard has to be adapted as it does not take into account the specifics of single-industry towns.

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