Selecting and assessing indicators for monitoring environmental safety in the Russian Arctic

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Abstract. In this study, we have analyzed the data for assessing the environmental status and effective future monitoring of environmental safety of individual territories in the Arctic Zone of the Russian Federation, estimating whether these data were complete and sufficient for the given purposes. Based on analysis of the currently available official statistical data for the one of the regions of the Arctic Zone (Murmansk Region), we have selected indicators reflecting the level of environmental safety in the Arctic as a whole. Indicators for ensuring environmental safety in the Murmansk Region have been proposed for each target corresponding to the chosen strategy. We have collected the relevant statistical information for these indicators and assessed the possibility of using the obtained data to monitor the implementation of the environmental safety strategy. We have formulated conclusions on the degree to which the data were accessible and complete. As a result of analysis of the collected data for assessing and monitoring environmental safety of the Russian Arctic territories, we have found that data were partially or totally missing for some indicators. We propose to introduce revisions, including the indicators for the targets “Improving the legal regulation of environmental management and protection” and “Providing access to eco-friendly products to the population” as the statistical environmental data mandatory for monitoring.

1. Introduction
Human impact on the Arctic environment has been steadily growing over the recent decades. New shipping routes emerging, intensified oil drilling on the Arctic shelf and eco-tourism are negative consequences of human activity in the Arctic.

Economic growth and environmental status of the Arctic are two of the most important areas (components) of sustainable development, mutually affecting each other; a system for monitoring these factors has to be developed, along with a set of indicators that allow to trace both economic and environmental consequences of economic activities in the Arctic. This issue is very crucial for the Russian Arctic, where government policy stimulates heightened economic activity during development of Arctic territories. However, the system for ensuring environmental safety of the territories is not yet fully formed.

2. Environmental safety system
Environmental safety (as defined by the Federal Law of the Russian Federation No. 7-FZ of January 10, 2002, on Environmental Protection) is interpreted as protection of the natural environment and of vital human interests from negative impact of economic and other activities, natural or man-made
disasters and their consequences. Environmental safety management is traditionally a three-tier system [1–4], with the environment acting as the object of management at all levels.

Global level. Environmental safety management is aimed at solving global problems: pollution of the oceans, climate change, ozone layer depletion, desertification of Earth, greenhouse effect. Solution of global problems is supported by international organizations such as the UN, UNESCO, UNEP, International Union for Conservation of Nature and Natural Resources, World Wildlife Fund, etc. [5–11]. To achieve environmental safety, most Arctic states have developed national security strategies for the Arctic, describing their security priorities in the region [12]. The precarious situation where national security interests of the five countries bordering the Arctic Ocean (Canada, Denmark (via Greenland), Norway, Russia and the United States) compete is further aggravated by a lack of a unified structure aimed at solving these problems [13, 14].

A mechanism should be developed for solving regional problems of environmental safety in the Arctic, recognizing the mutual benefits of maintaining international cooperation, transparency and stability.

Regional level. This level includes management within large economic and geographical zones, executed by governments and different supranational unions (CIS, European Union, African Union, etc.). Environmental safety management at this level is aimed at maintaining and restoring environmental quality with rational use of natural resources in different areas of interaction [15, 16] and implementing the green economy approach [17]. Environmental safety management of the Russian Arctic zone can be formed at this level. Current problems of environmental safety of the Russian Arctic zone are solved from either a sectoral or a territorial standpoint, or by specific agencies. This is one of the most important issues hindering an integrated approach to ensuring environmental safety of the Russian Arctic zone. As pointed out in [18], the problems of the Arctic zone should be considered integrally.

Local level. This level includes management of environmental safety in cities, districts and individual enterprises and executed by local administrations or company management, with the help of environmental regulation structures. The local level is chosen for analysis, as it provides the most complete and transparent data.

Ensuring environmental safety of the Arctic regions is an urgent goal for Russia, as confirmed not only by a number of scientific publications on the problem [1–4, 19], but also by governmental activity in developing environmental legislation (Strategy for Ecological Safety of the Russian Federation for the period up to 2025, State Policy in the Area of Environmental Development in the Russian Federation for the period up to 2030, approved by the President of the Russian Federation on April 30, 2012, and other legal acts). The Government of the Russian Federation has approved a state program for Environmental Monitoring with the following objectives:

- regular monitoring of the environment;
- storage and systematization of data on the state of the environment;
- analysis of incoming data for identifying anthropogenic and natural factors affecting the state of the environment;
- providing not only federal and local government agencies but all interested individuals and legal entities with reliable data on the state of the environment.

Environmental safety is a complex problem that can only be solved by reconciling the conflicting interests of different regional actors (industrial enterprises, regional and municipal authorities, local community, etc.) and making coordinated management decisions in different areas of regional management. It follows then that a system of indicators should be developed for assessing and monitoring environmental safety of the Arctic region. The goal of the study has been to select the indicators corresponding to the proposed targets within the framework of the strategy for ensuring environmental safety of the Arctic (using the example of the Murmansk Region), based on the considerations that the data should be up-to-date, complete and reliable. Since the Federal State Statistics Service provides data allowing to assess the level of environmental pollution by the key
parameters, one of the objectives of the study has been to analyze whether the data for the Arctic territories is accessible, up-to-date and complete (sufficient).

3. Methodology

The balanced scorecard system (BSC) should serve as a methodological basis for solving this problem. The strategic maps (balanced scorecards for individual levels of management, such as regional and municipal levels) proposed should allow to coordinate the competing interests in ensuring environmental safety of the Arctic Zone. The map presented and discussed in detail in [20] differs from the traditional approach in that the authorities (unlike commercial companies) should focus on the stakeholder (or customer in the classical version of the BSC) component, instead of the financial one.

| Stakeholders                      |
|-----------------------------------|
| Monitoring population’s health    |
| Minimizing damage from man-made accidents for population |
| Improving quality of environment  |
| Improving legal regulation of environmental management and protection |
| Providing access to eco-friendly products to population |

Figure 1. Stakeholder component of Strategic Map for the region’s environmental safety

Choosing a system of indicators that could be used to analyze each block (Fig. 1), we were guided, among other things, by the criteria of transparency and availability of the data from the sources of official regional statistics. This way, we were able to assess whether regional authorities adhere to the stated criteria, collect the necessary data and use it to correct the existing policies, and whether these data are accessible and transparent for the population of the region.

4. Results

The Murmansk Region has been chosen for analysis because it has the most complete statistics database; in addition, this region has adopted a Strategy for Social and Economic Development of the Region and publishes annual reports on its economic performance. The strategy describes the development of the region up to 2025 and consists of 3 stages. The current second stage (2017–2020) should involve a transition to an innovative trajectory of sustainable integrated socio-economic development. Achieving environmental safety and sustainability are not included as separate targets at any stage of the Strategy. Four strategic directions have been formulated, including “Ensuring a comfortable and safe living environment for the population of the region”, which should logically comprise ensuring environmental safety.

Let us consider the indicators that could be used to assess to what extent the first target of the proposed strategic map, “Monitoring the population’s health” (Table 1), is achieved. We have compared the data with the indicators given in the Strategy for Social and Economic Development of the Murmansk Region.

| Table 1. Indicators for monitoring the health of the region’s population |
|-----------------------------|--------|--------|--------|--------|
| Indicator                   | 2013   | 2015   | 2017   | 2025 forecast |
| Births, persons             | 9210   | 9111   | 7810   | -           |
| Deaths, % of births         | 0.93   | 0.97   | 1.07   | -           |
| Average life expectancy, years | -     | -     | 71.7   | 73.1       |
| Mortality rate per 1,000 population | 11.0  | 11.6   | 11.1   | 10.1       |
| Deaths per 100,000 population, including: | 639.2 | 639.7 | 584.4 | 630.0 |
| from cardiovascular diseases |        |        |        |            |
cancer 173.3 188.2 190.2 169.6
respiratory diseases 29.9 22.6 21.0 -
digestive diseases 57.4 65.6 62.2 -
mortality (without mortality from external causes) 997.8 1031.3 987.8 1016.0
Infant mortality (children under 1 year of age) 6.3 5.9 5.4 5.9
per 1,000 population

A decline in the population of the Murmansk Region, decline in the birth rate and increase mortality rate can be observed. Population mortality rates (without mortality from external causes) fluctuate. Positive trends include a decrease in infant mortality (for children under 1 year of age) and in deaths from cardiovascular diseases. Indicators above their projected values have been obtained for these categories. At the same time, mortality from cancer has increased, which is explained both by the aging of the population in the region and better detection of cancer in mass screening. However, achieving some indicators of the Strategy (mortality rate, average life expectancy) seems problematic.

The second target is “Minimizing damage from man-made accidents for the population”. A similar section, “Increasing the level of protection of population and territories from natural and man-made disasters, fires, and war hazards”, is outlined in the development strategy for the Murmansk Region. Targets (indicators) include casualties and rescues in disasters and fires, however, these data are not given in the open annual report for the region. Let us consider some available indicators allowing to analyze the situation (Table 2).

Table 2. Workplace accidents, 2013–2017

| Indicators | 2013 | 2014 | 2015 | 2016 | 2017 |
|------------|------|------|------|------|------|
| Injuries in workplace accidents leaving victim incapacitated for 1 day or more and fatal injuries per 1,000 employees, total persons | 273 | 258 | 259 | 213 | 193 |
| Fatalities per 1,000 population | 3% | 6% | 4% | 5% | 8% |
| Total days per year missed from work due to injury | 52.4 | 55.4 | 46 | 46.3 | 44.3 |
| Sick leave duration per one injured, days | 192 | 215 | 178 | 217 | 230 |
| Spent on workplace health & safety measures, RUB million | 2194.3 | 2499.5 | 2620 | 2708.1 | 4102.7 |
| First diagnosed with occupational disease, persons | 124 | 134 | 129 | 63 | 77 |
| including per 10,000 employees | 7.89 | 8.79 | 8.98 | 4.73 | 5.77 |

It is evident from Table 2 that although the number of injuries in workplace accidents is on the decrease, the proportion of fatal accidents has increased, as has sick leave duration per injured person. Notably, expenses for workplace health and safety have increased by two times in 2013–2017, which indicates that financial resources are used with low efficiency.

Analyzing incidence rates, we selected three groups of diseases which have the highest prevalence in the region as a consequence of environmental situation (Table 3). We should note that external effects rank second and make up 9% of the total. This indicator decreased in 2014 but has remained unchanged since.
Table 3. Incidence rates (first diagnosed)

| Indicator                                           | 2013   | 2014   | 2015   | 2016   | 2017   |
|-----------------------------------------------------|--------|--------|--------|--------|--------|
| Total persons                                       | 896.7  | 850.3  | 835.5  | 875.8  | 825.3  |
| Respiratory diseases, cases                         | 380.6  | 376.2  | 376.5  | 423.2  | 381.7  |
| Share in total diseases                              | 42%    | 42%    | 42%    | 47%    | 43%    |
| Injuries, poisoning and other external causes, cases| 113.1  | 80.4   | 76.5   | 79.8   | 77.1   |
| Share in total diseases                              | 13%    | 9%     | 9%     | 9%     | 9%     |
| Urogenital diseases, cases                          | 55.8   | 54.7   | 60.1   | 53.0   | 62.4   |
| Share in total diseases                              | 6%     | 6%     | 7%     | 6%     | 8%     |

Despite a slight decrease in the total number of detected diseases, the proportion of diagnosed cases of respiratory diseases and urogenital diseases has not changed. The situation is getting progressively worse considering the decrease in the population, particularly working, in the region (Table 4).

Table 4. Morbidity and injury growth rates compared to the previous period

| Indicator                                           | 2013   | 2014   | 2015   | 2016   | 2017   |
|-----------------------------------------------------|--------|--------|--------|--------|--------|
| Workforce growth rate                                | -      | -0.02  | -0.01  | -0.02  | -0.01  |
| Morbidity and injury growth rates                    | -      | -0.05  | -0.02  | 0.05   | -0.06  |

The third target includes indicators allowing to monitor the decrease/increase in the quality of the environment.

Table 5. Environmental protection

| Indicators                                          | 2015   | 2016   | 2017   | 2025   |
|-----------------------------------------------------|--------|--------|--------|--------|
| Current (operational) expenses for environmental protection, including payments for environmental protection services, RUB thousand | 450,211 | 422,096 | 590,638 | - |
| Objects with stationary sources of air pollution, units | 7      | 7      | 11     | -      |
| Pollutants from all stationary sources, thousand tons | 30.34  | 420.92 | 193.70 | -      |
| Pollutants captured and neutralized, total:          |        |        |        |        |
| Air pollutants captured and neutralized from total amount collected for treatment, thousand tons | 24.856 | 414.83 | 187.38 | -      |
| Pollutants captured and neutralized from total amount from stationary sources, % | 81.9   | 98.6   | 96.7   | -      |
| Pollutant emissions into air per GRP unit, tons/RUB million | 0.08   | 0.99   | -      | 0.23   |

The shares of expenses on environmental protection for the key industrial sectors and areas of activity in the Murmansk Region are shown in Fig. 2,3. Mining and manufacturing are major industries in the region. There were no expenses in 2017 on research and development and on projects
aimed at mitigating negative anthropogenic impacts on the environment.

Thus, the data available for this indicator seems sufficiently complete, accessible and transparent.

The next target is “Improving the legal regulation of environmental management and protection”. Some information on environmental management in the Arctic Zone can be obtained from the data provided by the Federal State Statistics Service. Another source of information is the Federal Service for Supervision of Natural Resources (Rosprirodnadzor), which is part of the Ministry of Natural Resources and the Environment of the Russian Federation. Rosprirodnadzor supervises rational use of mineral and living resources, use and reproduction of animals, organization and functioning of specially protected natural areas of federal significance, etc. Rosprirodnadzor’s site contains a fairly wide array of publicly available information. Users of natural resources have the options for self-assessment for compliance with the mandatory requirements of the law, for choosing areas for management of objects of negative impact, and for self-assessment for compliance with a list of requirements, with the results of the assessment available for viewing via the user’s account.

The data are often incomplete because sectoral databases are not coordinated with each other. Sectoral authorities (Ministry of Transport, Federal Agency for Fishery, etc.) do not possess data on environmental risks, the Ministry of Natural Resources and Environment has no comprehensive dataset on the prospects for developing the Arctic territories. As a result, the Ministry of Natural Resources and Environment is incapable of implementing functional measures reducing the impact on ecosystems (for example, restrictions on shipping and fishing), since they fall under the jurisdiction of other agencies. In turn, sectoral ministries cannot initiate environmental protection measures, as this is outside the scope of their authority.

The laws and regulations of different levels, from international conventions ratified by Russia to departmental instructions and guidelines, are poorly developed and coordinated. Some regulations date back to the Soviet period and need to be updated to modern standards. Consistent regulations have not been worked out, for example, on the amounts, types and methods of environmental monitoring studies on the Arctic shelf. Since no comprehensive legal framework has been provided by the state so far, corporations have developed their own standards, without attempting to account or compensate for negative impacts of industrial practices.

Attempts to find a compromise between economic growth and environmental protections can lead to conflicts and market failures, which can be prevented through government regulation and through forming an effective institutional system [21, 22, 23, 24, 25]. Inconsistent industrial standards generate problems for regional governments, forced to coordinate their programs through different agencies guided by different regulations. At the same time, with no comprehensive legal framework in place, the government unable to fully protect the region’s interests when interacting with industrial corporations that have a negative impact on the environment and often fail to fully recognize the interests of both the population and the region as a whole. The national
project Ecology has been developed, aimed at providing a framework for solving the above issues, including state regulation in the field of environmental safety and coordination of interests at all levels. In order to achieve and maintain environmental safety of the Russian Arctic, the draft of the National Public Standard “Arctic Region: Environmental Safety” recommends that each region of the Russian Federation develops, approves and implements a Strategy for Social and Economic Development, which must include a section on developing the infrastructure for environmental management of the region [26].

The next target for the stakeholder component is providing the population with access to eco-friendly products. Unfortunately, statistics for production and consumption of eco-friendly products is not collected at the moment. The Russian market of organic products is not regulated by any laws. In 2018, the State Duma adopted and the Federal Council approved Federal Law No. 280-FZ of August 3, 2018, on Organic Products and Modification of Separate Legal Acts of the Russian Federation. The law regulates issues related to establishment and maintenance of a unified state register for producers of organic products, containing product labeling, information and procedural guidelines, and details measures of state support for producers of these products.

The law only comes into force in 2020 and it is prohibited to label organic products produced during the transition period. When the law enters into force, it will allow to collect data on production and consumption of eco-friendly products. However, the law only regulates produced agricultural products: provisions of the law do not extend to agricultural products that are not produced (for example, hunting and fishing products) as their production chains cannot be fully controlled. However, products of hunting and fishing are an important component for the Arctic Region.

The situation with waste disposal is particularly acute in the Russian Arctic. The Strategy for the Development of the Arctic Zone regulates which products, containers and packaging can be imported into the Arctic, restricting import if economic and technological measures are not ensured for disposal. Therefore, products in eco-friendly and biodegradable packaging should be included as a separate indicator for this target.

5. Conclusions and discussion
To summarize, we have analyzed the data for assessing the environmental status and effective future management of environmental safety of individual areas of the Arctic, estimating whether the data available were complete, up-to-date and sufficient; as it turned out, data on some indicators were either partially or totally missing. Data are provided with a time lag of more than a year. Incomplete data (in particular, on environmental impact, as well as on the state of ecosystems and resources) dramatically reduces the efficiency of the measures taken to ensure environmental safety. For this reason, we have carried out analysis of the indicators corresponding to the chosen strategy for ensuring environmental safety of the Russian Arctic territories for each target, choosing the Murmansk Region for consideration; analysis has revealed that the indicators need to be further refined. For example, we believe that it is advisable to designate the indicators for monitoring the targets “Improving legal regulation of environmental management and protection” and “Providing the population with access to eco-friendly products” as statistical data that are mandatory for collection.

There is currently no unified institution regulating and ensuring data collection and providing access to sources of data on the environmental status, which engenders additional difficulties at every level of environmental safety management.

A task of crucial importance is developing a comprehensive system for managing environmental safety of the Russian Arctic, which would allow collecting/supplying all necessary data for all responsible structures at each level. This system of environmental safety management implies collection, analysis and control of relevant indicators of the environmental safety strategy at each level.

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