Potential for transition to circular economy in regions of the Russian Arctic

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Abstract. The paper considers the issues related to maintaining the environmental safety of regions in the context of sustainable development. We have established that the goals of circular economy, aimed at saving resources and using regenerative environmentally friendly production technologies are correlated with the goals of achieving sustainable development. We have analyzed Russia’s existing legislation concerning the principles of circular economy and sustainable development. We have found there is currently no unified integrated strategy aimed making the transition to circular economy. We have analyzed the indicators from the standpoint of their correlation with the goals of sustainable development, approaches of other countries and statistical data available. We have developed a system of indicators for assessing the level of circular economy in the context of sustainable development, adapted for regional specifics in view of the the current level of environmental monitoring. The results of analysis were used to make recommendations for establishing the conditions favoring the transition to circular economy, including at the regional level.

1. Introduction
Ensuring long-term sustainable development, maintaining sustainable economic growth while preserving the vulnerable environment the Arctic are important interrelated factors. Development of the Russian Arctic in the last decade has led to heavier anthropogenic pressure on the Arctic environment. Expanding sea routes, increased drilling on the Arctic shelf produce negative consequences for the Arctic, even with the advent of safer modern technologies.

The system for maintaining the environmental safety of the Arctic is still evolving, coming into conflict with the traditional linear model of economy, firmly established since the transition to industrial society, its key principles being: take – make – waste. Uncontrolled extraction of natural resources driven only by the short-term interests of individual businesses has led to resource scarcity, with considerable price volatility. This situation entails additional risks for business, including environmental and social ones [1].

A possible approach to reconciling conflicting interests is the model of circular economy aimed at conserving resources and using regenerative environmentally friendly production technologies. Society’s drift towards circular economy brings to the forefront the urgent problem of establishing a system for monitoring the indicators tracking both the economic and environmental consequences of regional development. This issue is particularly pressing for the Russian Arctic, where state policy generates increased economic activity of entrepreneurs, while the regulatory framework is still poorly developed, complete and transparent data are scarcely available, and social conscience is low.

2. Circular economy and environmental safety
First concepts of circular economy were described in mid-20th century by Kenneth Boulding [2], Walter Stahel, Robert Frosch and Nicholas Gallopoulos [3]. Notable contributions to the developing theory of digital economy were made by the concept of biomimicry introduced by Janine Benyus [3], the Cradle-to-Cradle design by Michael Braungart and William McDonough [3], and Gunther Pauli’s Blue Economy inspired by ecosystems [3].
In 1991, the World Business Council for Sustainable Development proposed the concept of eco-efficiency, a strategy urging businesses to establish economic practices that would not only lead to economic benefits but could have a positive impact on the environment [3].

In 2010, the Ellen MacArthur Foundation brought together scientists and entrepreneurs to disseminate information on limited resources and possible solutions based on the principles of circular economy, optimizing flows of biological and technical resources in the system by generating both biological cycles and technical cycles for managing non-renewable natural capital.

The circular economy has the following characteristics:
- zero waste, which minimizes the consumption of limited resources and maximizes added value;
- balance of businesses of different sizes, large businesses are complemented by small businesses that are highly adaptable to external conditions;
- all processes are based on renewable energy sources in order to reduce resource dependence;
- prices should reflect the full costs, accounting for all negative effects and consequences of production, subsidies and lack of transparency in pricing are a barrier hindering the transition to circular economy [4].

Most of the authors interpreting the term ‘circular economy’ tend to focus on the environmental impacts; only Moreau [5] considered circular economy solely as a way to obtain economic benefits. Webster, Hobson, Wu and Ma [5,6] adopted a holistic approach to system sustainability based on environmental protection, while other authors take a narrower view related to managing limited resources with minimal losses. Only Webster covered the social aspects, while most researchers lack a clear understanding of how much the circular economy contributes to social sustainability, and the concept has rather an indirect effect on the social wellbeing. Webster’s interpretation included the temporal aspect, emphasizing that the concept can have positive long-term effects. In contrast to other studies, Singh, Ordonez and Haupt, Vadenbo, Hellweg [6] discussed the aspect of consumption in their interpretations, associated, among other things, with solving social problems [7].

The strategies reviewed in [8] were developed for use by manufacturing companies involved in innovations, oriented towards circular economy (CE). Potential applications of the model in different industries are described in [9–11] for the construction and energy sectors, including alternatives developed for storage of renewable energy; business models intended for slowing and closing resource loops in a circular economy are composed.

Thus, the model of circular economy depends on how it is defined and what goals are set. From a global standpoint, the concept solves the problem of interaction between humans and nature and is one of the paths to sustainable development. Notably, the model of circular economy is inextricably linked with preserving the environmental safety of territories and the goals of their sustainable development.

3. Circular economy and goals of sustainable development in Russia: regulatory framework

Russian Federation has not currently adopted a unified strategy for environmental protection or a strategy for transition to circular economy at present; there are several strategies established as part of the program aimed at achieving sustainable development goals, and private environmental and socio-economic strategies drawing on individual principles of the circular economy.

These strategies are described in about 30 regulatory documents, including Decrees of the President, Government Orders, Federal Laws, issued over the course of 25 years since 1994. There are additional laws or government acts regulating narrower sectors, approving technical regulations; moreover, national standards (GOSTs) regulate mineral extraction and control environmental pollution.

Analyzing documents of these types, we can conclude that many laws and regulations on the environmental sphere adopted more than a quarter century ago are still in force, even though they may well be obsolete, failing to meet Russian or global environmental challenges of today.

The development strategies adopted in recent years confirm that the problem of rational use of resources and waste management is important for Russia. Still there is no unified strategy that could facilitate the transition to circular economy.
Let us now focus on the targets set out in the development strategies currently in force in our country that are related to basic principles of circular economy (Table 1).

Table 1. Development strategies adopted in Russia incorporating basic principles of circular economy [12–16]

| # | Strategy                                                                 | Year         | Target                                                                 | Number of indicators |
|---|--------------------------------------------------------------------------|--------------|------------------------------------------------------------------------|----------------------|
| 1 | Water Strategy of the Russian Federation up to 2020                      | 2009         | guaranteeing access to water resources for population and sectors of economy; protecting and restoring water bodies; preventing negative impacts from water bodies | 8                    |
| 2 | Energy Strategy of the Russian Federation up to 2030                     | 2009         | establishing an innovative and efficient energy sector answering the needs of the growing economy in energy resources and the interests of Russia’s foreign economic policy, contributing to socially oriented innovative development of the country | 7                    |
| 3 | Environmental Security Strategy of the Russian Federation up to 2025     | 2017         | preserving and restoring the natural environment, maintaining the quality necessary for human wellbeing and for sustainable development of the economy, eliminating accumulated environmental damage from industrial and other processes in the context of intensified economic activities and global climate change | 17                   |
| 4 | Industrial Development Strategy for Processing, Utilization and Neutralization of Production and Consumption Waste up to 2030 | 2018         | establishing and developing the industrial sector for recycling and disposal of waste, ensuring maximum utilization of waste in production and systematic reduction of the amount of unused waste, based on the 3R principle (reduce waste generation, reuse and recycle to recoverable resources) | 11                   |
| 5 | Strategy for Development of Mineral Resources of the Russian Federation up to 2035 | 2018         | providing sustainable supplies of minerals for socioeconomic development and maintaining an adequate level of economic and energy security of the Russian Federation | 2                    |

Let us consider the possibilities for using the main target indicators for assessing the environmental safety of Russia, in particular due to transition to circular economy. We should note that:

- Water and Energy Strategies were adopted more than 10 years ago for a long-term planning period, which does not allow to account for the rapidly changing climatic situation, deteriorating environmental, social and economic problems, or to adjust the action plan without delays.

- indicators included in different strategies are partially or almost completely identical.

Analyzing how the targets in the strategies comply with the principles of sustainable development, we found that only the Water Strategy and the Environmental Security Strategy combine economic, social and environmental factors. The Energy Strategy and the Strategy for Development of Mineral Resources do not touch upon the environmental aspects, and the Industrial Development Strategy for Processing, Utilization and Neutralization of Production and Consumption Waste does not cover the social sphere.

Let us analyze the results of the strategies in terms of how they comply with the indicators of Sustainable Development Goals (SDGs) [17]. If a strategy complies with the SDGs, this means that the target indicators developed by the UN are achieved, which in turn means that an internal mechanism for collecting statistics for official indicators or a system of national progress indicators should be established. A study of 43 countries published in 2019 by the UN Sustainable Development Solutions Network (SDSN) found that no common approach was taken to monitoring the implementation of the SDGs, and the number of national indicators developed by different countries for monitoring the SDGs varied from 34 indicators in Belgium to 244 in Canada [18].
Notably, Russia’s Water, Energy and Environmental Security strategies cover more of the SDG objectives than systems for assessing the circular economy of foreign countries. Unlike foreign approaches, they include the objectives of preserving marine and terrestrial ecosystems; however, the strategies do not contain indicators of domestic material consumption and material footprint, which are important for assessing the circular economy.

China, Russia, the United States, and the United Kingdom use official SDG indicators without developing national indicators. Information on the progress of the SDGs in Russia is published on Rosstat’s website. The SDG indicators were adopted in 2015, however, a data collection methodology has been developed so far only for 33% of indicators in Russia, for 59% in the USA, and for 74% in the UK [19,20,21]. China has no statistical mechanism for collecting data but it is compensated by the National Strategy for transition to circular economy. The low share of the indicators collected means that the adopted strategies are ineffective for tracking the progress. Most of the indicators collected in Russia are economic or concern the healthcare sector.

To summarize, Russia’s regulatory framework needs to be updated, in particular, to cover the development of a unified integrated strategy for transition to circular economy. Development strategies of the Russian Federation are closely related to goals of sustainable development, but there is currently no mechanism for collecting statistical data on many indicators of the strategies, and the methodology for tracking the progress towards achieving the SDGs is poorly developed.

4. Methodology

To assess how a specific goal (preserving the environmental safety of the region) is achieved, we use the indicator system for monitoring the level of circular economy based on analysis of existing methods. The experience of foreign countries was used to select the indicators in view of the goals set out in the development strategies currently adopted by the Russian Federation, covering aspects of circular economy, as well as SDG indicators. The balanced scorecard system (BSC) serves as a methodological basis for solving this problem. The proposed strategic maps (balanced scorecards for individual levels of governance, e.g., regional and municipal) should allow to coordinate the competing interests in maintaining environmental safety in the Arctic.

The strategic maps considered in [22] can be used to ensure environmental safety and sustainable development of the territories. The maps presented differ from the traditional approach in that the authorities should focus on the stakeholder (or customer in the classical version of the BSC) component, instead of the financial one. The second level introduced by the authors is ‘Industry and Entrepreneurship’ instead of the traditional ‘Business’.

| Industry and entrepreneurship |
|-------------------------------|
| 1. Improving quality of natural resources (distribution of natural resources, use of natural resources) | 2. Establishing effective processes for waste management (waste recycling) | 3. Reducing industrial emissions | 4. Land remediation |

Fig. 1. Industry and Entrepreneurship component of Strategic Map for the region’s environmental safety

The map was composed for the Murmansk Region, where the environmental monitoring system is fairly well-developed. However, the region is also where the country’s largest industrial enterprises of the country (mining and non-ferrous metallurgy) are located. It is the enterprises of the mining industry, ferrous and non-ferrous metallurgy that are the biggest contributors to pollution. On the other hand, these enterprises are the main source of investments in fixed assets aimed at environmental protection. Their share is about 97.8% of the total volume of such investments.

The Industry and Entrepreneurship component characterizes the concept (essence, goals) of circular economy. Therefore, we studied the legislation adopted in the Russian Federation, international experience in assessing the progress in achieving such goals (circular economy), additionally focusing on the criteria for transparency and accessibility of information from official
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Available statistical sources of the region, in order to select a system of indicators that can be used to analyze how each goal is achieved with respect to this component (Fig. 1).

5. Results

Let us establish the key indicators based on analysis of the SDGs, the principles of circular economy, foreign approaches, and Russia’s legislation for each goal (Fig. 1).

The choice of indicators is explained in Table 2. We chose the indicators meeting one or more of the following criteria: correlated with indicators of sustainable development goals; correlated with foreign approaches to assessing circular economy; contained in development strategies of the Russian Federation, including regional ones. The indicators were analyzed in terms of the available statistical data.

Table 2. Analysis of potential uses for indicators

| #  | Indicator                                                                 | Data available | SDG        | Country’s approach                                                                 | Regional indicator can be calculated (Murmansk Region) |
|----|---------------------------------------------------------------------------|----------------|------------|-----------------------------------------------------------------------------------|---------------------------------------------------------|
| 1  | Number of organizations for processing, disposal and decontamination of waste | +              | -          | Development Strategy of Russian Federation                                         | + (including form of ownership)                           |
| 2  | Share of government spending on environmental R&D                          | +              | 9.5.1      |                                                                                  | Ongoing expenses for environmental protection, including on R&D aimed at reducing negative anthropogenic environmental impacts. Data available on investments in fixed assets of organizations and aimed at protecting natural resources |
| 3  | Number of environmental patents granted                                     | +              | 9.5.1      | France                                                                           | -                                                       |
| 4  | Share of recycled waste                                                    | +              | 12.5.1     | China                                                                             | Data available on decontaminated, buried, treated waste |
| 5  | Use of processed raw materials                                             | -              | -          | China, France, Germany, Netherlands                                               | -                                                       |
| 6  | Contribution of processing industry to GDP                                 | -              | -          | Netherlands                                                                      | -                                                       |
| 7  | Domestic consumption of materials per capita                               | +              | 8.4.2/12.2.2 | France, Netherlands                                                              | -                                                       |
| 8  | Resource efficiency                                                        | +              | 8.4.1/12.2.1 | Germany, Netherlands                                                             | -                                                       |
| 9  | Self-sufficiency of raw materials                                          | +              |            | Germany, Netherlands                                                             | -                                                       |
| 10 | Use of renewable energy sources                                            | +              | 7.2.1      | Netherlands                                                                      | -                                                       |
| 11 | Pressure on natural resources                                              | +              | 6.4.2      | Germany, France, Netherlands                                                      | -                                                       |
| 12 | Share of wastewater safely treated                                        | +              | 6.3.1      | China                                                                             | Indicator can be calculated. Recycled and reused water supply. Discharged wastewater treated to standard quality |
CO₂ emissions per capita

+ 9.4.1 China, Netherlands
Atmospheric emissions of major pollutants (including CO₂), other emission indicators available. Data are partially classified. Per capita indicator can be calculated.

Share of landfill waste

+ China, France
Indicator can be calculated

Share of specially protected areas

+ 14.5.1/15.1.2 Development strategy of Russian Federation
Data on specially protected areas available. Indicator can be calculated.

Ratio for growth of mineral reserves to their production

+ Development strategy of the Russian Federation
Indicators for facilities put in service include ‘Capacities and facilities for environmental protection and rational use of natural resources, excluding waste recycling and waste incineration, plants and landfills for recovery, decontamination and disposal of toxic industrial, household and other wastes’. From 2014 to 2018, such facilities were introduced only in 2017 but data are also classified.

The current state program of the Murmansk Region on Environmental Protection and Reproduction of Natural Resources allocates RUB 1,582,533,400 as implementation costs for 2014–2020. The share of expenses from the regional budget is about 8%. From 81% to 95% of the program funds were spent in different years. The funds were used in several main directions (subprograms); however, there is no subprogram for waste recycling for subsequent reuse.

The structure of GRP by type of economic activity includes ‘Water supply; water disposal, organization of waste collection and disposal, pollution containment measures’ but contributions of recycled products to GRP are not covered as separate items.

The section on ‘Investments in fixed assets of organizations aimed at environmental protection and rational use of natural resources’ includes ‘Facilities (plants) for processing and recycling industrial waste’ but data for this item are classified. The indicators for facilities put in service include ‘Capacities and facilities for environmental protection and rational use of natural resources, excluding waste recycling and waste incineration plants, plants and landfills for recovery, decontamination and disposal of toxic industrial, household and other wastes’. From 2014 to 2018, such facilities were introduced only in 2017 but data are also classified.

The report on the environmental situation contains data on the decontaminated, buried and treated waste, but no data on recycled waste.

We used the balanced scorecard system, analysis of approaches of foreign countries, goals of sustainable development and Russia’s legislation from the standpoint of circular economy, developing the key indicators for monitoring the progress towards achieving these goals (Table 2). We excluded several indicators from analysis based on the criteria of data availability and correlation with SDG indicators. The final system covers 7 goals of sustainable development, social, economic and environmental aspects, the basic principles of circular economy related to consumption of resources, their rational cyclical use and reduction of negative environmental impacts. Table 3 gives the indicators that can be used for the Murmansk region, as even indicators available for Russia cannot be calculated in full for the regions. Table 3 combines the indicators that can possibly allow to coordinate the SDGs (environmental protection) and the principles of circular economy for Russia and the regions.

Table 3. General and regional indicators for assessing progress towards achieving sustainable development goals

| Indicator | Potential regional indicator |
|-----------|-----------------------------|
| 1. Improving quality of natural resources (distribution of natural resources, use of natural resources) |
| X₁: share of government spending on environmental R&D (% of total spending on R&D) | 1. Ongoing expenses on environmental protection, including on R&D aimed at reducing negative anthropogenic impacts on environment 2. Investments in capacities and facilities for environmental protection and rational use of natural resources, excluding waste recycling and waste incineration plants, plants and landfills for recovery, decontamination and disposal of toxic industrial, household and other wastes. |
2. Establishing effective processes for waste management (waste recycling)

\( X_2 \): share of recycled waste (% of waste processed by all methods)

\( X_3 \): share of safely treated wastewater (% of total wastewater)

\( X_4 \): CO\(_2\) emissions per capita (metric tons per capita)

\( X_5 \): domestic consumption of materials per capita (1000 kg of domestic resources per capita)

\( X_6 \): using energy from renewable sources (% of total energy use)

\( X_7 \): efficiency of resources (material footprint in kg per GDP unit)

\( X_8 \): pressure on natural resources, i.e., freshwater withdrawal (% of freshwater reserves available)

\( X_9 \): number of environmental patents granted (% of world total)

\( X_{10} \): share of specially protected areas (% of total area of territories important for biodiversity)

\( X_{11} \): investments in fixed assets of organizations, aimed at protecting natural resources

3. Reducing industrial emissions

\( X_{12} \): share of safely treated wastewater (% of total wastewater)

\( X_{13} \): CO\(_2\) emissions per capita (metric tons per capita)

4. Land remediation

\( X_{14} \): share of specially protected areas in the region (% of total area)

\( X_{15} \): share of landfill waste in region

\( X_{16} \): expenses for protection and remediation of lands, surface water and groundwater

Not all indicators applicable for Russia can be calculated at the regional level. We suggest using other indicators, based on the principles of accessibility and transparency of information. Regional specifics can be taken into account by using additional data.

6. Conclusions and discussion

We have assessed the conditions favoring the transition to circular economy and achieving goals of sustainable development.

First of all, we can conclude from review and analysis of the legislative framework that several strategies containing repeating elements have been adopted at present; furthermore, many laws regulating nature management and environmental protection have not been updated to account for the current environmental problems facing the world. In view of this, a unified strategy should be developed for transition to circular economy, covering aspects of rational consumption, environmentally friendly production, reuse of goods and resources, reduced waste generation, processing of raw materials, protection, conservation and rehabilitation of natural resources, mitigating negative impacts to the environment.

Analysis of the statistical indicators characterizing sustainable development targets allowed to identify the indicators that contribute to achieving SDGs 6, 7, 8, 9, 12, 14, 15, affecting the social, economic and environmental aspects. We have excluded many indicators from consideration because there is no statistical mechanism for data collection.

In particular, this concerns processing municipal solid waste, with the following data available:
- amount of municipal solid waste removed;
- amount of MSW removed to waste treatment facilities;
- amount of MSW removed to waste disposal facilities;
- amount of MSW removed to waste decontamination facilities.
There are no data on the final methods used for handling the waste after it is transported to treatment and disposal facilities by the corresponding services. Notably, while the method chosen for decontamination may either contribute to development of circular economy, for example, composting, or hinder it (e.g., incineration without energy recovery), these data are not available for waste disposal.

It should be borne in mind that refining the statistical data collected on decontamination methods cannot solve the problem of waste recycling, which is the main obstacle to transition to circular economy in our country.

Based on the results obtained, we can give the following recommendations for establishing the conditions for transition to circular economy in Russia: developing a unified integrated strategy for transition to a model that includes updating the existing regulatory framework; improving the mechanisms for collection of statistical data, including at the regional level, counteracting the negative experience of waste management from foreign countries and adapting the system to the needs of waste disposal and reduced waste generation by recycling; developing public awareness campaigns promoting transition from linear to circular economic model as an important and necessary step. Introducing this set of measures, along with coordinated efforts from the government, the business community, and the population, can make it possible to begin the transition to circular economy at the regional level and generate the conditions necessary for achieving sustainable development.

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