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The Approaches to the Development of Regional Frameworks of Sustainable Development Indices and Indicators

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ABSTRACT

The active growth of the world's population has led to the emergence and aggravation of the issues of human-nature interaction. Resulting from more than thirty year long discussions at different levels, the term sustainable development had been introduced by the international scientific community, and later the sustainable development goals were indentified. Currently, the Russian Federation has defined national Sustainable Development Goals (SDGs) indicators, however they cannot be used for the assessment of the socio-ecological and economic development of the region to their full extent. Using the example of the Novosibirsk region, a list of indicators for the assessment of the sustainable development status was determined. Based on the comparison of these indicators, the integral characteristics of the regional sustainable development factors were calculated, and using these characteristics the duration of the status periods was identified.

Keywords: *sustainable development, sustainable development indicators, sustainable development indices, socio-ecological and economic condition.*

1. INTRODUCTION

Sustainable development as a new paradigm of socio-economic development of society is a universally acknowledged necessity to change the trajectory of the contemporary global development. There is a consensus that the consumer economy and the irrational use of natural resources, coupled with an exponentially growing population and increasing economic and social inequality, are a dead end road. Since 1992, the whole world, under the UN guidance, has been slowly and with mixed results developing practical aspects of the sustainability concept implementation. An important aspect of this work is to identify reference points of the initial status of a particular country or region, and to develop criteria that determine trends on the way to the sustainable development. Such evaluation points include sustainable development indices and indicators. The formation of a functioning framework of regional sustainable development indicators is an extremely important and complex scientific and practical task. The framework of indicators should not be just a mere set of

indicators describing individual characteristics of the process status, but a real tool for the development of management decisions, applicable in all social spheres.

2. MATERIALS AND METHODS

The complexity of the task is determined by the complexity of the system under research. Contemporary natural and man-made systems from the local to the global level contain a huge number of constituent subsystems: natural, man-made, economic, social, informational, interconnected by a complex set of direct and reverse, positive and negative connections. For that reason, there is a need to implement an instrumental assessment of the situation using quantitative and qualitative indicators.

For almost thirty years, certain countries and major international organizations have been developing unique frameworks of sustainable development indices and indicators in order to assess the sustainability of society. One of the first integrated frameworks of sustainable development indices and indicators was the framework

of 132 indicators, developed in 1996 by the UN Commission on Sustainable Development (CSD). The framework includes environmental, social, economic aspects of sustainable development, as well as institutional aspects: international legal instruments, the role in the development of different population groups, information aspects of sustainable development. The framework takes into account spatial (global, regional and local) and temporal components.

In 2001, the Organization for Economic Cooperation and Development (OECD) constructed a framework of indicators, including 3 types of indicators: pressure - state - response. Indicators of pressure are determined by the peculiarities of goods and services production and consumption, reflect the intensity of anthropogenic impact on the environment, the peculiarities of resource consumption. Indicators of the state reflect the current environmental conditions, their dynamic changes through the analysis of human health, the costs of cleaning up discharges and emissions of pollutants, the productivity of agricultural land. Indicators of the response assess the societal response aimed to solve emerging environmental problems reflected in the system of environment-related fees, environmental protection costs, the analysis of the share of development of green technologies, etc. Subsequently, the OECD pressure-state-response model was adopted as the basis for the development of other frameworks of sustainable development indicators, in particular, it was used in the development of European indicators of Eurostat [5].

The World Bank, as a part of the World Development Indicators annual report[17], publishes various indicators of sustainable development in dynamics since 1980, grouped into 6 main sections: general, population, environment, economy, state, market. The World Bank's set of indicators includes more than 550 indicators, on the basis of which The Little Green Data Book [18] has been published since 2000, reflecting the main environmental, social and economic indicators of sustainable development.

Russia is also developing its own framework of sustainable development indicators. This indicator framework is based on the collected federal and regional statistical data. Since 2015, section 2.8 Indicators for achieving the Sustainable Development Goals of the Russian Federation has been added to the Federal Plan of Statistical Indicators, initially it included 90 indicators. Starting with 2021 Rosstat collects data according to the National Set of Indicators for the Sustainable Development Goals [19], which includes 160 indicators for 17 Sustainable Development Goals.

The analysis of the existing framework of sustainable development indicators identified two methodological approaches to their construction. The first approach is based on the set out of a framework of individual indicators reflecting different aspects of sustainable

development. As a rule, when following this approach, all the indicators can be divided into three groups: environmental, social and economic. Some groups contain certain institutional indicators, but they can also be included into each of the three groups listed above. The majority of the world's indicator frameworks is based on a similar principle of collecting information.

This approach to data systematization contains a large number of indicators, for example, in Russia there are 160, which are hard to use as a tool for management decision-making. It is difficult to work with such a number of indicators, they are hardly comparable due to the difference in quantitative and qualitative characteristics, as well as due to the lack of measurement units comparability. For Russia, the difficulty also lies in the fact that these data are collected in different departments, and the data in the National Set for a number of indicators do not contain dynamic series, there is no regional component for some indicators, and and there is still a lot of work to be done to complete the list with the required data.

The second approach is the development of integral (aggregated) indices, which include a large number of indicators adjusted and averaged by units of measurement, reflecting the complex state of individual aspects of achieving the Sustainable Development Goals. The calculation of indices is also based on the aggregation of indicators for three thematic groups: environmental, social and economic. The model can be built in different structured variations, the most common are: - topic/problem – indicator; - goals - tasks - indicators; - topic - sub-topic - indicator; - variations of the OECD system pressure - state - response [1].

In 2001, the challenges of aggregating different indicators into single integral indices were addressed in the Report On The Aggregation Of Indicators Of Sustainable Development by the UN Commission on Sustainable Development [16]. The report noted that the main problem in aggregating indicators is to determine the values of indicators, as well as their significance and role in the formation of an aggregated indicator.

Examples of integral sustainability indicators frameworks may include:

- The System Of Ecological And Economic Accounting (SEEA) was proposed by the Statistical Department of the UN Secretariat in 1993, the system takes into account the role of the environmental factor in national economies;

– Human Development Index (HDI) - the indicator reflects the social aspect of sustainable development and is based on the integration of three indicators: longevity, the achieved level of education and GDP per capita, measured through purchasing power parity;

- the Genuine Savings Index reflects the size of national savings after taking into account the amount of depletion of natural resources and environmental damage;

- the Living Planet Index reflects the state of natural systems and is measured annually as part of the World Wildlife Fund (WWF) report;

- the Ecological Footprint Indicator is an indicator reflecting the pressure on the environment through qualitative measurement of the consumption of food, energy and materials, equivalent to the area required for the absorption of the wastes generated, etc.

The analysis of the listed and other existing frameworks of aggregated indicators shows that their application accurately reflects the sustainability characteristics of a single country, but often does not take into account intra-country, regional characteristics, which results in difficulties in using integrated indicators when analyzing regional and local peculiarities of achieving sustainable development goals.

3. RESULTS AND DISCUSSION

The assessment of the sustainable development of the Russian Federation, in our opinion, should as well be carried out within the regional context. This analysis can be made using both the National List indicators and indicators reflecting regional specificity. At the same time, the comprehensive definition of sustainability indicators on the regional level is limited due to the insufficiency of high-quality official information. This insufficiency of information results from the fact that it is being generated by different sources.

The developed regional frameworks of sustainable development indices, due to their differences, cannot be universal and require significant adjustments when apllied to other regions. Thus, regional indicator frameworks are being developed with rergard to the availability of statistical data and the selected approaches, [4,7,10,15]. The analysis of these frameworks shows their practical incompatibility, these significant differences make it impossible to compare individual regions through sustainable development indicators.

Until 2015, when creating regional frameworks of sustainable development indicators, their developers experienced significant difficulties due to the lack of systematized data on regional sustainabilty characteristics, data were collected by different departments and were not always available for the analysis. However, even after the development of the National Set of Sustainable Development Indicators, little has changed so far, since little time has passed, and the amount of data on particular indicators is given only for Russia as a whole, without the division by regions, which makes it difficult to use the set for the analysis.

The authors also attempted to develop a similar model for the Novosibirsk Region based on the framework of sustainable development indices and indicators for the Tomsk Region, but taking into account its territorial features [13]. But the proposed model may be of a reference nature, and does not provide sufficient data for the management decision-making required for the sustainable development of the region.

Taking into account the set of indicators of the National Set of Sustainable Development Indicators, an attempt was made to develop integral sustainabilty indicators for the Novosibirsk region in order to unify the system and to facilitate the dissemination of the experience gained in the proccess of creating frameworks in other regions. The model was based on the theme (problem) – indicator – index structure.

To carry out the analysis, all the indicators of the National Set were divided into three groups:

- environmental (24 indicators: 6. Clean water and sanitation; 12. Responsible consumption and production; 13. Combating climate change; 14. Conservation of marine ecosystems; 15. Conservation of terrestrial ecosystems);

- social (64 indicators: 3. Good health and well-being; 4. Quality education; 5. Gender equality; 10. Reduction of inequality; 16. Peace, justice and effective institutions; 17. Partnership for Sustainable Development);

- economic (72 indicators: 1. Eradication of poverty; 2. Eradication of hunger; 7. Low-cost and clean energy; 8. Decent work and economic growth; 9. Industrialization, innovation and infrastructure; 11. Sustainable cities and settlements).

Next, the following algorithm was applied when developing a system of integral indicators and assessment of the sustainable development of the Novosibirsk region:

- selecting indicators for each group of factors;

- for each factor, bringing the indicators to a comparable form;

- calculationing the integral value of the status level of each factor;

- assessing the dynamics of the status of the integral value of each factor;

- comparing the obtained indicators.

Table 1. Indicators for assessing the level of sustainable development of the Novosibirsk region

Factors of sustainable development	Content of indicators
Environmental	X1 - pollutants, released into the atmosphere by stationary sources, thousand tons X2 - captured and neutralized air pollutants coming from stationary sources, thousand tons. X3 - the discharge of polluted wastewater into surface waters, million m3 X4 - use of fresh water, million m3 X5 - production and consumption wastes, thousand tons.
Social	X6 - population, thousand people, at the end of the year X7 - the number of births per 1000 people X8 - the number of deaths per 1000 people X9 - number of doctors per 10,000 people the number of average X1 - medical personnel per 10,000 people X10 - the number of hospital beds per 10,000 people X11 - capacity of outpatient polyclinic facilities, visits per a shift for 10,000 people X12 - the number of registered crimes, thousand units. X13 - life expectancy at birth, years X14 - diseases, registered in patients with a diagnosis established for the first time in their lives per 1000 people X15 - blood and hematopoietic organs diseases and immune system diseases per 1000 people
Economic	X16 - the average annual number of employed, thousand people. X17 - unemployment rate, % X18 - real income of the population, % compared to the previous year X19 - GRP volume index, % compared to the previous year X20 - index of the physical volume of investments in fixed assets, % compared to the previous year X21 - the degree of depreciation of fixed assets at the end of the year, % X22 - number of enterprises and organizations at the end of the year industrial production index, % compared to the previous year X23 - the cultivated area of all agricultural crops in farms of all categories, thousand hectares X24 - newly build residential housing, thousand m2

In this study, statistical data on the Novosibirsk Region published in data books and available on the Rosstat official website were used to assess the sustainable development of the Novosibirsk region. Combining the indicators of the Sustainable Development Goals, analyzing the quality of available information, experience in developing sustainable development indicators of the Russian Federation regions [3,4,5,6,7,10] made it possible to focus on the following indicators of socio-economic development and the ecological state of the Novosibirsk region:

As can be seen from the units of measurement, the indicators assessing the ecological, social and economic condition of the region are incomparable. For further calculations, all the values of the above indicators were brought to a comparable form by normalizing each indicator by its maximum value [2] using the formula (1):

$$Xi\,norm = \frac{Xi}{max\,Xi} \qquad ((1)$$

where, $Xinorm$ is the normalized value of the i indicator;

Xi - indicator;

$max\,Xi$ is the maximum value of the i indicator.

To determine the integral level of the environmental factor (or environmental well-being), social factor (social well-being) and economic factor (economic well-being), the method of adjusted multivariate mean was used, taking into account the influence of a specific indicator on the integral assessment [2].

$$Pi = \frac{1}{k}\sum_{i=1}^{k} x_i^{norm} \qquad ((2)$$

where, Pi is an adjusted multi-year indicator,

k is the number of indicators,

xi is the standardized or normalized value of the i indicator.

The use of a multivariate mean makes it possible to interpret data and compress information to the values necessary for the analysis, and in the process of calculations to move from a multivariate space to an

Indices of the Novosibirsk region sustainable development
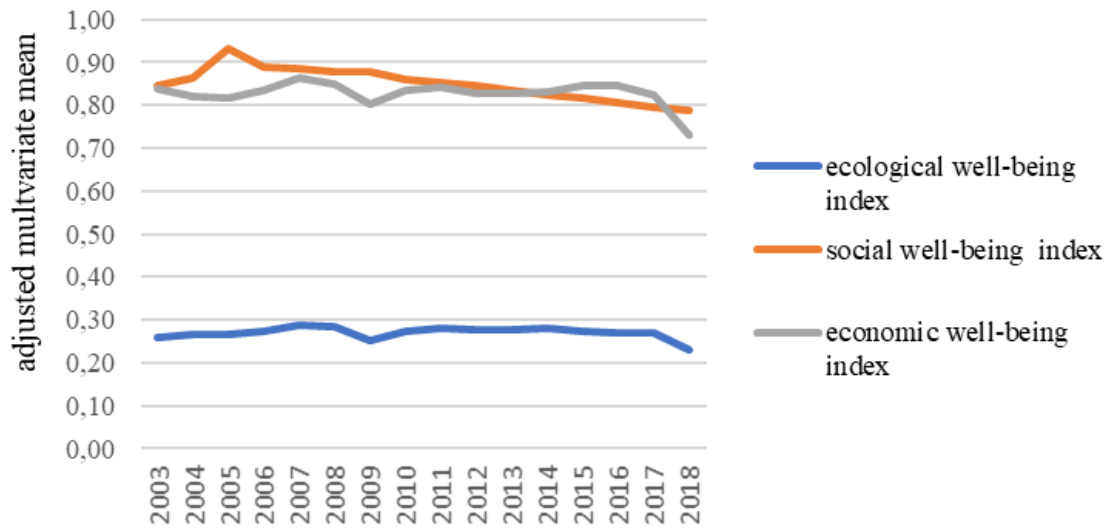
Figure 1 Indices of the Novosibirsk region sustainable development in the values of the average multivariate indicators of environmental, social and economic well-being for the period of 2003-2018.

Table 2. Grades of states of sustainable development factors of the Novosibirsk region for the period of 2003-2018.

Process status	Bad	Average	Good
Environmental well-being	2006, 2007, 2008, 2010, 2011, 2012, 2013, 2014, 2015, 2016	2003, 2004, 2005, 2017	2018
Social well-being	2013, 2014, 2015, 2016, 2017, 2018	2003, 2004, 2007, 2008, 2009 2010, 2011, 2012	2005, 2006
Economic well-being	2018	2005	2003, 2004, 2006, 2007, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017
Sustainable development	2018	2012, 2013, 2014, 2015, 2016, 2017	2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011

unvariate [12]. When using multivariate mean in this study, all its values are within the range from 0 to 1, which allows us to present the data obtained in comparable indicators, including graphically.

These calculations have led to the following results:

The use of sustainable development indicators in a comparable form made it possible not only to compare them with each other, but also to visualize them for further use and analysis.

The analysis of the data obtained shows a clear dependence of the trends of environmental and economic well-being for the period under study. At the same time, taking into account the analyzed data, in case of the ecological well-being index, the lower the index value, the better is the state of the environment, and in case of the economic well-being index, the higher the indicator value, the more favorable is the economic situation. Most likely, indicators reflecting the environmental well-

being of the region, due to their specificity, depend rather on economic well-being than social. The importance of the latter is influenced, apparently, not by the level of economic well-being, but by the support of the population and state funded social facilities.

At the next stage of the analysis, we carry out the periodization of each factor of the sustainable development of the Novosibirsk region through the method of grouping them with equal intervals. We grade the states of the factors as bad, average or good. As a result of the division , we obtain the following:

The results of the periodization confirm the previously made conclusions that in different periods of the Novosibirsk region sustainable development, the impact of factors of the regional socio-environmental and economic state is guided by its own laws.

4. CONCLUSION

The proposed methodology for designing a framework of sustainable development integral indicators makes use of available statistical environmental, social and economic data. The number of indicators can be quite large, but their normalization and translation into adjusted multivariate values allow not only bringing them into comparable values, but also presenting them in a form applicable for management decision-making, thus ensuring the sustainable development of the region. When using the proposed methodology, it should be taken into account that when calculating the indices, we get relative data for the observation period. The period from 2003 to 2018 was chosen for the study, thus, the situation was analyzed regardless of the impact of the Covid 19-21 pandemic. Currently, the data are being collected to analyze the impact of the pandemic on various indicators of the Novosibirsk regionsustainable development. At present it is premature to talk about the actual consequences, more time is needed to accumulate additional data and to conduct an analysis.

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