

Tetiana V. Kasianenko<sup>1</sup>, Yeugene I. Nagorny<sup>2</sup>

## GROUNDING THE APPROACHES TO ESTIMATION OF ECOLOGICALLY ORIENTED INNOVATIVE DEVELOPMENT

*The article investigates the assessment methodology for social, ecological and economic system development, and reveals its various combinations. Within the indicative approach the authors systematize the methodology of ecologically oriented innovative economic development assessment. The notion "indicators of the innovative activity ecologization concept" is improved. Key indicators of innovative activity ecologization concept are suggested.*

*Keywords:* sustainable development; ecologically oriented innovative development; ecologization.

*JEL classification:* O13; O31; Q32.

Тетяна В. Касьяненко, Євген І. Нагорний

## ОБҐРУНТУВАННЯ ПІДХОДІВ ДО ОЦІНЮВАННЯ РІВНЯ ЕКОЛОГІЧНО СПРЯМОВАНОГО ІННОВАЦІЙНОГО РОЗВИТКУ

*У статті досліджено і систематизовано методології оцінювання рівня розвитку соціо-еколого-економічної системи, виявлено їх різні комбінації. В рамках індикативного підходу проведено систематизацію методологій оцінювання екологічно спрямованого інноваційного розвитку економіки. Удосконалено поняття «індикатори концепції екологізації інноваційної діяльності». Запропоновано та обґрунтовано базові індикатори концепції екологізації інноваційної діяльності.*

*Ключові слова:* сталий розвиток; екологічно спрямований інноваційний розвиток; екологізація.

*Табл. 1. Літ. 19.*

Татьяна В. Касьяненко, Евгений И. Нагорный

## ОБОСНОВАНИЕ ПОДХОДОВ К ОЦЕНКЕ УРОВНЯ ЭКОЛОГИЧЕСКИ НАПРАВЛЕННОГО ИННОВАЦИОННОГО РАЗВИТИЯ

*В статье исследованы и систематизированы методологии оценки уровня развития соціо-еколого-экономической системы, выявлены их различные комбинации. В рамках индикативного подхода проведена систематизация методологий оценки экологически направленного инновационного развития экономики. Усовершенствовано понятие «индикаторы концепции экологизации инновационной деятельности». Предложены и обоснованы базовые индикаторы концепции экологизации инновационной деятельности.*

*Ключевые слова:* устойчивое развитие; экологически направленное инновационное развитие; экологизация.

**Problem statement.** During the last 50 years we have evidenced the intensive growth in planet population and also rapid scientific and technical progress, which caused deterioration of most ecosystems, great decrease of biological productivity and biological variety, catastrophic exhaustion of grounds and mineral resources in the Earth surface, hydrosphere and atmosphere pollution. The necessity to satisfy humorous human needs lead to economy intensive growth, changes in world economy ratio, in producing capacities, technique and technologies, production assortment, consumption patterns. Models of both production and consumption, formed in the world, fail to provide the conditions human and Nature harmonious coexistence.

<sup>1</sup> Sumy State University, Ukraine.

<sup>2</sup> Sumy State University, Ukraine.

It is necessary to change today's economy practice through refusal of natural resources "zero" value, that will create financial conditions for social and economic development balance, to decrease great man-induced impact on the environment, to stop its degradation. The criterion for sustainable development has to be not gain in production, but its increase potential evaluation in terms of environment saving, people's wealth and life quality growth.

**Recent research analysis.** Significant contribution to the study of ecologization was made by the following scientists: N.M. Andreeva and S.K. Kharichkov (2004), O.F. Balatsky (2007), S.M. Ilyashenko (2012), N.V. Karaeva et al. (2011), Ye.V. Khlobystov et al. (2010), M.A. Khvesyk (2008), L.G. Melnyk (2005), O.V. Prokopenko (2010; 2011), V.M. Tregobchuk (2002), O.O. Veklych (2003) and others. Despite significant scientific achievements in this field, the problem of estimating the level of ecologically oriented innovative development of separate regions and economic subjects in the sustainable development context is still present.

**The objective of the article** is to systematize and analyze the methodology of estimating the level of sustainable development with purpose to investigate the system of innovative activity ecologization indicators.

**Key research findings.** It is important to find criteria system and measuring indices, which help estimating the level of social, ecological and economic system development within the sustainable development concept. Numerous international organizations, national and foreign scientific schools work in this direction nowadays. Analyzing the most recent researches we can note the indicative and quasi-dynamic are the current approaches to sustainable development estimation.

The quasi-dynamic concept (Barannik, 2012) is based on the methodology estimating various potentials of development by means of quantitative and qualitative factors. They are considered in the model in general terms, and this from our perspective complicates quantitative and qualitative changes presentation in dynamics. The indicative approach is the most objective in this case.

Economic literature explains the concept of indicator from the viewpoint of economic system, as a factor, economic value of change measuring, which is used to ground economic policy, economic processes development and results estimation and allows seeing the direction in which development is to be expected.

L.G. Melnyk (2005) sees the indicators of sustainable development as separate "fragments" of information, showing the condition of the whole system. The observation of these small, but important "fragments" helps better understanding of the complete picture of the system current state and finding its direction: it's improving, degenerating or not changing. N.V. Bibik (2009) thinks that sustainable development indicators are the factors, used to estimate people's life quality, human activity impact on the environment and people's health.

Within the general framework of the indicative approach indicators and methodologies are used in quite a variety.

With the system of partial indicators, which characterize separate aspects of sustainable development, many methodologies are worked out by international organizations, using different interpretation schemes. E.g., UN Sustainable Development Committee ranges indicators by priority and they are presented by scheme: "theme – sub-theme – indicator". Today their number is 57 (UN, 2007). Essentially, indicators

are suggested to estimate country's macroeconomic level and are not interrelated factors, measuring various features.

The ECDO use integrative indicators of the system "environment – economy", with horizontal interconnection between factors within every system by blocks "impact – state – reaction". Integrative indicators are the blocks of factors, which together characterize change trends, reasons for these changes and ways of reaction.

The UN and the World Bank structure their indicators as true savings, human potential development index, natural capital, ecological stability index. The integrative indicator of true savings unites into general index the estimations of social ecological and economic system. It is calculated by the World Bank for all countries (World Bank, 2010). The value of this factor is very important to conduct investments into human capital, innovative development ecologization policy etc.

Indices are widespread indicators. They show the correlation of certain values. The index form of a factor allows comparing countries by ecological sustainability, estimating the results of environmental policy, correlating economic growth and nature protection.

The aggregate indicator of sustainable development is the human potential development index, which mostly shows the social constituent of sustainable development. According to foreign scientists' calculations, regions with high material life level, but with complex ecological conditions have lower index, than those regions, which have little gross regional product per capita, but higher lifetime expectancy. In this index negative ecological consequences are partially reflected (diseases etc.), that is the reason of low lifetime expectancy. Methodology allows state and regional levels estimation for further decision-making concerning development for ecologization.

The ecological sustainability index presents the progress of various countries in ecological direction, it is a good measure of man-made impact on nature, it considers plants extermination, efficiency of land resources use, possibilities in solving global ecological problems, is both ecological and economic measure. The ecological sustainability index is calculated by 22 indicators, each indicator has 2–5 variables of similar weight, ranging ecological problems as all equally important. Finland, Norway, Canada, Sweden, Switzerland are the most ecologically stable countries by this index (Bobulyov et al., 2001). This index is a general aggregate indicator of sustainable development, its value is obtained by information aggregating, for its calculation other indices are also used; they characterize ecological sustainability with variable factors.

Based on the international methodology today most countries try to investigate their strategies and sustainable development factors considering their individual social and economic conditions. E.g., Russian scientists developed their sustainability indices for various management levels, with the purpose to compare the achieved sustainability level in regions, additional specific indices consider regions' economic, social and ecological peculiarities. In order to develop indicators at the regional level selection is suggested, based on the quantitative reflections of the determined problems, considering official statistics. For Tomsk region, for example, sustainability indicators were introduced within the framework "theme – problem – indicator", each determined problem having its own indicators, which were ranged by the priority level according to regional specific. For Russian capital the indicators structuring

was conducted by the methodologies of the UN Sustainable Development Committee and OECD and adapted to this metropolitan. Indicators of sustainable development are observed on the global scale, showing economic, social and ecological aspects of the current generation needs without limitations in satisfaction of future generations needs (Bobulyov et al., 2001).

In theory and practice one can distinguish the following methodologies within the indicative approach.

The first methodology is based on the system of partial indicators with the sub-systems of economic, ecological, social and institutional factors, each indicator showing sustainable development aspects.

The second methodology means creating the integral indicator, based on integration of ecological and economic, economic, ecological, social and economic, ecological factors.

The third is the aggregated indicator, and the aggregating process is conducted on the basis of 3 groups of factors: economic, social and ecological.

The Institute of Applied and System Analysis of the National Academy of Sciences in Ukraine has developed the metrics to measure sustainable development (MMSD) by the integral factor sustainable development index and harmonization degree, adapted to national statistics data and reporting public authorities offices (Zgurovskiy et al., 2010).

The index of sustainable development presents the integrative estimation of the society development aggregated considering together all 3 constituents of sustainable development. The integrated estimation by 11 policy categories and 45 indicators determines the directions for further strategic managerial activities, and it may be used as a tool for managerial decisions.

MMSD is conducted in such a sequence: at the first stage – shaping the parameters in the form of factors, which characterize sustainable development spheres. They come down to indicators with calculating their weight. A group of indicators is related to a certain policy. At the second stage – each development sphere's own measuring index is calculated, that is aggregate estimation of a particular development sphere. To calculate each index through its constituents with proper weighty coefficients, all indicators come down to normed type in the range from 0 to 1. At the third stage the integrative index of sustainable development is calculated and the harmonization degree is defined within the system of 3 indices: economic, ecological, social. By this metrics scientists present the sustainable development indicator as a quantitative presentation of characteristic concerning one or more development measurers, with information simplification and aggregating. It gives an opportunity to estimate the development level, to increase efficiency and functionality for further managerial decisions.

Using the calculations for 27 administrative units (Kasianenko, 2013) on the basis of sustainable development index value (*Isd*) all regions were divided into 6 groups (clusters). The first group with extra-high level of sustainable development ( $1.00 > Isd > 0.6$ ) consists of 7 objects – Kyiv ( $Isd = 0.64$ ). This is explained by high indexes values of economic and social measurers. Although according to the index of ecological measure the capital takes one of the last places, this would not prevent it from getting into the first place in the total rating.

3 Ukrainian regions have very high index value of sustainable development ( $0.60 > Isd > 0.55$ ): Kharkiv ( $Isd = 0.58$ ), Dnipropetrovsk ( $Isd = 0.57$ ) and Lviv ( $Isd = 0.56$ ).

Very low index values of sustainable development ( $0.47 > Isd > 0$ ) are in the group, including Kyiv, Sumy, Kirovograd regions and Crimea. They are characterized by low index values of sustainable development, particularly ecological (Kyiv and Sumy regions) and social (Kirovograd region and Crimea) measures.

On one hand, this method gives an opportunity to compare sustainability of regions' development and on the other hand, it doesn't consider totally the specificity of ecological and economic constituents of this or that region, nature and climate conditions, geographical location.

Thus, besides the existing independent methodologies within the indicative approach one can distinguish their various combinations. Systematized methodologies are shown in Table 1.

*Table 1. Systematization of methodologies within the indicative approach, systematized by the authors*

#	Methodology within indicative approach	Interpretation of the concept "indicator" within methodology	Types of indicators	Factors type	Research source and title
1	Systems	Complex of independent data – factors within the sustainable development system	Partial	Economic, ecological, social, institutional	Sustainable Development UN Committee, OECD
2	Integrative	General (singular) factor, more often index, which informs about social ecological and economic system state	General	Ecological and economic Social ecological and economic Ecological	The World Bank
3	Aggregating	Factors received by aggregating through grouping data by proper generalized statistic features	Mediate General	Economic, ecological, social, institutional	Index of ecological sustainability, natural capital
4	Combined (authors' approach)	The simultaneous presence and combination of various indicators	Partial and general Partial, mediate, general General and mediate	Ecological and economic Social ecological and economic Ecological, economic, social, institutional etc.	National Academy of Sciences of Ukraine, Sustainable Development Institute of Russian Federation

Introduction stages of sustainable development into economy activity include the innovative development ecologization concept, which shows change of public production ecological compatibility level, level of natural resources production and consumption, level of state, regions and economy subjects' social and economic

development. Sustainable development corresponds to the concept of innovative activity ecologization by its essence.

In order to define the innovative activity development ecologization indicators as partial measures, representing ecological, economic and social aspects of sustainable development, general integrated or aggregating factors in various combinations determine the concepts peculiarities.

Basic indicators of the innovative activity ecologization concept consider branch peculiarities and measure the factors received through systematizing the methodologies above:

*Concept 1 – liquidation of ecodestructive impact consequences after production and consumption processes:*

1. Cleansing structures for waste waters.
2. Equipment to deactivate harmful emissions.
3. Equipment for wastes utilization.
4. Equipment for pollution processing in the environment.
5. Service to clean polluted emissions.

*Concept 2 – ecological improvement of production technologies:*

1. Technologies to control pollution of the environment included the technologies to clean waste waters.
2. Cleaner technological processes: new processes with less pollution or more effective use of resources.
3. Technologies of ecological control and ecological instruments.
4. Technologies to save natural reproduced energy.
5. Technologies of water resources saving improvement.
6. Technologies to control noise and vibration.
7. Technologies of measure (biomarkers).
8. Ecological services to control solid and dangerous wastes.
9. Ecological consulting.
10. New systems of ecological services.
11. Ecological management to decrease the impact on the environment.

*Concept 3 – decrease of material and energy intensity in production and consumption:*

1. Innovative products similar to the existing ones but with less resources uses.
2. Repeated use of materials, recycling.
3. Organization of production with great resources saving.
4. Services, which allow using less resources or less intensive, for example, repeated use, joint use.

*Concept 4 – ecologization of all stages in ecological and economic cycles:*

1. New technological systems which are more friendly to the environment.
2. Ecological changes at all stages of technological cycle.
3. Systematic innovations, which change consumer behavior.
4. Ecological education.

**Conclusions.** The authors analyze the methodological approaches to estimating the development level of social ecological and economic system. Contemporary and objective approach to eco-oriented innovative development in the context of sustainable development is indicative, with various measure indicators and methodologies.

Within this indicative approach the authors systematize the methodologies to estimate ecologically oriented innovative development at macroeconomic and regional economic levels. It is defined, that besides the existing separate independent methodic approaches, their various combinations are possible.

The concept "indicators of the innovative activity ecologization concept" is improved. It gives opportunity to determine both partial measures, which show sustainable development ecological, economic and social aspects and general integrative and aggregating factors, and their various combinations, which define peculiarities of this or that concept and foresee the direction in which economy subjects target their activity.

Basic indicators of the innovative activity ecologization concept are defined considering branch peculiarities, the measure factors can be received on the basis of the systematized methodologies.

Perspectives for further researches in this area include practical aspects of estimating ecologically oriented innovative development level in Ukraine, in its separate regions and for economic subjects in the context of sustainable development.

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