Gender and social interaction: calculation model of ecological and economic indicators for sustainable development of the region

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The paper proposes a model for calculating the integrated ecological and economic indicator, which has considerable potential for application as a reliable instrument for the expenditures harmonization for environmental and social purposes, namely gender and social interactions, as part of the sustainable development paradigm implementation at the regional level. It has been shown that the use of three-factor functions (factors of industrial development, environmental investments and structural changes in the economy) allows obtaining more relevant results for making managerial decisions by more accurate description of real processes. It has been proved that the social component ought to take into account the gender peculiarities of regional development and be reflected in decision-making procedures of local authorities, namely, the gender components of the region's development have to be reflected in statistical reporting and be subject to the requirements of the Sustainable Development Goals, which are officially approved by the Ukrainian government. Gender interactions have to be the subject to a comprehensive study of region sustainable development based on increasing the social significance of attracting vulnerable strata of the population to active labor and political activities, increasing the efficiency of "social lifts", forming stable equal relations between territorial communities of different levels of economic development and financial capacity. The main task is to find the balance of interests between the needs of certain types of economic activity development in the region, the development of social parameters and the need to preserve the environment. It has been noted that the most effective means of finding this balance is the corresponding economic and mathematical instrumentarium. Moreover, the necessity of such interaction realization on the conditions of balanced support of the national economy functioning in terms of reproductive, technological, activity-specific and external macroeconomic proportions determines the use of the balance-sheet method of "input-output" and balance-based models build upon it. Therefore, the actual issues of scientific and practical support of sustainable development process implementation at the regional level identify the tools for taking into account the influence factors on social policy in the context of the principles introduction of such development. The study of specific cases of the ecological and economic modeling methods use to substantiate effective social policy at the regional level has considerable real possibilities for detailed elaboration, which also results in the use of separate mechanisms of ecological and economic modeling for the needs of effective social policy conduct at the regional level.

Key words: gender; social interaction; sustainable development; social policy; regional development.

Introduction

The issue of sustainable development and mechanisms introduction in the practice of social life is constantly given considerable attention. In recent years, there have been a significant number of multidimensional studies on the economic, social and environmental components of social development taking into account the national specificity of socio-economic relations. Methods and ways of using instruments and mechanisms of sustainable development in various spheres of public life in Ukraine have been explored in detail. At the same time, the study of the methodology for assessing the status of the social, economic and environmental components of sustainable development, especially at the regional level, has sufficient prerequisites for a detailed study, which is to highlight the results of research on the use of monitoring and evaluation materials for socio-economic development undertaken by public authorities executive power in order to assess the implementation status of the sustainable development tasks.

The progressive movement, under the official documents, is currently being evolved by the development vector which presupposes the state sustainable development [1]; it requires constant monitoring of achievement status of the set goals in accordance with the Sustainable Development goals, approved by the United Nations Summit on Sustainable Development in 2015 in the final document "Transforming our world: Agenda for Sustainable Development to 2030" [2]. The 17 goals and 169 objectives identified at the highest level are integrated and coherent and ensure the balance of all three components of sustainable development, taking into account the experience of implementing its principles in recent decades. It ought to be noted that regional and sub-regional mechanisms can contribute to the effective implementation of sustainable development strategies in exact actions at the national level.

It is this Agenda that emphasizes the need for high-quality, accessible, current and reliable extended data that is essential for the process of making managerial decisions in order to assess progress made and ensures the widest possible coverage of all aspects of sustainable development. At the same time, emphasis is placed on the priority use of data and information obtained through existing national reporting mechanisms.

Accordingly, it is rational to use the comparing indicators method of global sustainable development objectives with the indicators of socio-economic and environmental relations at the regional level that are adopted in national management systems.

In this sense, the National Report "The Goals of Sustainable Development: Ukraine" (hereinafter - SDG), which contains the system of sustainable development goals adapted to the national peculiarities of Ukraine (86 national development goals and 172 indicators for the national strategy development), is intended as the effective instrument for making such a comparison between the planned and the actual status and their monitoring [3]. It can be claimed that the report broadly illustrates the practical guidelines for the sustainable development principles implementation and is actually its own matrix to determine the long-term prospects for sustainable development. However, from the point of view of making managerial

decisions, the specific disadvantage of the report is its advisory, recommendatory status, which makes the recommendations not mandatory for the state bodies' execution.

The agenda states that each country has a primary responsibility for its own economic and social development, and the role of national policies and strategies in the field of sustainable development cannot be overemphasized. In this context, it is important to establish the extent to which public valuation tools meet the needs for establishing the implementation status of sustainable development requirements, followed by adjustments in managerial decisions.

Taking into account this definition of adequate mechanisms for coordinating the development of the main components of sustainable development is of particular importance in terms of ensuring the planning of tasks and measures of country socio-economic development, especially at the regional level.

From the point of view of effective achievement of the sustainable development goals within a country, the most significant human communities and the nature of social interactions between them and with government institutions play a key role. As has already been noted, their activities have to be subject, inter alia, to the sustainable development principles, aimed at the integrated satisfaction of the basic needs of present and future generations. In this case, the quantitative analysis of social interactions as a method of diagnosing the society state on the subject of compliance with the stability postulates becomes of special significance.

It has also to be noted that since achieving the goals of sustainable development that is, first of all, activity, then social interaction in a conceptual sense should be considered in the context of the management theory, that is to characterize as a process of interaction between individuals and social groups in the process of realizing their interests [4]. Proceeding from this definition, for the purposes of quantitative analysis, it is necessary to find out indicators characterizing the main descriptive parameters of the interacting social group, methods of its interaction and achieved goals as a result of such interaction. Of course, such indicators have to maximally disclose that part of the interaction of the social group that is relevant to the goals of sustainable development, adapted to the Ukrainian realities.

Goal

Development of a model for calculating an integrated ecological and economic indicator that has significant potential for use as a reliable tool for reconciling the costs of environmental and social goals, namely, gender and social interactions, as part of the sustainable development paradigm implementation at the regional level.

Theoretical basis

Identify unresolved issues. According to the "Agenda-21", the basis for program activities in the interests of women as a social group is their active inclusion in all types of developmental work. Particularly important, taking into

account national peculiarities, seems to be the involvement in achieving the following objectives:

- the elimination of violence against women in all its forms;
- achievement of women equality in all aspects of society, including participation in measures for the protection and rational use of the environment;
- ensuring women's participation in the work on the rational use of ecosystems assurance and preventing the deterioration of the environment state at the national level;
- increasing the proportion of women in positions of different levels who are concerned with raising awareness, education and learning in the field of environment and development.

Taking into account the established directions of social interaction, which is carried out by women as a social group in the context of sustainable development, it is possible to distinguish a number of indicators that characterize this process of interaction, which are conventionally grouped into three main blocks: social group indicators, indicators of social group activity and indicators of results activities of the social group.

According to the indicators of the first block, that is, the descriptions of the social group, the demographic data can be attributed (the total number of women, their distribution by age group, type of settlements, regions, natural growth, the number of births by age of the mother, women in divorce, migration, etc.), labor market data (employment level, employment structure by occupational groups, number of full-time employees and their educational level, employment mobility, unemployment rate, average salary level, etc.), data in relation to educational characteristics (indices of positive parity among pupils, learners and students of educational institutions of Ukraine, distribution of students of higher educational institutions according to the majors, the structure of scientists conducting research and development in the branches of science, etc.), data characterizing the state of health (morbidity by classes of diseases, diseases with especially dangerous outcomes, the number of abortions, etc.) and data in the field of justice and crime (distribution of convicts, the composition of the victims by type of crime, etc.). The overwhelming majority of these data is contained in the data of state statistics bodies [5, 6] or, more broadly, in executive bodies responsible for the state policy implementation in certain sectors.

The second set of indicators has to contain data that characterize the activities of the social group aimed at achieving their goals; in this case, the emphasis is on the sustainable development goals. This includes data on institutions and organizations representing the interests of the group, data on measures to improve the legislation on the realization of the women interests, information on the level of women representation in government and senior management positions, data on measures to increase the competence level of the group representatives on issues of the sustainable development implementation, information about participation in representative activities to promote the women interests, data on outreach and information campaigns on the rationale for the need to meet the interests of the social group. It has to be noted that these data are practically absent in the state statistics and its derivation

requires special separate research or detailed analysis of the reporting and reference, preferably periodic, industry and scientific information. With regard to women as a social group, this is information from the Ministry of Social Policy of Ukraine, the Commissioner for Human Rights of the Verkhovna Rada of Ukraine, other central executive authorities, scientific and research institutions, etc.

The block of performance indicators of the social group contains data that characterize the achievement degree of the goals in the context of the group role in the sustainable development mechanisms implementation. This approach is used in the National Report of the SDG, where indicators are proposed for each task, which should specify the performance level of such tasks. With regard to women as a social group, taking into account the stated goals of the activities in the processes of sustainable development, data on the proportion of women in senior positions in government bodies, including those responsible for the environmental policy implementation, the ratio of average wages for women and men, the level of women employment, the proportion of women among environmental researchers, the number of appeals for gender-based violence, the number of regulatory acts aimed at maintaining women's interests and so on. In terms of accessibility and availability, these data are sufficiently present in both the state and departmental statistics.

It ought to be noted that such an approach to dividing the indicators of the interaction of social groups into three main groups (blocks) is justified not only for women, as a social group, but for other social groups. Differences can only relate to the specific content of each block, depending on the objective characteristics of the social group and the goals it achieves in the context of sustainable development. Ultimately, these are the goals of sustainable development that are planned to be achieved for the needs of the group and determine the data set for quantitative analysis of social interactions of sustainable development. In view of this, the consideration of characteristics indicators of other social groups that play a significant role in achieving sustainable development is further from the point of view of emphasizing their specific features in this area of social life.

A key requirement for such harmonization tools is their ability to handle large amounts of data that characterize such complex socio-economic systems as a region.

Thus, the actual issues of scientific and practical support of the sustainable development implementation process at the regional level identify the tools for taking into account the factors of influence on social policy in the context of the introduction principles development. At the same time, the study of specific cases of the use of ecological and economic modeling methods in order to justify effective social policy at the regional level has considerable real possibilities for detailed elaboration, which also results in the use of separate mechanisms of ecological and economic modeling for the needs of conducting effective social policy at the regional level.

Results and Discussions

The signs of the territory development are not only the increase of purely economic data, but also the positive dynamics of complex indicators that characterize the

interconnection of the economy with the social and environmental components and indicate the achievement of high quality of population life. The mutual influence of social and economic development is manifested in particular in the fact that economic achievements contribute to the achievement of the priority goals in the social sphere (job creation, raising living standards, improving working conditions, expanding access to health care services and obtaining an adequate education level). At the same time, industrial development has some aspects of negative impact on the society, for example, the increased environmental pollution indirectly or directly affects the level of population morbidity, thereby reducing social standards.

In these conditions, the ability of the regional economic system to self-redevelopment or self-development, which envisages the ability of the region, acting in the direction of strengthening the country's economic security, providing reproductive processes, meeting the needs of the population, and adhering to the concept of sustainable development of the regional system, becomes of particular importance [7]. For its effective research it is necessary to develop appropriate tools, mathematical models and techniques that will adequately investigate the interconnection of economic, environmental and social indicators, identify existing patterns and make the necessary assessments, conclusions and appropriate management decisions.

It is important that the used tools make it possible to determine the relationship between the parameters of functions and indicators of different levels (the economy as a whole and separate industries or macro regions), assess the impact of structural changes in the economy and changes in the structure of investments by type, explore the distribution of resources between industries (macro regions) and build the optimal direction for development according to different criteria [8].

Therefore, the main task is to find a balance of interests between the needs for development in the region of certain types of economic activity, the development of social parameters and the need to preserve the environment. The most effective means of finding this balance is the corresponding economic and mathematical tools. Moreover, the necessity of realization of such interaction on the conditions of balanced support of the national economy functioning in terms of reproductive, technological, activity-specific and external macrostructural proportions determines the use of the "input-output" balance-sheet method and the balance models based on it [9].

The simulation of sustainable development involves the synthesis of heterogeneous social, economic, scientific and technical and environmental factors. At the same time, the use of purely monetary estimates and ignoring universal physical indicators does not allow this synthesis and dramatically reduces the management effectiveness. The advantage of simulation, as a complex direction of scientific research, designed to unite in a strict mathematical form the phenomenon of fundamentally different nature, is that with such a method of research it is possible to study the object, based on its created spatial characteristic, which is often impossible in the course of the natural observation.

Ecological and economic modeling makes it possible to analyze the state of complex dynamic systems, to evaluate the processes occurring in them, and to develop forecasts

and variants of the system's response to natural phenomena and management decisions [10], as well as to assess the decisions effectiveness made for the region sustainable development and to identify key factors of this development.

Particularly important ecological and economic modeling has to establish the investments effectiveness in environmental activities within the framework of ecological and economic interaction and the definition of additional resources on this basis in order to improve the social parameters of regional development.

As a solution to this issue, it is proposed to apply a model for calculating the integrated ecological and economic indicator, where the pollution function (as the most important in the ecological-economic system) can be applied, which can take into account two or three factors and can be built on separate or complex (integrated) indicators.

So, in the case of using two factors, the formula for calculating the integrated ecological and economic indicator will have the following form:

$$E(t) = F(X_1(t), X_2(t), t) \quad (1)$$

where: $E(t)$ is the investigated ecological and economic indicator, $X_1(t)$ is a factor that shows economic development and, as a rule, has a negative impact on environmental parameters (i.e. GDP, investment in industry or new construction, other indicators of economic development), $X_2(t)$ is a factor that reflects the monetary value of targeted activities aimed at improving the quality of environmental parameters and, as a rule, has a positive impact on the environment (implies the cost of environmental protection, investment in environmental projects, money for the alternative energy development, etc.). In this case, it is advisable to make a number of assumptions: the function F is unambiguous, continuous and that is twice differentiated, as a result of the increase in the cost of one factor, usually decreases its efficiency. The numerical value of the factors is always ≥ 0 .

In order to effectively calculate the results of the interaction of environmental and economic processes, it is advisable to introduce several additional specific indicators, namely:

rate of substitution - a quantitative expression of one factor necessary to maintain a constant level of influence on environmental parameters with some change in another factor;

elasticity of compensation (ranging from 0 to 1), which reflects the degree of complexity of the compensation of one factor to another. If elasticity equals 0, then the change in one factor leads to a proportional change in environmental parameters, which can not be substituted by another factor; if elasticity equals 1, changes in environmental parameters caused by the change of one factor can be completely leveled due to another factor;

factor elasticity, which is a logarithmic derivative of factors, and characterizes the degree of influence of each particular factor on the integrated ecological and economic indicator. For example, with an increase in GDP (or another economic indicator) by 1%, the integrated ecological and economic indicator is increased by $\delta_1\% \delta$, and with the increase of investments (inputs) in the protection of the environment (or another environmental indicator that

affects the state of the environment) – decreases by $\delta_2\%$, because δ_2 has a negative elasticity;

ecological variability that is associated with a change in the level of pollution, which depends on time or other factors.

The main influence on the indicators of environmental change is provided by structural changes in the economy, for the assessment of the influence degree of which the following equations are made:

$$\begin{aligned}\delta_1 &= \sum_i \delta_{1,i} * \frac{E_i(t)}{E(t)} \\ \delta_2 &= \sum_i \delta_{2,i} * \frac{E_i(t)}{E(t)} \\ p &= \sum_i p_i * \frac{E_i(t)}{E(t)} + \delta_0\end{aligned}$$

$$\delta_0 = \sum_i (\delta_{1,i} * (L_{1,i} - L_1) + \delta_{2,i} * (L_{2,i} - L_2)) * \frac{E_i(t)}{E(t)}$$

where $E(t)$ is the studied ecological and economic indicator, L_1 is the logarithmic derivative of the economic indicator, L_2 is the logarithmic derivative of the ecological index, t -year, i -sector (it has different meanings depending on the economy, region, etc.).

Selection of different sectors (regions, industries) allows to investigate the possibilities of redistributing factors between sectors of the economy in order to minimize pollution:

$$\begin{aligned}E(t) &= \sum_i E_i(t) = \sum_i F_i(X_{1,i}(t), X_{2,i}(t), t) \rightarrow \min \\ X_1(t) &= \sum_i X_{1,i}(t), \quad X_2(t) = \sum_i X_{2,i}(t), \\ X_{1,i}(t) &\geq 0, \quad X_{2,i}(t) \delta_{1i} > 0, \quad \delta_{2,i} \leq 0, \\ &\quad \delta_{1i} + \delta_{2,i} \geq 0, \quad i = \overline{1, N}\end{aligned}$$

The proposed model can also be constructed for two-factor and three-factor functions.

The use of three-factor functions allows to obtain more relevant results by more accurate description of real processes, because they take into account the ambiguity of the economic development impact on the environment state, which arises as a result of the economic projects availability, often associated with a change in the economy structure, which does not impair the state of the environment, and, on the contrary, have a positive effect on the environmental parameters condition (the use of the newest and more efficient and, at the same time, ecological technologies, modernization of production, etc.).

If the three factors are taken into account, the calculation formula for the integrated ecological and economic indicator will have the following form:

$$E(t) = F(X_1(t), X_2(t), X_3(t), t) \quad (2)$$

where: $E(t)$ is the studied ecological and economic indicator, $X_1(t)$ is a factor indicating economic development, and usually has a negative impact on the environment (GDP, investments in industry or new construction, other indicators of economic development), $X_2(t)$ is a factor that reflects a targeted activity aimed at improving the quality of the environment and, as a rule, has a positive impact on environmental parameters (environmental protection costs, investments in environmental projects, development costs

to alternative energy, etc.), $X_3(t)$ is a factor reflecting structural changes in the economy and, as a rule, has a positive impact on the environment (investments in modernization of production, transition to more effective in the environmental aspect of production methods, etc.). The numerical expression of factors is always ≥ 0 ; an increase in costs of one factor usually results in a decrease in its efficiency.

Practice shows that the optimal choice of three factors for calculating the integrated ecological and economic indicator is investments for a certain period:

- in the development of the economy by extensive means (the creation of new industrial complexes, etc.);
- in the development of the economy in an intensive way (modernization of production);
- in environmental projects.

With this choice of factors, it is possible to calculate the optimal allocation of investments in three main areas, which can ensure that the level of pollution is achieved if a certain amount of production is reached:

$$\begin{aligned}I(t) &= \sum_i I_i(t) = \sum_i F_i(X_{1,i}(t), X_{2,i}(t), X_{3,i}(t), t) \rightarrow \min \\ X_1(t) &= \sum_i X_{1,i}(t), \quad X_2(t) = \sum_i X_{2,i}(t), \quad X_3(t) \\ &= \sum_i X_{3,i}(t),\end{aligned}$$

$$\begin{aligned}Y(t) &= G(X_1(t), X_3(t)) \geq Y_0(t) \\ X_1(t) + X_2(t) + X_3(t) &= \text{const} \\ X_{1,i}(t) &\geq 0, \quad X_{2,i}(t) \geq 0, \quad X_{3,i}(t) \geq 0, \quad \delta_{1i} > 0, \quad \delta_{2,i} \\ &\leq 0, \quad \delta_{1,i} + \delta_{2,i} + \delta_{3,i} \geq 0, \quad i = \overline{1, N}\end{aligned}$$

The use of the proposed model can make the optimal managerial decision both on investments in the whole country and on investing in individual regions.

Optimization of investments in environmental activities will allow the authorities to reallocate funds in the direction of improving the social component of sustainable development while ensuring the proper level of environmental safety of the regions [11].

Conclusions

Thus, in the course of the study, it has been substantiated that the mechanisms of ecological-economic modeling and, in particular, the model of calculation of the integrated ecological and economic indicator, have considerable potential for application as a reliable tool for harmonizing the costs for environmental and social purposes in the framework of implementation of the sustainable development paradigm at the regional level.

It has been shown that the use of three-factor functions (factors of industrial development, environmental investments and structural changes in the economy) allows obtaining more relevant results for making managerial decisions by more accurate description of real processes.

Prospects for further research

Further research in this area ought to focus on the search for mechanisms of ecological and economic modeling that would directly take into account social factors in the process

of interaction of the traditional triad of sustainable development (ecological, economic and social components of development). The social component should take into account the gender peculiarities of regional development and be reflected in decision-making procedures of local authorities.

The gender components of the region's development have to be reflected in statistical reporting and be subject to the requirements of the Sustainable Development Goals, which are officially approved by the Ukrainian government.

Gender interactions ought to be the subject of a comprehensive study of sustainable development of the region based on increasing the social significance of attracting vulnerable strata of the population to active labor and political activities, increasing the efficiency of "social lifts", forming stable equal relations between territorial communities of different levels of economic development and financial capacity.

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