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Optimization Model of the Socio-Ecological-Economic Development of the Administrative Territory

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Abstract:

In this paper, we contribute to the literature focusing on the development of methodical approach to the conducting of a comprehensive diagnostics of the state and level of the balance of the socio-ecological-economic system of the administrative territory, which, unlike existing ones, implies the determining of partial and integral indices of the socio-ecological-economic development, by comparing the existing and reference values of development of social, ecological and economic fields of activity. The article suggests the express diagnostics of the level of the socio-ecological-economic balance of the system on the basis of the graphic method, which, as a result, allows the forming of the optimization model of the socio-ecological-economic development of the administrative territory. The distribution of financial resources is proposed to be implemented on the basis of the disproportions in the development of social, environmental and economic fields of activity and allocation of financial resources, first of all, to those fields that provide the maintenance of the trajectory of balanced socio-ecological-economic development of administrative-territorial units.

Keywords: socio-ecological-economic development; administrative territory; balanced development; sustainable development.

JEL Classification: Q01; F63; Z32.

Introduction

As of today, it is impossible to achieve high level of the socio-economic development without integration of the ecological factor into the management system of different levels of social organization. The perspective of humanity first of all is determined by the state of environment security, which influences the development of all

components of the society. Therefore, the issue of ensuring the sustainable development of the socio-economic systems is very important and relevant. The basis for its achieving is the balance and environmentally-oriented management of structural and functional elements: society, economy, nature.

1. Literature Review

The scientific discourse of the balancing of the ecological and economic processes began to develop intensively after the publication of "World development report 1992: development and the environment" with main message - the necessary of integration environmental considerations into development policymaking. Original observations and proving hypothesized relationship between various indicators of environmental degradation and income per capita were made by Grossman and Krueger's (1995). Grossman and Krueger in their study used environmental Kuznets curve (Kuznets 1955) and the obtained results showed that if income per capita grows, the pollution and other types of degradation of the environment firstly grow, and then decrease after reaching a certain level of wellbeing. Ignoring the fact of excessive use of natural resources for economic development, especially non-renewable resources, led to a degradation of the environmental situation as a whole.

In this respect, it is appropriate to come back the Hubbert curve (Hubbert 1956), a model for the use of non-renewable resources. The Hubbert peak theory says that the extraction of fossil fuels in a certain region will firstly have growing rate till certain turning point, but after it the decline will begin. The problem is that the rate of use of renewable resources should not exceed the rates of their recovery, and the rate of the depletion of non-renewable resources should not exceed the rates of finding a recoverable substitute for these resources.

Important contribution of the widespread idea that economic activity and state of the ecosystem have fundamental importance to human well-being and survival was made by such programmes as Millennium Ecosystem Assessment (2005), TEEB Foundations (2010), TEEB Synthesis (2010). Sustainable development and balanced development of the socio-ecological-economic system has become a key guiding principle for the global society (World Business Council for Sustainable Development, 2011, 2012; National Research Council, 1999; UNU-IHDP-UNEP, 2012). Millennium Ecosystem Assessment (2005) states that changes of ecosystems, that had been caused by human, have led to a significant increase of people well-being and level of economic development. But these benefits have been achieved by their value increasing in the form of many ecosystems' degradation, increasing the risk of non-linear changes of ecosystems and increasing the level of poverty for some groups of people and territories. If these problems are not solved, they will significantly reduce the benefits that future generations can receive from ecosystems.

A significant contribution to the study of the concept of the sustainable development was made by Pearce (1994) and Turner (1993), by connecting the sustainable development concept with two areas of environmentalism: 1) technocentrism (very weak sustainability and weak sustainability) and ecocentrism (strong sustainability and very strong sustainability). The supporters of "very weak sustainability" idea (Solow 1974, 1986; Hartwick 1977) assumed that the main condition of sustainable development is that the future generation should be provided with such level of material and natural capital that is not less than for present generation. Material and natural capital are considered to be interchangeable. The supporters of "weak sustainability" idea (Pearce and Atkinson 1994, Barbier and Markandya 2012) considered the possibility of achieving the sustainable development and rational management of the resources through "green" market policy that was based on the environmentally friendly economy. Making economies more sustainable requires urgent progress in three key policy areas: valuing the environment, accounting for the environment and incentives for environmental improvement (Barbier and Markandya 2012), as well as efficient using of resources and energy, production of innovation and science-intensive products (Kolmykova *et al.* 2013; Kasyanenko *et al.* 2013).

Daly, as a supporter of "strong sustainability", supported the idea of developing the economy with the most possible conservation of natural resources and on the basis of the principles of precaution and the safest standards. Material and natural capital are considered as complementary not interchangeable ones. Strong sustainability is grounded on the thermodynamic foundation of a steady-state economy. The principle of "very strong sustainability" (Georgescu-Roegen 1976; Daly 2000) consists in the preservation of nature with a minimum expenditure of resources and the reduction of the scale of growth of the economy and the population. The need for zero economic growth and zero population growth is determined. Very strong sustainable development is based on the laws of thermodynamics and on the ideas that any reduction of natural capital is irreparable. The American researcher Costanza (2001) believes that "strong sustainability" is more correct and better because natural and man-made capitals are to be complementary factors rather than interchangeable ones.

It is also necessary to take into account the social component within formation of the sustainable development. According to the data of the World Health Organization (WHO) the polluted environment is one of the main causes of high mortality in the world. Almost a quarter of the world's population dies just because of bad environmental conditions: environmental risks cause the emergence of more than 100 dangerous diseases, and every year they kill 12.6 million people, that is 23% of all deaths that occur in the world. The WHO report names a list of environmental causes and their connection with mortality, namely: environmental pollution, chemical exposure, climate change and ultraviolet radiation, more than 100 diseases and injuries, etc. Vasylyeva, T.A. *et al.* (2018) evaluated that the quality of social institutions is determined by ability to provide an extension of average life expectancy, to maintain an adequate level of health and employment.

The concept of balanced development of the socio-ecological-economic systems is the most important principle of the sustainable development of the administrative territories under modern conditions of intensified anthropogenic load on the environment and aggravation of the environmental problems. The concept of ecologically balanced development combines three subsystems, i.e. social, economic and ecological (or natural) and reveals the principles of their interaction. The analysis of the literature confirmed the need for paying more attention to the study of the optimal correlation in the development of economic, social and environmental fields of activity. Partially this problem was studied by Gurman *et al*. (2010) by creating program system DSEE model 1.0 is created, which involves a cluster computing device to implement parallel algorithms of scenario calculations, optimization and improvement of an approximate optimal control for the socio-ecological-economic model of a region.

2. Methodology

We chose the socio-ecological-economic system of the administrative territory as the object of our study. The choice of the level of the territory (region, administrative-territorial unit) is connected with the fact that the influence of globalization and integration causes the transformation of the regional structures and regional economy and certain socio-economic disproportions of regional development are formed.

Within socio-ecological-economic system the social component is considered as a group of people united by certain relations, conditioned by the historically changing ways of producing material and nonmaterial benefits, the common territory of residence, and the degree of risk of facing the unpredictable and undesirable consequences. The components of the social subsystem include the following: the elements of demographic, social, ethnic character, sex and age structure; the level of employment, birth and death; the level of education, the qualification of labour resources, as well as such indicators as relative share of people affected by the total population, the relative share of the need for manpower in relation to the total number, etc. The ecological component of the socio-ecological-economic system is considered as natural combination of the environment, a system of abiotic and biotic factors that influences a person and, vice versa, which is heavily influenced by a person by his or her activity. The economic component of the socio-ecological-economic system contains a complex of production means. They are characterized by such indicators as: the relative share of primary energy, the capital intensity, the turnover of funds, labour intensity, energy intensity, material intensity, production cost, etc.

3. Results

The formation of the optimization model of the socio-ecological-economic development of the administrative territory is organized and presented as follows: paragraph 3.1 presents a methodology for the complex diagnostics of the level of socio-ecological-economic development of the administrative territory based on the index method. Paragraph 3.2 proposes a graphic method for determining the level of the socio-ecological-economic balance of the administrative territory.

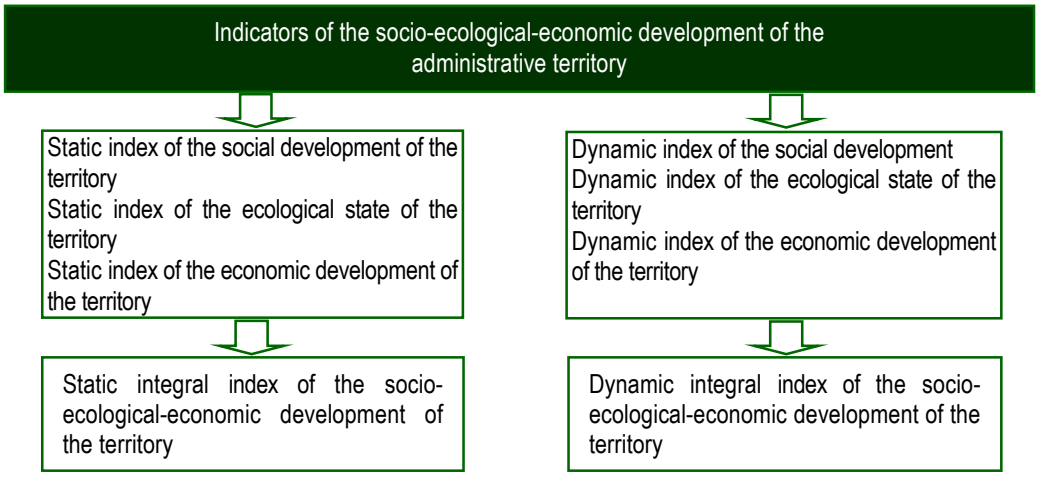
3.1 The methodology for the complex diagnostics of the level of the socio-ecological-economic development of the administrative territory based on the index method

The sustainable development of the administrative territory depends on the level of its socio-ecological-economic balance (Alibekova 2014; Bondar *et al.* 2015). To determine this indicator, we propose a method for the complex diagnostics of the socio-ecological-economic development of the administrative territory. This diagnostic is based on the index method, which involves the calculation of static and dynamic integral indices (Figure 1).

The calculation of static integral index of the socio-ecological-economic development of the territory is based on the comparison of the indicators of studied administrative territory with the indicators of the reference territory.

The territory with the best individual indicators of the socio-ecological-economic development is takes as reference territory

Figure 1. Elements of complex diagnostics of the socio-ecological-economic development of the administrative territory



. The calculation of dynamic integral index of the socio-ecological-economic development of the administrative territory is carried out as ratio of the corresponding individual indicators of the development of studied territory in the next and previous periods. The static and dynamic integral indices of the socio-ecological-economic development of the administrative territory is proposed to be determined as the geometric mean values of the partial indices of social, economic and ecological development (Table 1).

Table 1. Scheme of formation of static and dynamic integral indices of the socio-ecological-economic development of the territories

Period / Territory	t	$t+1$	
Studied territory	$\sum x_t, \sum y_t, \sum z_t$	$\sum x_{t+1}, \sum y_{t+1}, \sum z_{t+1}$	Dynamic integral index of the socio-ecological-economic development
Reference territory	$\sum x_{ref}, \sum y_{ref}, \sum z_{ref}$	$\sum x_{ref(t+1)}, \sum y_{ref(t+1)}, \sum z_{ref(t+1)}$	
	Static integral index of the socio-ecological-economic development	*where:* x_t, x_{t+1}, x_{ref} are indicators of social development of the territory in *t-th*, $t+1$ periods and reference territory; y_t, y_{t+1}, y_{ref} are indicators of ecological development of the territory in *t-th*, $t+1$ periods and reference territory; z_t, z_{t+1}, z_{ref} are indicators of economic development of the territory in *t-th*, $t+1$ periods and reference territory.	

Constituents of integral index of socio-ecological-economic administrative territory development are presented in APPENDIX 1. The integral index of the socio-ecological-economic development of the territory is proposed to be determined as the geometric mean values of the partial static indices of social, economic and ecological development. Stimulants are the indices, the increase of which improves the overall assessment of the state of the research object, and the destimulators on the contrary cause a deterioration of the assessment of the state. Indices-destimulators are calculated as an inverse quantity for comparing them to the same basis and unambiguous characteristics. It is proposed to determine socio-ecological-economic development index in the following way, Table 2.

To carry out more accurate analysis of the obtained data, the methodology for calculating the static integral index of the socio-ecological-economic development provides the differentiation of administrative territories into groups of the same type of territories (the criterion of grouping may be the indicator of population density). The determination of integral index without differentiation of the administrative territories into groups will give aggregated results. Besides, we believe that it is more properly to compare the indicators of the territories

which do not differ significantly by the population density. Static integral indices have certain criteria and limitations are presented in Table 3.

Table 2. Determination of integral index of socio ecological-economic development of the territory

Indicators of social development		Indicators of ecological state		Indicators of economic development	
Indicators stimulants	Indicators destimulants	Indicators stimulants	Indicators destimulants	Indicators stimulants	Indicators destimulants
$x_{ij} = \frac{a_{ij}}{a_{ij(ref)}}$	$x_{ij} = \frac{a_{ij(ref)}}{a_{ij}}$	$y_{ij} = \frac{b_{ij}}{b_{ij(ref)}}$	$y_{ij} = \frac{b_{ij(ref)}}{b_{ij}}$	$z_{ij} = \frac{c_{ij}}{c_{ij(ref)}}$	$z_{ij} = \frac{c_{ij(ref)}}{c_{ij}}$
where: x_{ij} is standardized indicators of *j*-th territory social state; a_{ij} is *i*-th indicator value, characterizing *j*-th territory social development state; $a_{ij(ref)}$ is reference value of *i*-th indicator, characterizing social development state.		*where:* y_{ij} is standardized indicators of *j*-th territory ecological state; b_{ij} is *i*-th indicator value, characterizing *j*-th territory ecological state; $b_{ij(ref)}$ is reference value of *i*-th indicator, characterizing ecological state.		*where:* z_{ij} is standardized indicators of *j*-th territory economic state; c_{ij} is *i*-th indicator value, characterizing *j*-th territory economic state; $c_{ij(ref)}$ is reference value of *i*-th indicator, characterizing economic state.	
Social development index		Ecological state index		Economic development index	
$I_{soc} = \sqrt[n]{x_1 \cdot x_2 \cdot \ldots \cdot x_n}$		$I_{ecol} = \sqrt[n]{y_1 \cdot y_2 \cdot \ldots \cdot y_n}$		$I_{econ} = \sqrt[n]{z_1 \cdot z_2 \cdot \ldots \cdot z_n}$	
Integral index of socio-ecological-economic development of the territory $I_{ceed} = \sqrt[3]{I_{soc} \cdot I_{ecol} \cdot I_{econ}}$					

Table 3. The determination of the level of the socio-ecological-economic balance of administrative-territorial unit using static integral index ($I_{int(stat)}$)

Value	The degree of balance	Characteristic of the socio-ecological-economic development of the territory
$I_{int(stat)} = 1$	Very high	There is an optimal state of balance of the territory.
$1 > I_{int(stat)} \geq 0{,}8$	High	High indicators of social, economic and ecological development, the availability of the reserve of ecological, economic resources, high potential of human development.
$0{,}8 > I_{int(stat)} \geq 0{,}6$	Normal	The ability to maintain for some time positive trends in the use of social, economic and ecological potentials.
$0{,}6 > I_{int(stat)} \geq 0{,}4$	Satisfactory	The possibility to minimize loss of the territory from violation of the territory at the expense of available resources.
$0{,}4 > I_{int(stat)} \geq 0{,}2$	Unsustainable development	A significant violation of the socio-ecological-economic balance of the territory.
$0{,}2 > I_{int(stat)} \geq 0$	Depressive development	The unstable state of the territory requires significant attention to the socio-ecological-economic problems of the territory. Otherwise, such situation can lead to a chaotic development of the system, that is, the threat of the impossibility of predicting integrated systems can occur.

Let us consider in more detail the formation of dynamic integral index of the socio-ecological-economic development of the territory. For this purpose, we introduce a system of indices that assess the social, ecological and economic components of the territory development (Table 4).

The dynamic index of the social, ecological and economic development is proposed to be determined on the basis of a methodology based on the modification of the resource approach to the administrative-territorial level. Its universality consists in that fact that, being resource by itself it simultaneously reflects the cost aspect of production efficiency. Besides, this approach is quite convenient for usage from the point of view of the necessary statistical data availability.

The dynamic index of the social development is proposed to be determined on the basis of two indicators: the load per vacant workplace and the average monthly nominal wage.

$$I_{soc(dyn)} = \sqrt{I_{c1} \cdot I_{c2}}, \quad (1)$$

where: I_{c1} is load index per 1 vacant workplace at this administrative territory, that is calculated by the formula:

$$I_{c1} = (C_1^1 - C_1^0) + 1, \quad (2)$$

where: c_1^1, c_1^0 is respectively, the coefficients of load per 1 vacant workplace at the end and beginning of the year.

Table 4. Calculation of dynamic indices of social, ecological and economic development of the administrative territory

Components of dynamic index of the socio-ecological-economic development		
Dynamic index of the social development	Dynamic index of the ecological state	Dynamic index of the economic development
$I_{soc(dyn)} = \sqrt{I_{c1} \cdot I_{c2}}$, *where:* I_{c1} is load index per 1 vacant workplace; I_{c2} is index of the average monthly nominal wage of the employees.	$I_{ecol(dyn)} = \sqrt{I_{antr} \cdot I_{prot}}$, *where:* I_{antr} is index of anthropogenic load on the territory; I_{prot} is protection index.	$I_{econ(dyn)} = 1 + C_e$, $I_{econ(dyn)} = I_c \cdot \gamma IC + I_f \cdot \gamma D + I_p \cdot \gamma NRP$, *where:* C_e is coefficient of the economic efficiency of production on the territory, calculated by the formula; I_c is index of return on current assets at the end of the year compared to the beginning of the year; I_f is index of return on fixed assets at the end of the year compared with the beginning of the year; I_p is index of the return on productivity of living labor at the end of the year compared to the beginning of the year; γIC is share of intermediate consumption in the volume of output; γD is share of consumption of fixed capital in the volume of output; γNRP is share of net regional product in the volume of output.
Dynamic index of the socio-ecological-economic development of the territory		
$I_{int(dyn)} = \sqrt[3]{I_{soc(dyn)} \cdot I_{ecol(dyn)} \cdot I_{econ(dyn)}}$		

Coefficient of load per 1 vacant workplace is calculated as:

$$C_1 = \frac{1}{Load}, \quad (3)$$

where: $Load$ is load per 1 vacant workplace is calculated by the formula:

$$Load = \frac{C_{release}}{C_{demand}}, \quad (4)$$

where: $C_{release}$ is release of labor force; C_{demand} is labor demand; I_{c2} is index of the average monthly wage of the employees of this administrative territory is calculated by the formula:

$$I_{c2} = \frac{w^1}{w^2}, \quad (5)$$

where: w^1 is average monthly wage of the employees in the current year; w^0 is average monthly wage of the employees in the base year.

We use the indicator of the environmental tax on the placement of pollutants in the natural environment and the adjusted costs for environmental protection to calculate the dynamic index of the ecological development. The amount of environmental tax depends on the amount of harmful substances placed in the environment, the class of their harmfulness and the tax rate. The adjusted costs for the environmental protection (C_{prot}) are defined as the sum of current expenses and capital expenses for the environmental protect, resulted in a comparable type with current expenses by the formula:

$$C_{prot} = C_{prot\_current} + CAPEX_{prot} + C, \quad (6)$$

where: $C_{prot\_corrent}$ is current expenses; $CAPEX_{prot}$ is capital expenses; C is coefficient of comparison of economic efficiency of capital investments.

Thus, we determine dynamic index of ecological development ($I_{ecol(dyn)}$) by the formula:

$$I_{ecol(dyn)} = \sqrt{I_{antr} \cdot I_{prot}}, \quad (7)$$

I_{antr} is index of anthropogenic load on the territory, determined by the formula:

$$I_{antr} = \frac{ET^1}{ET^0}, \quad (8)$$

where: ET^1 is environmental tax in the current year; ET^0 is environmental tax in previous year.

I_{prot} is protection index, determined as:

$$I_{prot} = \frac{C_{prot^1}}{C_{prot^0}}, \quad (9)$$

where: C_{prot^1} is adjusted costs for environmental protection in the current year; C_{prot^0} is adjusted costs for environmental protection in the previous year.

Dynamic index of the economic development of the territory is proposed to be determined on the basis of such indicators as follows: output of products and services (O); intermediate consumption (IC); consumption of fixed capital (D); net regional product (NRP); current assets (CA); fixed assets (FA); number of employees (N) (Voronin 2007). Dynamic index of the economic development of the territory ($I_{econ(dyn)}$) can be determined by the formula:

$$I_{econ(dyn)} = 1 + C_e, \quad (10)$$

$$I_{econ(dyn)} = I_c \cdot \gamma IC + I_f \cdot \gamma D + I_p \cdot \gamma NRP, \quad (11)$$

where: C_e is coefficient of economic efficiency of production on the territory and is determined by the formula:

$$C_e = \frac{P_e}{O}, \quad (12)$$

where: P_e is economic effect of production on this territory; O is output of products and services.

Herewith, the economic effect of the territory is determined by the formula:

$$P_e = (I_c \cdot \gamma IC + I_f \cdot \gamma D + I_p \cdot \gamma NRP) - O, \quad (13)$$

where: I_c is index of return on current assets at the end of the year compared to the beginning of the year; I_f is index of return on fixed assets at the end of the year compared with the beginning of the year; I_p is index of the return on productivity of living labor at the end of the year compared to the beginning of the year; γIC is share of intermediate consumption in the volume of output; γD is share of consumption of fixed capital in the volume of output; γNRP is share of net regional product in the volume of output.

Share of intermediate consumption in the volume of output γIC is determined as:

$$\gamma IC = \frac{IC}{O}, \quad (14)$$

where: IC – intermediate consumption.

Share of consumption of fixed capital in the volume of output (γD) is determined by formula:

$$\gamma D = \frac{D}{O}, \quad (15)$$

where: D is consumption of fixed capital (depreciation).

Share of net regional product in the volume of output (γNRP) is determined by formula:

$$_{\gamma}NRP = \frac{NRP}{O}, \quad (16)$$

where: NRP is net regional product.

Index of return on current assets (I_c) is determined by the formula:

$$I_c = \frac{c^1}{c^0}, \quad (17)$$

where: c^1 is return on current assets in the current year; c^0 is return on current assets in the base year.

Return on current assets (c) is determined by the formula:

$$c = \frac{O}{CA}, \quad (18)$$

where: CA is current assets.

Index of return on fixed assets (I_f) is determined by the formula:

$$I_f = \frac{f^1}{f^0}, \quad (19)$$

where: $f^1$is return on fixed assets in the current year, f^0 is return on fixed assets in the base year.

Return on fixed assets (f) is determined by the formula:

$$f = \frac{O}{FA}, \quad (20)$$

where: FA is fixed assets.

Index of productivity of living labor (I_p) is determined by the formula:

$$I_p = \frac{p^1}{p^0}, \quad (21)$$

where: p^1 is productivity of living labor in the current year; p^0 is productivity of living labor in the base year.

Productivity of living labor (p) is determined by the formula:

$$p = \frac{O}{N}, \quad (22)$$

where: N is number of employees.

Static integral indices of the socio-ecological-economic development of the administrative territory allow the forming of their rating, determining the level of the socio-ecological-economic development of a particular territory in comparison with the reference territories and revealing the disproportions of development. In turn, dynamic integral indices of the socio-ecological-economic development of the administrative territory allow the assessing of the level of the development of a separate territory over time, comparing individual indicators of the development of the territory during the next and previous periods.

3.2 Conducting of the Express Diagnostics of the Level of Socio-Ecological-Economic Balance by the Graphic Method

A graphical method can also be used to determine the level of the socio-ecological-economic balance. According to this method the level of balance is calculated by the ratio of the areas of triangles that characterize the current and optimal state of the socio-ecological-economic system of the administrative territory.

$$I_{bal} = \frac{S(I_{soc}^{curr}, I_{ecol}^{curr}, I_{econ}^{curr})}{S(I_{soc}^{opt}, I_{ecol}^{opt}, I_{econ}^{opt})}, \quad (23)$$

where: $S(I_{soc}^{curr}, I_{ecol}^{curr}, I_{econ}^{curr})$, $S\left(I_{soc}^{opt}, I_{ecol}^{opt}, I_{econ}^{opt}\right)$ are the planes of the triangles that determine the current and optimal state of the socio-ecological-economic development of the territory respectively (Figure 2).

The plane of the triangle of the current state of the socio-ecological-economic system is formed on the basis of calculate (dynamic/static) indices of the socio-ecological-economic development. The calculated indices are the vertices of the triangle.

The plane $(I_{soc}^{curr}, I_{ecol}^{curr}, I_{econ}^{curr})$ shows the current socio-ecological-economic state of the administrative-territorial unit. The plane $\left(I_{soc}^{opt}, I_{ecol}^{opt}, I_{econ}^{opt}\right)$ characterizes the optimal state of the development of the territory, at which the maximum growth of the Gross Regional Product is ensured. The area of the triangles, that characterizes the current state of the development of the administrative territory and optimal state, is determined by geometric property of the vector product (Figure 3).

Let us calculate the area of the triangle ΔLNS as geometric property of the vector product:

$$S_{\Delta LNS} = \frac{1}{2}\left|\overline{LN} \cdot \overline{LS}\right|, \quad (24)$$

Vectors: $\overline{LN}$ is denoted by $\bar{n}$; $\overline{LS}$ is denoted by $\bar{S}$.
Coordinates: m. $L(L; 0; 0)$; m. $S(0; S; 0)$; m. $N(0; 0; N)$.

$\overline{LN} = \overline{(-L;0;N)}$

$\overline{LS} = \overline{(-L;S;0)}$

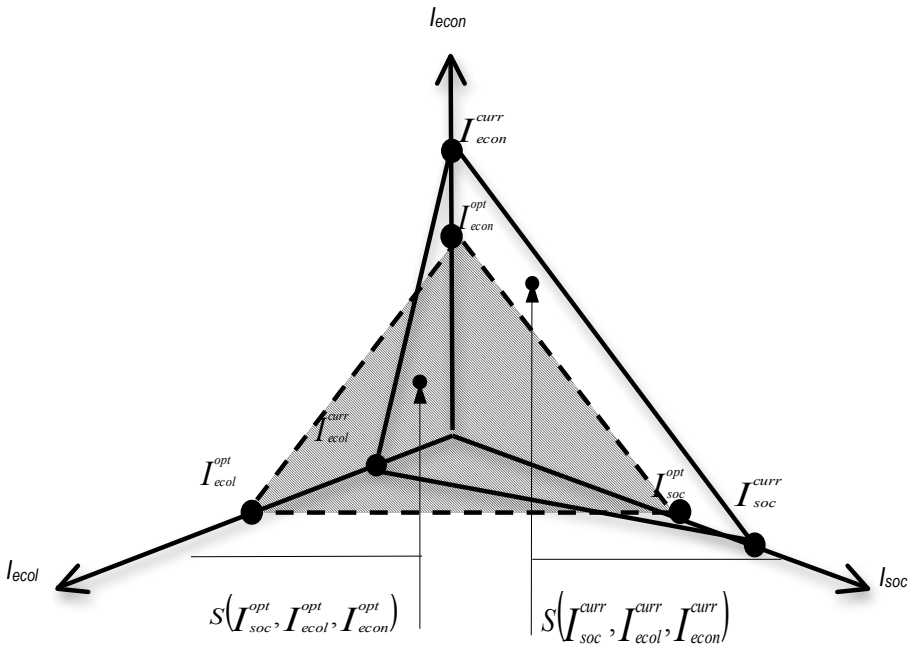
$$\bar{n}\cdot\bar{S} = \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ n_x & n_y & n_z \\ s_x & s_y & s_z \end{vmatrix} = \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ -L & 0 & N \\ -L & S & 0 \end{vmatrix} = 0\cdot i(-L\cdot N)\cdot\bar{j} + (-L\cdot S)\cdot\bar{k} - 0\cdot\bar{k} - 0\cdot\bar{j} - S\cdot N\cdot\bar{i} = -SN\cdot\bar{i} - LN\cdot\bar{j} - LS\bar{k}$$

$|\bar{n}\cdot\bar{S}| = \sqrt{(-SN)^2 + (-LN)^2 + (-LS)^2} = \sqrt{S^2N^2 + L^2N^2 + L^2S^2}$

Thus, the area of the triangle that characterizes the current state of the development of the administrative territory is calculated by the formula:

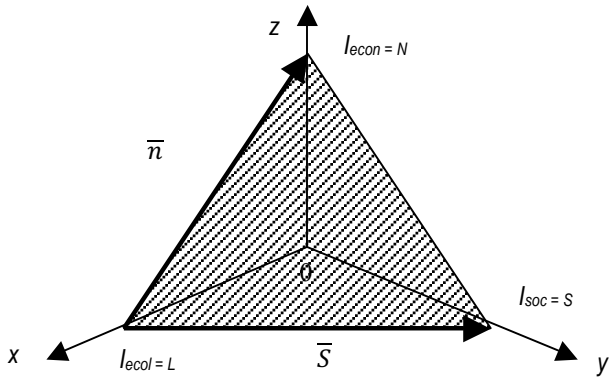
$$S_{\Delta} = \frac{1}{2}\sqrt{S^2N^2 + L^2N^2 + L^2S^2} \quad (25)$$

Figure 2. Graphic method of the determining the level of the socio-ecological-economic balance of the territory



At the same time, the index of the balance of the administrative territory is determined by the formula:

Figure 3. Calculation of the area of the triangle



It is suggested to determine the optimal values of social, economic and ecological development on the basis of the optimization model, which provides that the index of the gross regional product (*V*) is a function of the arguments *S* (social development index), *N* (index of economic development), *L* (social index). The next point of the problem is the optimization of the received dependence, that is, the search for such set of values of the variables *S, N, L* at which the objective function value *V (S, N, L)* is maximal. The solving of this problem can be carried out with the help of the MAPLE 11 computer complex. As a result, it is possible to receive a solution containing the optimal values of the social, economic and ecological development indices at which the maximum GRP can be achieved:

Thus, it is possible to determine the level of the socio-ecological-economic balance of the administrative territory on the basis of the ratio of the area of the current socio-ecological-economic state of the studied territory and the area of the optimal value of the socio-ecological-economic state of the studied territory. The results obtained by the graphic method and by means of the optimization model allow the determining of the deviations of the current and optimal level of the socio-ecological-economic balance of the administrative-territorial unit.

Conclusion

The functioning of the system of administrative and territorial management should ensure the sustainable development of the territories. As the research has shown, one of the main directions of this problem solving is the formation of balanced development of the socio-ecological-economic system of the administrative territory. In this regard, special attention should be paid to the issues connected with the comprehensive diagnostics of the state of the administrative territory and the determination of the degree of balance of the socio-ecological-economic system.

Disproportions in the socio-ecological-economic development of the administrative-territorial unit are based on the determination of static and dynamic integral indices of the socio-ecological-economic development of the administrative territory. The distribution of financial resources is proposed to be implemented on the basis of the disproportions (identified by graphic method) in the development of social, environmental and economic fields of activity and allocation of financial resources, first of all, to those fields that provide the maintenance of the trajectory of balanced socio-ecological-economic development of administrative-territorial units.

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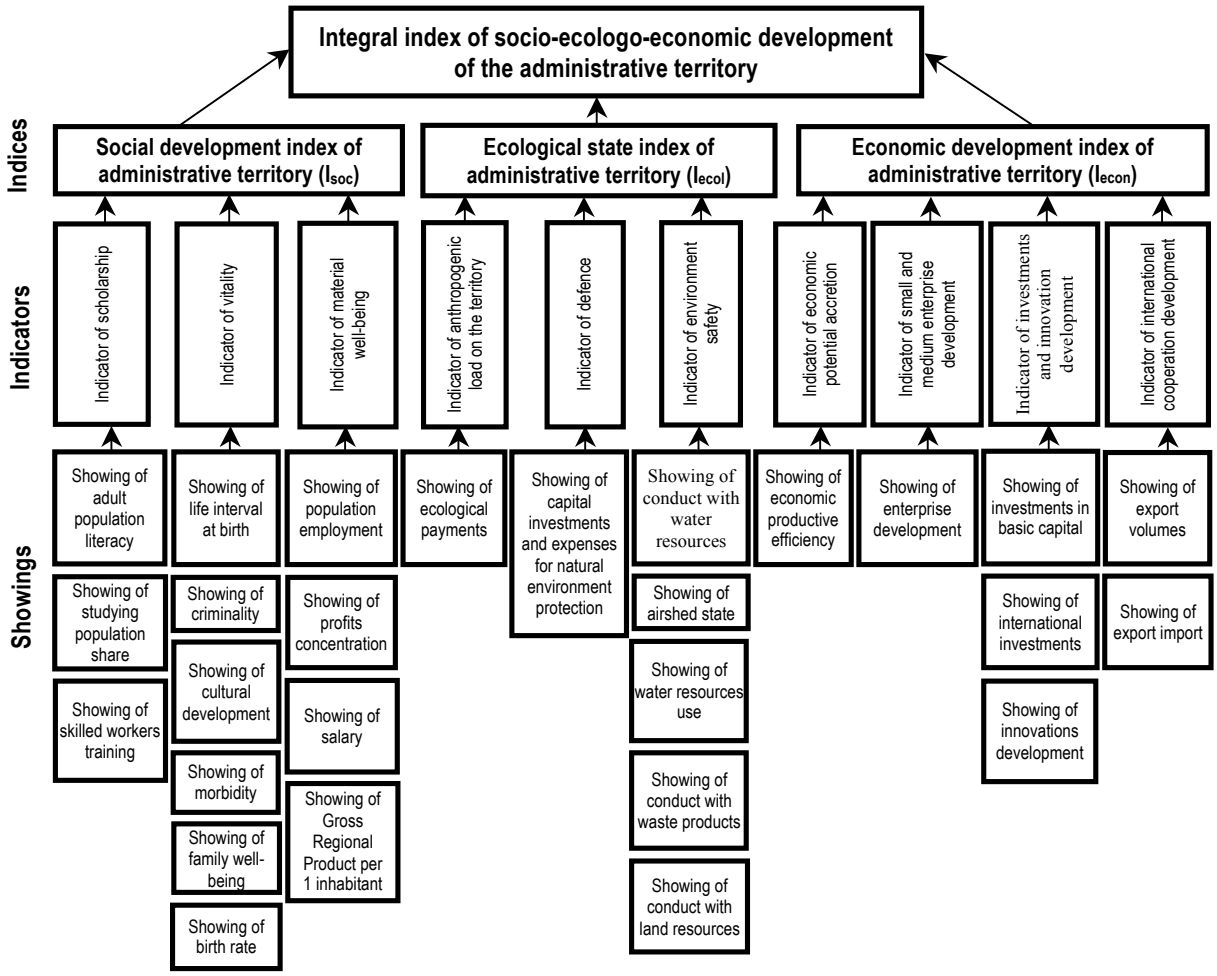
APPENDIX 1 - Constituents of Integral Index of Socio-Ecologo-Economic Administrative Territory Development



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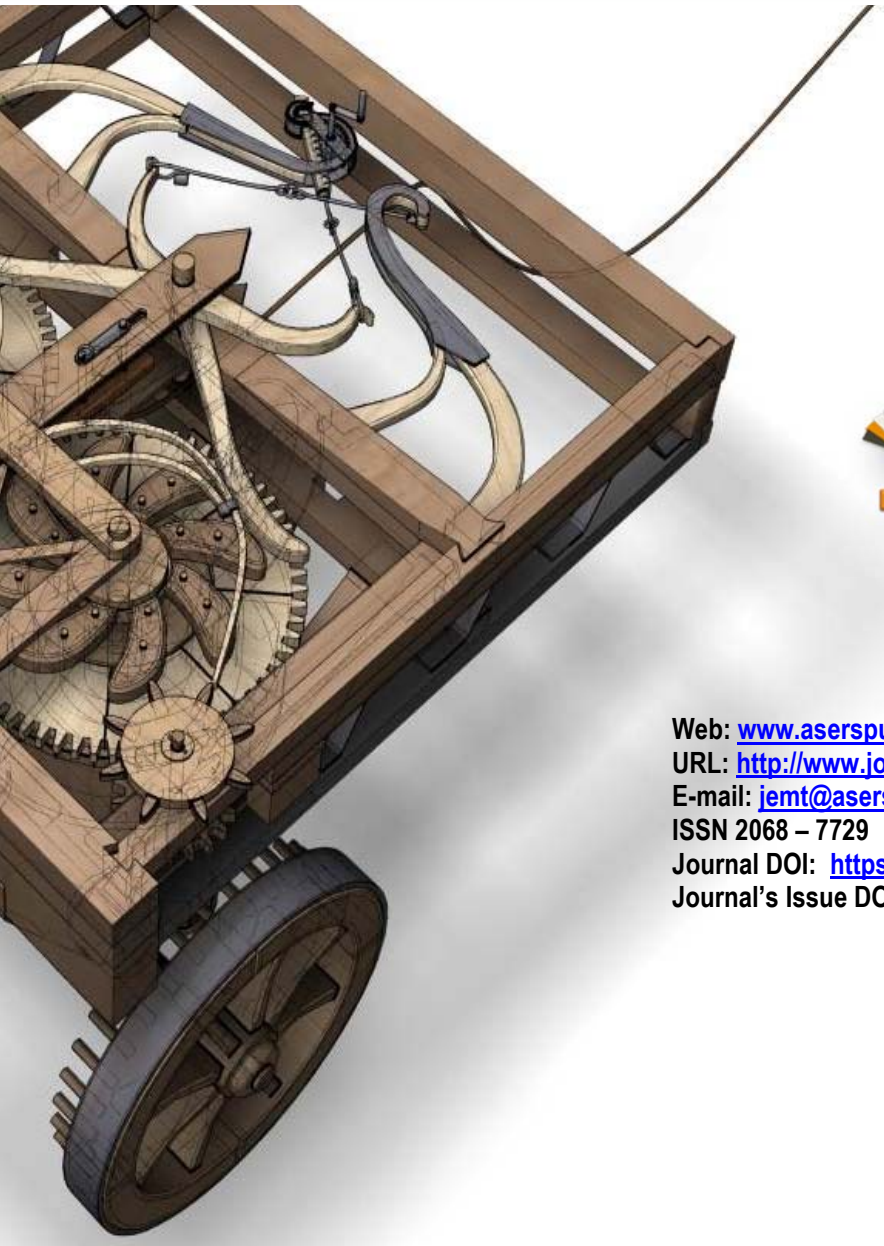

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