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Use of key indicators to monitor sustainable development of rural areas

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ABSTRACT

his study provides a multidimensional analysis of sustainable socio-economic development and its challenges in the rural areas of Ukraine. The methodology of realization of sustainable development's conceptual provisions was created. The advantages of using indicative assessment at the regional level were justified. The methodical approach how to define the indicators of sustainable development (including economic, socio-demographic, labor and environmental domains) of rural areas was proposed. Statistical data, experts' and rural residents' evaluation were used to assess the level of socio-economic development of rural areas. The proposed system of indicators is applicable not only to the rural areas of the whole region, but also to its different parts. The tracking model is based on the consistent use of economic, mathematical and expert methods: SWOT-analysis, factor, cluster and discriminant analysis. The construction of the dendrogram allows to determine the type of representative for each cluster. The modeling of sustainable socio-economic development for each sample is applicable to all areas within same cluster. A representative sample from each cluster makes it possible to identify the presence in the region of the so-called "points of growth" and to forecast their development. Two scenarios are considered: maximum (the share of GRP accumulation growth 21.2%) and moderate (the share of GRP accumulation growth 10.6%). GDP Gross Domestic Product growth will differentiate by the type of activity: cluster 1 (agriculture, hunting and forestry) 13% increase; cluster 2 (trade, service and household services) 21% increase; cluster 3 (tourism and international cooperation) 18% increase; cluster 4 (processing industry) 8% increase. Therefore, the using of key indicators for monitoring the sustainable development of rural areas provides an opportunity to take into account the specifics of sustainable development of different specialization branches of rural areas that will support high economic and social growth in the future.

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INTRODUCTION

The concept of sustainable development has now become a fundamental one for the development of the global community (Carroll, 2000). The largest UN forums in Rio de Janeiro (Rio+20, 2012) and Johannesburg (WSSD, 2002) were devoted to the problems and ways of human transition to sustainable development. First of all, it is connected with the growth of ecological danger in the world in the conditions of technogenic type of economic development, depletion and degradation of natural resources and increase of environmental pollution. The International Commission on Environment and Development (Brundtland, 1987) pays much attention to the essence of the definition of "sustainable development". Sustainable development of the society implies integration of economic, ecological and social issues and is aimed at solving 4 main tasks: ensuring economic growth, social development, effective solution of environmental protection problems, rational use and reproduction of natural resources. The analysis of the socio-economic environment of rural areas using SWOT analysis and factor analysis in developing sustainable development strategies, taking into account the need to involve the public in this process and using advanced strategic planning approaches, is common. (Manns, 2010; De Lucia, *et al.,* 2019). These tasks should be solved simultaneously within sustainable development of the society. Sustainable development indicators, on the one hand, should quantitatively characterize the achievement of sustainability goals, and, on the other hand, should be used to summarize and clarify its key aspects (Oerther, 2019; Nguyen, 2019; Kiselitsa, 2018, Gorlachuk *et al.*, 2018). With the help of these indicators, it is possible to assess the level of development of the country, region and municipality, to predict its future state (economic, environmental, social, demographic, etc.), ND to draw conclusions about the sustainability of the territory. There are ~~two~~ 2 approaches to the construction of indices and indicators: 1) Building a system of indicators that can be used to asses individual aspects of the development: environmental, social, economic; 2) Creation of integrated, aggregated indices, with the help of which one can comprehensively asses the development of a country (or a region). Aggregated indicators are divided into the following groups: socio-economic; ecological-economic; ecological-ecological; ecological-socio-economic. Scientists from different countries (Makate, 2019; Tulla, 2019; Battino, 2019; Yilmaz, 2019; Zainoddin, 2017; Cattaneo, 2016) adhere to 6 systems of sustainable development indicators in their studies: 1) the OECD indicator system; 2) the UN CSD indicator system; 3) the system of indicators to improve environmental management in Central America; 4) the system of environmental and economic accounting; 5) indicators of true savings; 6) indicators of real progress. The first system of eco-indicators of the Organization for Economic Cooperation and Development (OECD) is a "pressure-state-response" model (ISD, 2007). The system of indicators of true savings (genuine (domestic) savings) is the rate of accumulation of national savings after proper accounting of depletion of natural resources and damage from environmental pollution. The indicator of "true savings" was proposed by the World Bank (Hamilton, 1998). The concept of "true savings" is closely linked to the attempt to measure countries' national wealth through a new approach (Mannis, 2019). The World Bank has calculated the values of natural, produced (physical or artificial) and social capital, as well as their share in a country's total national wealth (Cieslikowski, 2009). The GPI has become one of the few alternatives to GDP that is widely discussed in the scientific community and used by governments and non-governmental organisations to better measure sustainable economic well-being (Talberth*et al.,* 2007). The dynamics of the GPI in developed countries in recent decades has been one of the main arguments used by proponents of the concept of "uneconomic growth".The analysis of research and publications on this issue (Manns, 2010; Borowy, 2014; Angilella*et al.*, 2018; Suganthi, 2018; Utting*et al.*, 2010; Wojcik-Len*et al.*, 2019; Kalashnikova *et al.*, 2019; Gheorghiu *et al.*, 2014) identifies 2 main methodological approaches to building sustainable development indicators: 1) Building an integrated, aggregated indicator that can be used as a basis for judging the degree of sustainability of socio-economic development; 2) Building a system of indicators, each of which reflects a separate aspect of sustainable development. Most often, within the framework of the general system, economic, environmental and social subsystems of indicators are singled out. The use of a comprehensive system of indicators is a necessary condition for the

start of work on the creation of a national system of sustainable development indicators. It should be borne in mind that indicators alone do not always provide an answer to the question of sustainability/ instability. The answer can only be obtained after the results have been correctly interpreted (Kubiszewski*et al.*, 2013). Sustainable development is not only about economic growth - improving living conditions and increasing incomes of the rural population is theoretically possible by simply redistributing resources among different segments of the population without increasing production (Kulchii, 2019; Widomski*et al.*, 2017). According to the 2018 Nobel laureate of the American environmental economist (Nordhaus, 2009), as long as traditional macro indicators remain the measure of human well-being. The indicators emphasize certain aspects of sustainability. In global practice, integrated socio-economic assessments of development are more narrowly defined, and they are dominated by social dimensions (human development, quality of life), as well as various combinations of indices assessing institutional development (Ottomano *et al.*, 2016; Schwartz*et al.*, 2003; Okunola, 2016). Integral measurements are complicated by the fact that heterogeneous socio-economic indicators do not

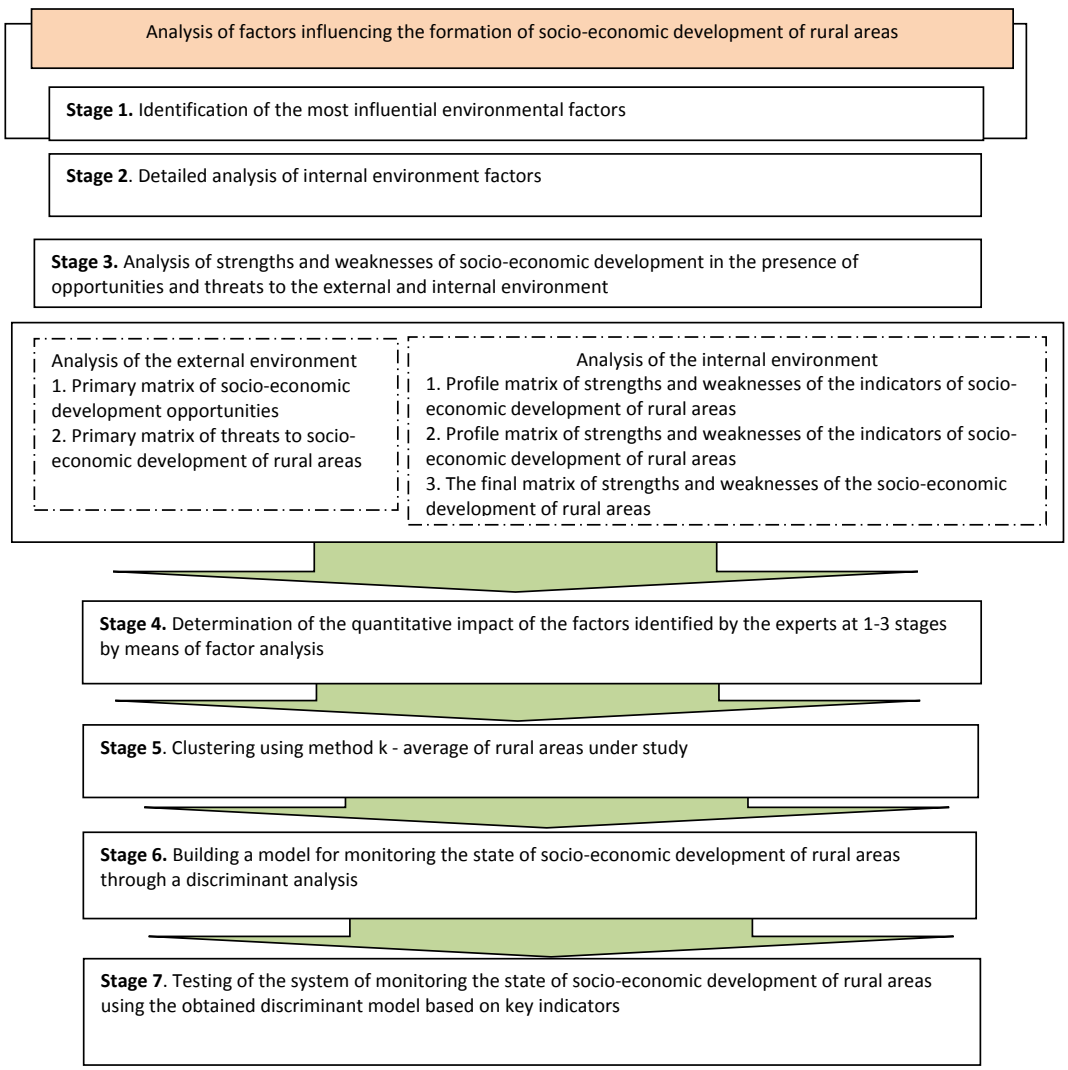


Fig. 1: Model for determination of key indicators for monitoring the state of socio-economic development of rural areas

always have a general trend (growth or decline) or a clear dependence on the level of development of the region, so the results of aggregation are often inexplicable and difficult to interpret (Shibaeva*et al.,* 2019; De Lucia *et al*., 2019). The difficulty lies in the impossibility of quantifying these indicators and in the inevitable errors due to the subjectivity of the researcher or expert's assessment.Comparison of the indicator systems for the countries in transition, to which Ukraine belongs, allows to conclude that there is a need for a diversified approach with the use of special surveys taking into account the specifics of our country. Ukraine has adopted and approved the 2030 Sustainable Development Strategy of Ukraine. But the environmental component has received little attention. The document only states that special attention should be paid to the safety of life and human health, which is impossible, in particular, without a safe state of the environment and quality drinking water, but their priority has not been identified. (SSDU, 2030). Due to methodological problems associated with bringing a large number of indicators to a comparable form, there is no universally recognized integrated indicator yet. The approach based on the construction of a system of indicators is more widespread. International systems of indicators consist mainly of non-aggregated indicators on specific areas of development and problems such as income inequality, unemployment, education, various aspects of health, and access to health services. Therefore, considering the unresolved parts of the problem as a novelty, it is proposed to carry out a comprehensive assessment of the state and potential of rural development, as well as to analyze their sustainability based on the definition of common (synthetic) indicators and indicators of sustainable socio-economic development. Therefore, the aim of the study is to develop a system of key indicators for monitoring the sustainable development of rural areas. The objectives of the study are to develop a model for sustainable socio-economic development of rural areas; identify strengths, weaknesses, threats and opportunities of rural territories by SWOT analysis, determine indicators of impact on rural development by factor analysis, classify territories by level of development by cluster analysis, determine by dendrogram the representative for each of the received clusters of rural territories - the so-called «Points of growth. This study has been carried out in Vinnitsa region of Ukraine in 2018

MATERIALS AND METHODS

At the first stage, a preliminary analysis of the entire set of indicators affecting the level of socio-economic development of the rural areas under study is carried out (Table 1). The analysis of weaknesses and strengths of the territory's development enables the authorities to define short-term operational goals, develop and implement projects along with medium-term strategic goals (Schwartz, *et al.,* 2003; Wojcik-Len, *et al*., 2019). The analysis of the weaknesses and strengths of the development of the territory allows the government to define short-term operational goals, develop and implement projects together with medium-term strategic goals. The type of targets is selected using a dendrogram method that identifies a representative - rural territory for each cluster. The location of its location in the dendrogram determines the goals: operational - if the territory is in a state of stagnation, strategic - if in a state of development. The implementation of these projects should eliminate the region's weaknesses and strengthen its strengths, take advantage of the opportunities offered by external forces and avoid threats, and analyze the factors affecting the socio-economic development of rural areas goals (Gorlachuk, *et al.,* 2018). The third stage analyzes and forecasts the factors of external and internal environment of rural areas, which determine the choice of key indicators for monitoring the state of socio-economic development of rural areas (Nguyen, *et al.,* 2019). A comprehensive analysis is made by comparing the external and internal environment factors identified at the first and second stages. As a result, a profile matrix of strengths and weaknesses of the indicators of socio-economic development of rural areas and the resulting matrix of strengths and weaknesses of this development is built. Complex expertise1-3 stages is a modified version of SWOT-analysis. A model for determining the key indicators of monitoring the state of socio-economic development of rural areas (Fig. 1) is proposed.

According to Table 1, the key problems of rural development in the Vinnytsia region, which hinder their harmonious development, are identified, namely: a high degree of wear and tear of fixed assets; limited own investment resources of farmers' enterprises for the modernization of production; a

Table 1: Analysis of internal (strengths and weaknesses) and external (opportunities and threats) factors in rural areas of the Vinnytsia region

Internal factors	
Strengths (S):	Weaknesses (W):
- Geographical location, transit potential - Availability of significant explored reserves of mineral resources - Significant potential for tourism and recreation development - Developed transport links and infrastructure - Powerful agricultural complex - High level of cooperation with processing companies - Recycling of secondary raw materials and waste - Significant reserve of energy capacities - Positive growth dynamics of small and medium business - Positive experience in attracting investors to the region - Availability of scientific and innovative potential - Competitive conditions for attracting labor force to the region (creation of an IT cluster) - A well-developed educational network of higher education institutions	- Technical and moral obsolescence of infrastructure, including communal infrastructure - Significant moral and physical wear and tear of equipment and insufficient technological provision of enterprises - Significant outflow of active and qualified employees outside the region - Poorly diversified economy
External factors	
Opportunities (O):	Threats (T):
- Interest of external investors in the region - Availability of restructuring of existing production facilities - Development of innovative industries, growth of enterprises with high-tech industries - Formation of processing industry clusters - Providing state aid to diversify excess capacity in the sugar and alcohol industries - Creation of international transport corridors in the region - Growth of domestic demand for certain types of products - Formation of land relations in rural areas - Introduction of a system of state support for agricultural enterprises - Introduction of state programs for the production of ecologically clean foodstuffs - Development of cross-border economic relations - Approximation of Ukraine's standards to EU standards - Simplification of the procedure for obtaining permits and licenses - Assistance from international economic development organizations	- Political and financial dependence on the center (centralization of financial resources), which limits regional development opportunities - Ineffective state regulatory policy, threat of decline of the leading economic sectors of the Vinnitsa region - Decrease in absolute growth of foreign direct investment - Imperfection of the regulatory framework for regulating investment processes and insufficient protection of investors' rights - Rising energy prices limit the development of traditional sectors of the region's economy - Limited financial resources (no cheap loans), primary capital

high proportion of those employed in the informal sector of the economy; poorly diversified economy of the region; insufficient supply of jobs in rural areas; a significant level of outflow of active and skilled workers outside. The results of the expert survey showed that these indicators relate to the economic, socio-demographic and labor fields. The ecological sphere of sustainable rural development has not been investigated. The next stage of the SWOT-analysis: determining the direction of influence of positive factors (opportunities) or negative factors (threats). Experts were asked to rate each indicator on a scale of ten: 9-10 - very strong; 7-8 - strong; 5-6 - neutral; 3-4 - weak; 1-2 - very weak. The rating scale was constructed to use the calibration method. This method considered the study area for the required number of intervals, taking into account the law of “normal distribution”. The maximum and reliable boundaries of each interior were presented by experts. Placement on four Internet sites has rated the holding at an average weighted average. In order to determine the positive or negative impact of these indicators, experts were asked to assess the possibility or threat by determining their probability of manifestation (from 1% to 99%) depending on their significance for socio-economic development (from 0 to 10).In order to identify the factors that were subsequently used to identify strengths, weaknesses, threats and opportunities for socio-economic development, a questionnaire was conducted. Fifteen people were selected as experts who work as managers of agricultural enterprises,

owners of farmers' enterprises, and specialists of district administrations. The number of experts was justified using the recommendations. To assess the degree of consistency of the experts' conclusions, the coefficient of correlation (W) was calculated using Eq. 1 (Lipsey, *et al*., 2001).

$$W = \frac{12S}{m^2(n^3-n)} = \frac{12}{m^2(n^3-n)}\left[\sum_{j=1}^{m}\left(\sum_{i=1}^{n} a_{ij} - \frac{\sum_{j=1}^{m}\sum_{i=1}^{n} a_{ij}}{n}\right)^2\right], \quad (1)$$

Where, a_{ij}- rank of i-th factor in j-th expert; m - number of experts; n - number of factors.

The value of the condensation factor is within the range of 0<W<1. When experts' conclusions about the influence of the studied factors on the opportunities and threats of social and economic development of rural areas fully coincide with W=1. Otherwise, the concordance coefficient is equal to 0. To estimate the significance of the coefficients, theχ^2 criterion was calculated, which is subject to the distribution with the number of degrees of freedom f=n – m – 1using Eq. 2 (Lipsey, *et al*., 2001).

$$\chi^2 = m(n-1)W = \frac{S}{\frac{1}{12}\min(n+1)}, \quad (2)$$

If the calculated value exceeds the tabular value for the corresponding number of degrees of freedom, then at a given level of significance it can be argued that a certain consistency of the experts' conclusions is random. To assess the consistency of the experts' conclusions on the matrix of ranks of factors of external and internal environment of the socio-economic environment of rural areas, the coefficient of correlation is -0.8813, which indicates a high consistency of the experts' conclusions. The actual value of Pearson's criterion for 5% of the significance level is -4.23, i.e. $\chi_{fact}^2 > \chi_{table}^2$, so it can be stated with 95% probability that the consistency of the experts' conclusions is not random.

Statistical analyses

At the fourth stage, the impact of factors on the socio-economic development of rural areas is measured quantitatively using factor analysis. Factor analysis allows to determine the impact of the selected indicators on the level of development of rural areas. At the fifth stage, using the cluster analysis (Hair, *et al.*, 1998), the selected indicators classify rural areas by the level of development. The basis for the cluster analysis is the matrix of indicators, previously identified at the fourth stage. The matrix can be presented as a rectangular table, using Eq. 3.

$$X = \begin{pmatrix} x_{11}x_{12}\ldots x_{1n} \\ x_{21}x_{22}\ldots x_{2n} \\ \ldots\ldots\ldots\ldots \\ x_{m1}x_{m2}\ldots x_{mn} \end{pmatrix}, \quad (3)$$

Where,x_{ij} is the value of j-th partial indicator characterizing the state of socio-economic development of the territory; m - number of objects (i.e. the number of rural areas under study), n- number of indicators characterizing the level of socio-economic development of these areas. The process of clustering rural areas using the k-average cluster analysis method is carried out in the following sequence (Hair, *et al.*, 1998). First, the number of clusters into which the total set of initial indicators should be broken down is justified, the initial breakdown of territories into clusters is made, and the centers of gravity of the resulting clusters are determined; the composition of each cluster is determined; if necessary, the number of clusters is changed and the number of objects is recalculated and redistributed by clusters, and the recalculation of the centers of gravity of clusters is made. The size and composition of the received clusters are determined by the average values and canters of gravity indicators, and the results are reflected in 2 types: in the form of a graph and in tables. The graph represents a set of curves of the obtained clusters, where the OX-axis indicators to be analyzed in the EI-axis are the average values of each cluster obtained. The tables reflect the information on the composition of each cluster: the name of the objects (rural areas) that were included in a certain cluster, as well as the average values of the economic indicators of the cluster. At the sixth stage, a system of monitoring the level of social and economic development of rural areas is built using the method of discriminant analysis. At the seventh stage, the monitoring system is tested.

Data description

The empirical base of the study was the indicators of socio-economic status of 27 rural areas of Vinnitsa

region for 2013-2018 (SEDU, 2018). These indicators were preliminarily classified by priority groups: indicators of economic development of the territory and indicators of social development of the territory. Analysis of the dynamics of the above indicators of the Vinnytsia region shows that the most dynamic growth was in the total area of the housing stock (106.6% growth), the number of preschool educational institutions (100.9% growth). Along with the growth of positive factors, there is a growth of factors that negatively affect the social development of rural areas of the region. The most increased indicators are: the number of patients with a first-time diagnosis of malignant neoplasms (104.2 per cent); and the number of pensioners (an increase of 1.8 per cent). The growth of the latter indicator from the social point of view is positive, which indicates the improvement of the quality of health care, medical development, etc. On the other hand, the increase in the number of pensioners increases the burden on employees from the point of view of formation of the pension fund. The main economic indicators of the territory development are shown in Fig. 2.

During the study period, the most increased indicators of the wage fund and social payments per month per employee (173.4%), the average monthly salary per employee (222.5%), the average size of monthly pensions for pensioners (173.3%), the sale of products by type of activity "agricultural production" (202.5%). The negative indicator in the economic development of the territories of municipalities is the growth of unemployment. In rural areas of Vinnytsia region this indicator in 2018 amounted to 81.14% compared to 2013.

RESULTS AND DISCUSSION

The conceptual model of formation of the system of monitoring of sustainable socio-economic development of rural areas is shown in Fig. 3.

Monitoring is an important tool of information support for the mechanism of socio-economic development of rural areas, effective management of this process. The proposed monitoring system consists of observation, analysis, assessment and forecast of risk factors present in the region in order to prepare managerial decisions and recommendations aimed at improving the socio-economic situation. Socio-economic evaluation is proposed to be obtained by analyzing social and economic processes with the help of the system of collection and processing of statistical information, with the use of communication channels, and the information obtained from external and internal environment is processed through the formation of a database, after which the analysis is carried out and managerial decisions are made (Fig. 4).

Further analysis allows to form the necessary basis for the substantiation of socio-economic development. This base should simultaneously

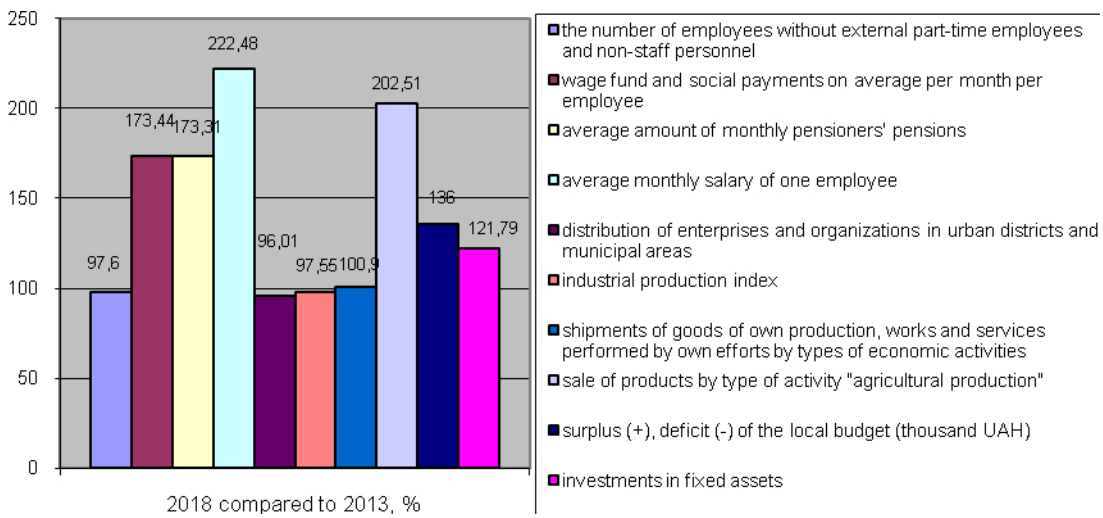


Fig. 2: Dynamics of economic indicators of rural areas of Vinnitsa region

System of monitoring of social and economic development of rural areas	Social and economic development of rural areas		
	Information system	**Analysis System**	**Forecasting system**
	Creation of the information field	Creation of threshold indicators for assessment of the achieved level of development	Formation of alternative scenarios of socio-economic development
	Development of methodological tools to assess the development of rural areas and their sustainability sustsustainability	Typologization of development and allocation of weaknesses in the regional system	Development of recommendations to reduce risk losses
		Factor analysis of sustainability	
	Retrospective and diagnostic analysis of rural data	Assessment of the impact of risk and uncertainty	Modeling of the threshold values of growth of the level of socio-economic development of the territory
		Development of recommendations	

Fig. 3: Conceptual model of formation of the system of monitoring of social and economic development of rural areas

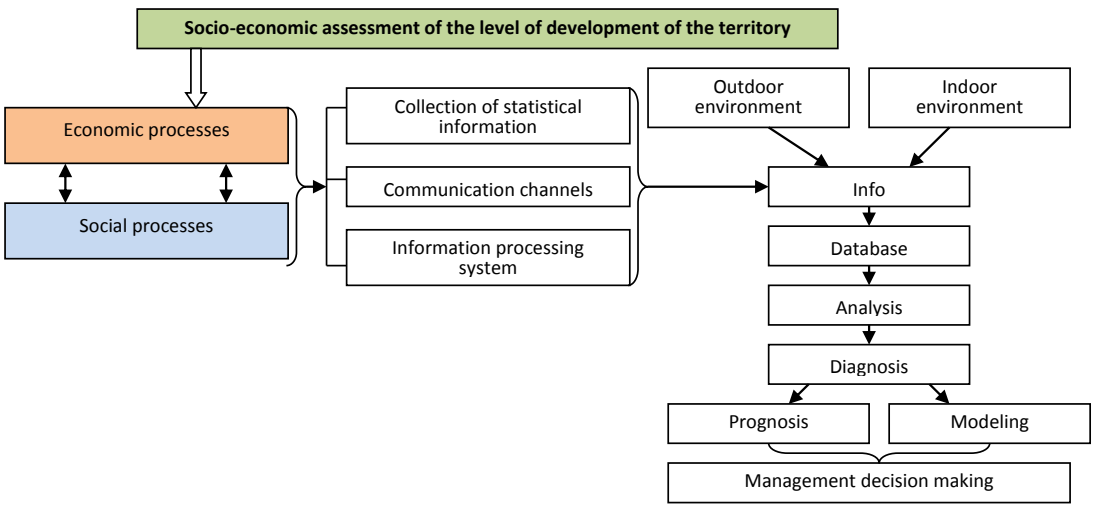


Fig. 4: Components of the assessment of the level of socio-economic development of rural areas

meet 2 criteria: it should be aimed at addressing the weaknesses of socio-economic development that make rural areas vulnerable, hinder its effective operation, and it should propose measures to transform the weaknesses into strengths. The complex of these actions allows to form a matrix of strategic advantages profile, to move to quantitative measurement of the level of social and economic development relative to the comparison base (Table 2). The first field - "Field of Strengths and Opportunity" (*S&O*)- demonstrates the opportunities that can be practically realized in the presence of internal strengths of rural areas, namely: the effectiveness of forms and methods of development of cooperation with processing enterprises contributes to an increase in demand in the domestic and foreign markets in the agricultural sector. The second field, the Strengths and Threats Field (*S&T*), reflects the likelihood of increased threats when rural areas have the capacity to prevent them. The third field, the Field of Weakness and Opportunity (*W&O*), diagnoses bottlenecks in the social and economic development of rural areas

Table 2: System of indicators affecting the socio-economic development of rural areas

Indicators	Designation
Economic indicators	
Gross regional product per capita	In1
Profitability level of main types of agricultural products	In2
Specific weight of certified products in the total volume of products	In3
Investments in fixed assets of agricultural (farmer) enterprises located in the region	In4
Share of processing industries in gross regional product	In5
Share of imports of major groups of food and non-food products	In 6
Per capita food production	In 7
Volumes of products sold for export by line of business	In 9
Labor indicators	
Share of economically active population in rural areas	In 8
Registered unemployment rate	In 12
Socio-demographic indicators	
Population with monetary incomes below the subsistence minimum in % of the total population	In 10
Share of spending on health care; education; culture, sports; social policy	In 11
Expenditures on final consumption of households per 1 person	In 13
The ratio of the subsistence minimum to the average per capita income of the population	In 14
Coverage of rural children by preschool institutions	In 15

when there are opportunities to address them. The fourth field, the Field of Weakness and Threats (*W&T*), demonstrates the underdevelopment of individual components of socio-economic development in the presence of threats from the external environment. Using the results of the study will allow for greater use of the Strengths and Opportunity (*S&O*) field and the neutralization or mitigation of the Weakness and Threats (*W&T*) field.

The factor analysis has shown that almost all 15 indicators identified by the experts in the SWOT-analysis have an impact on the socio-economic development of rural areas, were included in 4 factors. Table 3 shows the indicators, which were included in one of the factors, which are highlighted in red by STATISTICA program, and it means that these indicators are the most influential on the state of socio-economic development of the studied areas and should be included in the system of monitoring of the state of socio-economic development of rural areas in Vinnytsia region.

According to the data of Table 3, the first factor includes 4 indicators: gross regional product per capita, profitability level of main types of agricultural products, share of certified products in the total volume of import of main groups of food and non-food products. The second factor includes 3 indicators: investments in fixed assets of agricultural (farmer) enterprises located in the region, the share of processing industries in the gross regional product, the volume of export sales by activity directions. The third factor includes 2 indicators: the share of economically active population in rural areas, the population with monetary incomes below the subsistence level. The fourth factor includes 2 indicators: the share of spending on health care,

Table 3: Results of the factor analysis of social and economic development of rural areas (STATISTICA program listing)

	Factor Loadings (Unrotated) (дані територій) Extraction: Principal components (Marked loadings are >,700000)			
Variable	**Factor 1**	Factor 2	Factor 3	Factor 4
In1	0,872618	-0,249020	0,069639	0,030914
In2	0,766448	-0,361564	0,024251	-0,222332
In3	0,669841	-0,293990	-0,309234	-0,173145
In4	0,284305	0,783417	0,618265	-0,016099
In5	0,012836	0,794634	0,089561	-0,505071
In6	-0,523840	-0,692527	0,172460	0,012836
In7	-0,082746	-0,389497	-0,150747	-0,096683
In8	-0,406768	0,384208	0,887676	0,166734
In9	0,347473	0,910793	-0,684224	-0,308225
In10	0,123109	-0,202407	-0,817369	-0,209558
In11	0,012836	0,054540	0,000903	0,817369
In12	-0,161784	0,142327	0,123109	-0,003607
In13	-0,096683	-0,354483	-0,161784	-0,036887
In14	0,042532	-0,179222	0,042532	-0,292072
In15	0,540840	0,349024	0,197247	0,670549
Expl.Var	7,563611	1,821988	1,417022	1,232333
Prp.Totl	0,385042	0,283990	0,133394	0,115554

education, culture, sports, social policy, coverage of rural children by preschool institutions.The results of the factor analysis have shown that the peculiarities of socio-economic development of rural areas of Vinnitsa region are almost entirely characterized by 4 groups of factors, which is sufficient to justify the general trends in its formation. The first factor can be characterized as the ability of rural enterprises to produce and sell their products at affordable prices and quality, its level of influence is 38.5042% and has the greatest impact on the level of socio-economic development of the rural areas under study. The second most important factor is 28.3990%, which characterizes the financial condition of agricultural (farmer) enterprises of the territory, the degree of diversification of the economy of the territory. The third factor characterizes the level of economic activity of the inhabitants of the region (the overall level of its influence is 13.3394%). The fourth factor by its load is the last one and reflects the state of social policy of the region, the overall level of its influence is 11.5554%. Graphically, this dependence looks as Fig. 5.

Thus, the proposed system of indicators identified 4 factors that have the greatest impact on the level of socio-economic development of rural areas and built a factor model of the system of monitoring the status of socio-economic development of rural areas in the Vinnytsia region (Fig. 6).

The purpose of clustering to identify key indicators for monitoring the status of socio-economic development of rural areas in the Vinnytsia region is to analyze the results of clustering and identify the type of representative - the territory of each cluster. It should be analyzed, in which rural areas (districts of the region) with similar state of socio-economic development indicators for all indicators are located from the obtained clusters. Average values of the obtained clusters are presented in the graph and are shown in Fig. 7.

Fig. 7 shows that all rural areas of the region are divided into 4 clusters in terms of socio-economic development. The number and composition of objects (analyzed rural areas) obtained as a result of clustering are shown in Table 4.

According to the data of Table 4, according to the identification attribute - “the level of socio-economic development of rural areas”- cluster 1 includes territories that use agriculture in their economic activities and are at a rather low level of socio-economic development due to the small presence of processing enterprises and are the

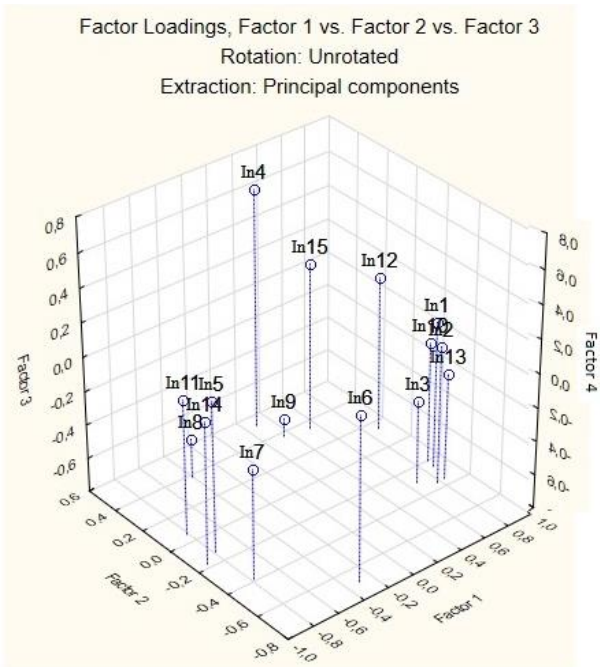
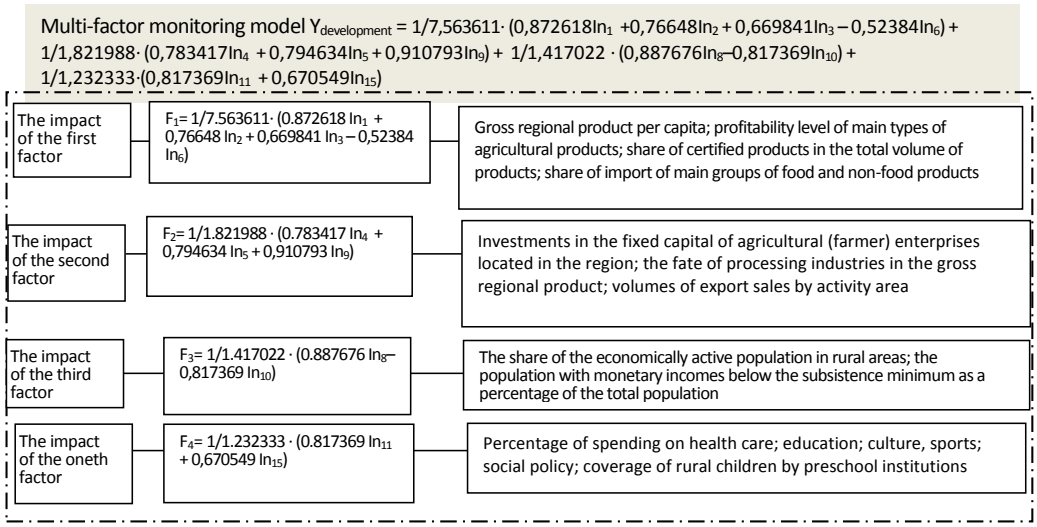


Fig. 5: Observational density graph around the mean value of each group of model factors

Fig. 6: Factor model of the system of monitoring the state of socio-economic development of rural areas



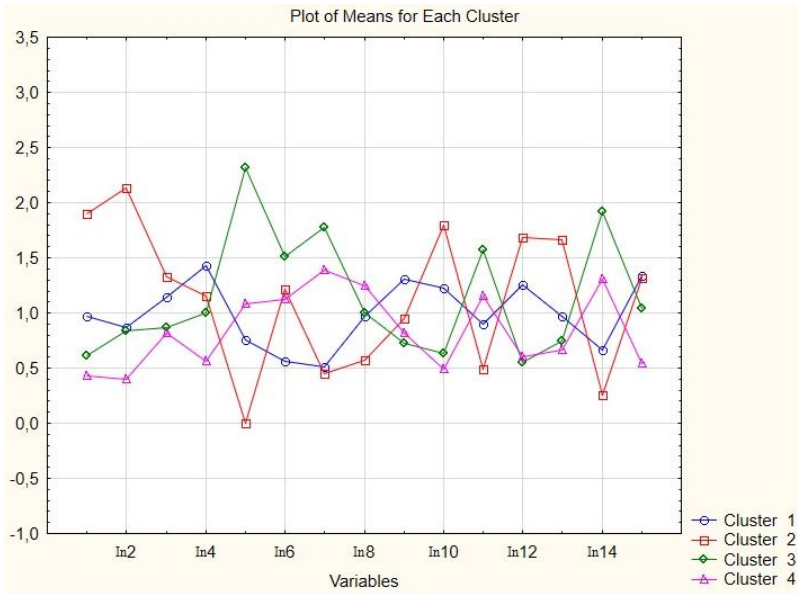


Fig. 7: Graph of average values of the socio-economic status of rural clusters in Vinnitsa region

raw material base of the entire region. The areas included in cluster 2 are also predominantly engaged in agricultural activities, but have a more developed infrastructure, so these areas are dominated by the tertiary (mixed) sector of the economy. The third cluster is characterized by the presence of personal farms, which specialize mainly in meat and dairy products, in addition to the industrial production of foodstuffs. Cluster 4 is characterized by the presence of a secondary sector of the economy (processing industry, construction, energy), where the most important place in them is occupied by processing (food) industry, represented mainly by food products. For further analysis, typical representatives in each of the identified clusters were identified. This can be done by building a dendrogram, in which, depending

Table 4: Objects (rural areas) that are part of the received clusters

Name of the district (rural area)	Number of territories	Cluster	Identification of the level of development	Cluster description
Lipowiecki Litinsky Oratowski Pushchinsky Funeral Tyrowski Tomaspolsky Tulchinsky Chechelnitsky Shargorodsky Illinsky	11	1	Quite a low level of socio-economic development of the territories	Primary sector of the economy prevails - it is represented mainly by agriculture and is the raw material base of the economy of the territories
Barsky Bershadskiy Murovanokurilovetsky Trostyanetsky	4	2	Low level of socio-economic development of territories	The tertiary sector of the economy (transport, communications, finance, trade, education, health care and other types of production and social services), which ensure the functioning of the primary and secondary sectors of the economy of these territories, prevails. Currently, this sector is not sufficiently balanced in its structure
Gaisinski Teplice Khmelnitsky Nemirovsky Yampolsky	5	3	Average level of socio-economic development of territories	Of all the enterprises in rural areas, only the agro-industrial complex processing (food) industry and agricultural enterprises are the main determinants of sustainable development of the rural economy of this cluster, so the economic fluctuations in them lead to
Vinnitsa Mogilev-Podolsky Kalinowski Kazatinsky Zhmerinsky Kryzhopolsky Chernivtsi	7	4	Sufficiently high level of socio-economic development of the territories	The secondary sector of economic development (manufacturing, construction, energy) is the most important link in the economic complex of rural areas for economic development. The most important place in them is occupied by the processing (food) industry, represented mainly by foodstuffs production

on the purpose of the analysis, the number of these types of representatives is determined by crossing the vertical line in the dendrogram chart (Fig. 8). The forecast of the results of the use of the rural area as a representative type of "growth point" for the development of a certain sphere of activity is shown in Fig. 8. At the same time, two possible scenarios of development were considered: inertial and maximal scenarios.

The construction of the dendrogram allows to determine the representative for each of the received clusters of rural territories - the so-called "growth points" and the most appropriate specialization of its activity. The first discussion point is the attempt to implement the proposed model instead of the inertial variant - the maximum variant of development. This situation is explained by the fact that the economy of rural clusters of Vinnytsia region is diversified. Therefore, attempting to adapt the restructuring of the sectoral structure of each rural area to an "ideal" state can lead to "alarming" and economic disaster scenarios. This is explained by the fact that the largest share of GRP accumulation in the maximum variant - 21.2% (against 10.6% in the inertial variant) is achieved against the background of a much larger scale of economic growth. The second point of discussion is the existence of very serious differences that allow this "fork" to focus on different combinations of rural economic development depending on the combination of external and internal factors and conditions. As a result, an attempt to eliminate these differences for cluster 1 is the development of agriculture, hunting, forestry. Under these conditions, Orativskyi district was defined as a representative type of cluster 1.

The conducted monitoring of sustainable rural development allows us to propose a development scenario for each of the four clusters (Fig. 9).

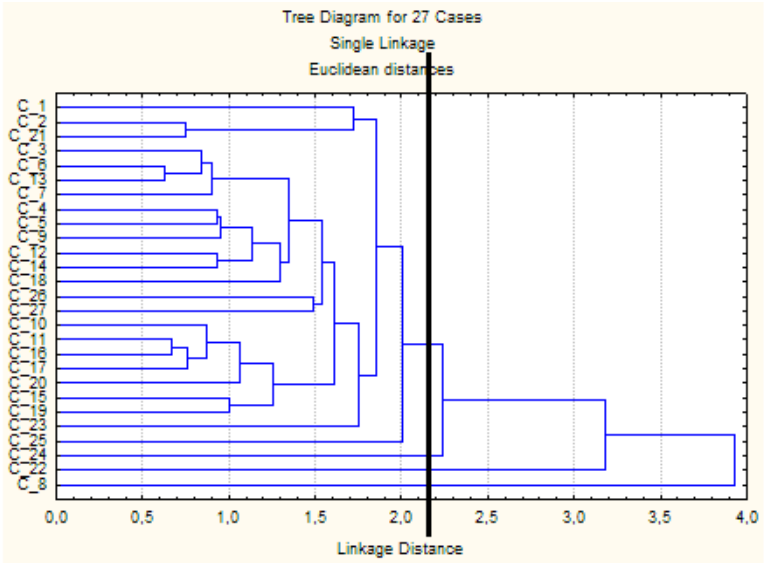


Fig. 8: Definition of a representative district for each rural area cluster in the Vinnytsia region

SymbolsforruralareasoftheVinnitsaregion: Barskiy C_1; Bershadskiy C_2; Vinnitsa C_3; Gaisinskiy C_4; Zhmerinskiy C_5; Illinetskiy C_6; Kalinovskiy C_7; Kazatinskiy C_8; Kryzhopolskiy C_9; Lipovetskiy C_10; Litinskiy C_11; Mogilev-Podolskiy C_12; Murovanokurilovetskiy C_13; Nemirovskiy C_14; OratowskiC_15; PesczanskiC_16; PogrebishcheskiC_17; TepliceC_18; TyrowskiC_19; TomaspolskiC_20; TrostyanetskiC_21; TulchinskiC_22; KhmelnitskiC_23; ChernowitskiC_24; ChechelnitskiC_25; ShargorodskiC_26; YampolskiC_27

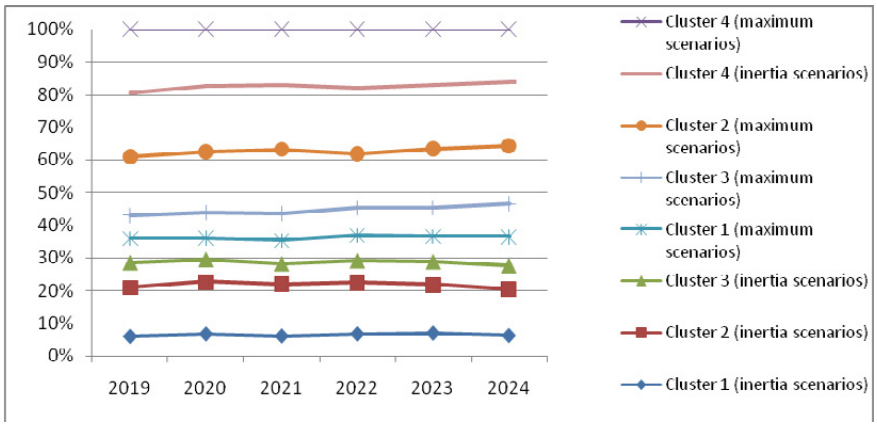


Fig. 9: Scenarios for rural development in Vinnytsia region

According to Fig. 9, for cluster 1 it is proposed: modernization and reconstruction of fixed assets of agricultural (farmer) enterprises, which will have a significant impact not only on the economic but also on the social development of the area - new jobs will be created, and the level of welfare of rural residents will be increased. In the 1st cluster the primary sector of the economy will prevail - it is represented mainly by agriculture (82% under the inertial scenario, 80% under the maximum scenario). For cluster 2, livestock development is proposed, which is much cheaper than crop production but plays an important role in agricultural development in these areas and economic stability. Here are all the main types of industry: livestock, pig and poultry. Implementation of this scenario will allow the development of the tertiary sector of the economy (transport, communications, finance, trade, education, health and other types of production and social services), which will ensure the functioning of the primary

and secondary sectors of the economy of these territories, and improve the balance of this sector in its structure, reduce the share of agriculture by 3-5%, increase the share of construction by 1-3%. Cluster 3 offers the development of tourism and recreation. Typical representative - Khmelnytskyi district, on the territory of which there is a resort, the main medical factor of which is mineral radon waters, by their unique composition have no analogues among the known mineral waters. For cluster 3, the share of agro industrial complex of processing (food) industry (by 1-3%) and agriculture (by 2-3%) is possible, which is a determining factor for sustainable development of the agricultural economy of this cluster. For cluster 4, the development of processing industry is proposed. The Kazatyn district is a typical representative of the region. As a result of the analysis 2 tendencies of specialization and diversification of economy and social sphere among clusters of rural territories of Vinnytsia region were identified with the implementation of inertial or maximum scenario. The implementation of this scenario will allow the development of processing industry by 40-46%, but reduce the share of agriculture by 18-20%.

CONCLUSION

The developed model of monitoring the state of socio-economic development of rural territories allows to implement different types or to define "growth points" for each of 4 clusters of rural territories. Modeling sustainable socio-economic development for the sample makes it possible to draw up a development plan for all other rural areas of the cluster. Determining the area - representative type for each of the clusters can actually determine the presence in the region of so-called "growth points" - the type of activity, economic sector or specific project, the development of which ensures the development of socio-economic system of the region as a whole. The following methods were used to build the monitoring model: SWOT analysis, factor analysis, cluster analysis, dendrogram. The SWOT analysis revealed the strengths and weaknesses of rural development, potential threats and opportunities for their implementation. Factor analysis allowed grouping of 11 indicators of sustainable development by 4 factors. Each of the four factors reflects a particular area of socio-economic development. Based on cluster analysis, rural areas were classified into 4 clusters according to the level of socio-economic development. The construction of the dendrogram allows to determine the representative for each of the received clusters of rural areas - the so-called "growth points" and the most appropriate specialization of its activity. Different types or "growth areas" need to be considered: increase in raw material potential; technological growth; social development, growth of human potential, development of production potential, development of social and industrial infrastructure, increase of capitalization of regional assets. The use of the proposed model allows the implementation of certain scenarios of economic growth for each of the clusters: agriculture, hunting and forestry - for rural areas 1 cluster; trade, services and domestic services - for rural areas of 2 clusters; tourism and international cooperation - for rural clusters 3; processing industry - for rural areas of 4 clusters. Therefore, the using of key indicators for monitoring the sustainable development of rural areas provides an opportunity to take into account the specifics of sustainable development of different specialization branches of rural areas that will support high economic and social growth in the future.

AUTHOR CONTRIBUTIONS

Throughout the current study performance; V. Shcherbak wrote and edited the introduction, conclusion and abbreviations section and constructed the conceptual model. L. Ganushchak-Yefimenko wrote the abstract, results and discussion. O. Nifatova wrote references, produced some of the paper graphs and clusters. N. Fastovets wrote the data description and justification. H. Plysenko constructed the study model. L. Lutay wrote the materials and methods. V. Tkachuk carried out the analysis of internal for SWOT. O. Ptashchenko wrote the statistical analyses and calculation.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript.

In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

%	Percentage
CJSC	
Expl. Var	Explanatory Variable
Fig.	Figures
GDP	Gross Domestic Product
GNP	Gross National Product
GPI	Genuine Progress Indicator
GRP	Gross regional product
ISQOLS	International Society for Quality of Life Studies
O	Opportunities
OECD	Organization for Economic Cooperation and Development
Prp. Totl	Percentage of The Total Variance Explained
S	Strengths
S&O	Field of Strengths and Opportunity
S&T	Field of Strengths and Threats
SCOPE	Scientific Committee on Problems of Environment
SEEA	System of Environmental and Economic Accounting
SWOT-analysis	Strategic planning technique to identify strengths, weaknesses, opportunities, and threats
T	Threats
UN	United Nations
UN CSD	The United Nations Commission on Sustainable Development
W	Weaknesses
W&O	Field of Weakness and Opportunity
W&T	Field of Weakness and Threats

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