AN INTEGRATED ASSESSMENT FRAMEWORK OF ENVIRONMENTAL DIMENSION OF THE DEVELOPMENT OF REGIONS OF UKRAINE

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ІНТЕГРОВАНЕ ОЦІНЮВАННЯ ЕКОЛОГІЧНОГО ВИМІРУ РОЗВИТКУ РЕГІОНІВ УКРАЇНИ

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ИНТЕГРИРОВАННАЯ ОЦЕНКА ЭКОЛОГИЧЕСКОГО ИЗМЕРЕНИЯ РАЗВИТИЯ РЕГИОНОВ УКРАИНЫ

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The article proposes the integrated indicator framework for the environmental dimension index assessment, which is constituent of the quality of people's life component of the sustainable development index of regions of Ukraine. The environmental dimension index and its components assessment results in the regional context for the 2009-2018 decade are presented.

Keywords: *aggregation, assessment, environmental sustainability, index, indicator, quality of life, region, sustainable development goals*

У статті запропоновано інтегровану систему показників для оцінки індексу екологічного виміру, який є складником компоненти якості життя людей індексу сталого розвитку регіонів України. Представлено результати оцінювання індексу екологічного виміру та його компонентів у регіональному контексті для 2009-2018 років.

Ключові слова*: агрегування, екологічна сталість, індекс, оцінка, показник, регіон, цілі сталого розвитку, якість життя*

В статье предложена интегрированная система показателей для оценки индекса экологического измерения, который является составляющей компоненты качества жизни людей индекса устойчивого развития регионов Украины. Представлены результаты оценки индекса экологического измерения и его компонентов в региональном контексте для 2009-2018 годов.

Ключевые слова*: агрегирование, индекс, качество жизни, оценка, показатель, регион, цели устойчивого развития, экологическая устойчивость*

INTRODUCTION

There are a variety of concepts and models of sustainable development depending on the context, the time of appearance, and dimensions and components number and integration level, from weak sustainability to strong sustainability, from three pillars' frame to more integrated framing. In September 2015, the United Nations General Assembly adopted the 2030 Development Agenda which includes 17 Sustainable Development Goals

(SDGs) to be achieved by 2030. The Ukrainian national SDGs system consists of 86 national development targets with 183 monitoring indicators [1]. The relationships between SDGs are complex and the achievement of some Goals requires the achievement of other Goals [2]. In 2016, Carl Folke, science director of Stockholm Resilience Centre, proposed «the wedding cake» visualization concept of the positioning of SDGs showing that economical and societal dimensions are parts of the environmental dimension of sustainable development in the context of the safe operating space for humans on Earth (the economy and society are embedded within the biosphere, Fig. 1) [3]. In the Folke's scheme SDG 6 «Ensure availability and sustainable management of water and sanitation for all», SDG 13 «Take urgent action to combat climate change and its impacts», SDG 14 «Conserve and sustainably use the oceans, seas and marine resources for sustainable development» and SDG 15 «Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss» are the parts of the biosphere foundation.

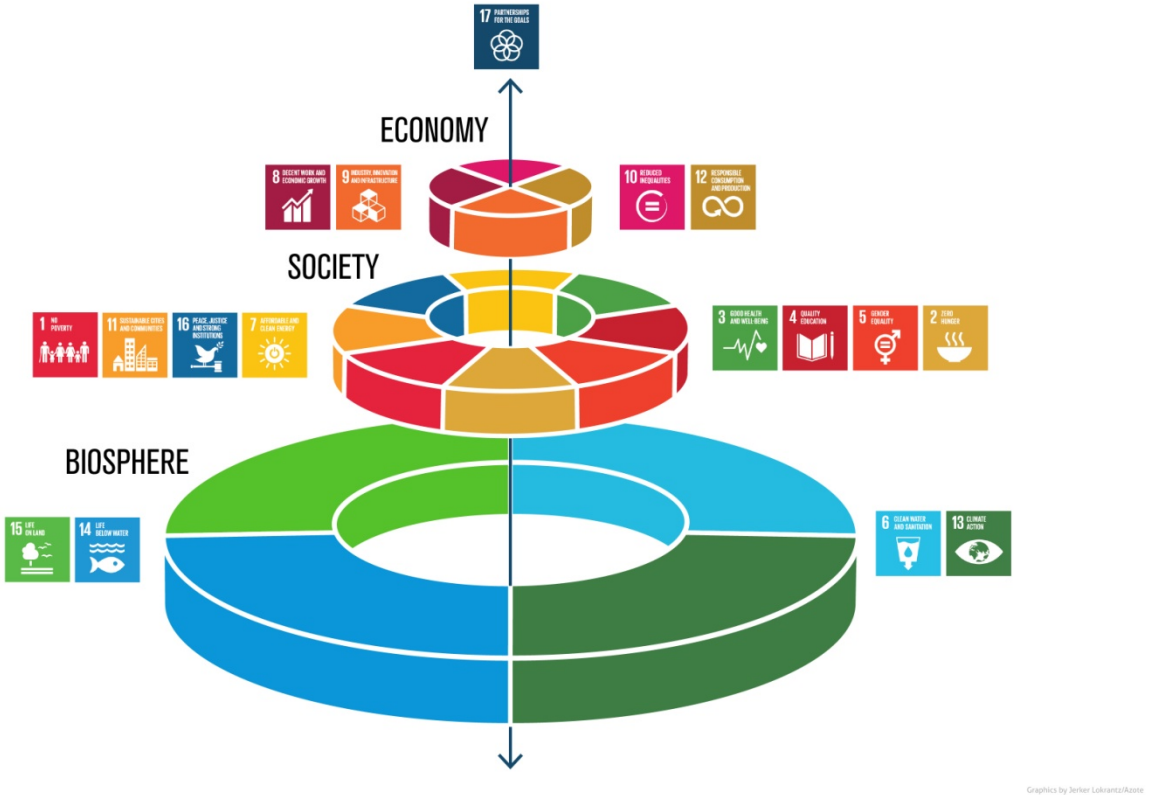

Figure 1. The Folke's SDGs «wedding cake»
(image URL is https://www.stockholmresilience.org/images/
18.36c25848153d54bdba33ec9b/1465905797608/sdgs-food-azote.jpg)

Nowadays the sustainability assessment is the wide scientific, research and practical area including popularly known indices as human development index, or ecological footprint, or happy planet index, highly specialized indices, SDGs-based non-integrated assessment systems, product evaluation metrics, social and environmental accounts, and more.

THE ENVIRONMENTAL DIMENSION INDEX OF THE QUALITY OF LIFE

The metric for sustainable development processes measurement for the regions of Ukraine [4] based on indicators of the quality and security of life components of the sustainable development index which are correspond SDGs. The quality of life component, C_{ql}, is an integration of three dimensions of sustainable development, economic (I_{ec}), environmental (I_e), and social (I_s), and based on three pillars' sustainability model. Water, climate change, and ecosystem issues or the biosphere foundation by the Folke's SDGs «wedding cake» are included into the environmental dimension index through pressure-state-response indicators as shown in Table 1.

Table 1. Indicators of the environmental dimension index

Index	*Category*	*Regional indicator*
State of the environment (33%)	Air (20%)	Integrated air pollution index
	Land resources (20%)	Environmental stability of the territory
	Nature Preserve Fund (20%)	Share of lands of reserves and national nature parks
	State of natural and technogenic safety (20%)	Share of the population in the area of possible chemical pollution (30%)
		Area of forest fires per sq km (40%)
		Area of fires in open areas per sq km (20%)
		Area of fires on peatlands per sq km (10%)
	Wastes (20%)	Accumulated waste of I-III hazard classes per sq km (50%)
		Accumulated waste of IV hazard class per sq km (50%)
Pressure on the environment (33%)	Air emissions (33%)	Emissions of pollutants into the air from stationery and movable pollution sources per capita
	Water stress (33%)	Intensity of water abstraction from natural water objects (50%)
		Pressure of discharge of polluted wastewater into water bodies (50%)
	Waste generation (33%)	Generated waste of I-III hazard classes per sq km (50%)
		Generated waste of IV hazard class per sq km (50%)
Environmental management (33%)	Climate change (33%)	GRP* carbon intensity
	Water efficiency (33%)	GRP* water intensity (50%)
		Water savings in industry (50%)
	Waste management (33%)	Utilization** of waste of I-III hazard classes per generated waste (50%)
		Utilization** of waste of IV hazard class per generated waste (50%)

** gross regional product in prices of the last reporting year*
*** the ratio of waste utilization in the region to the average volumes of waste utilization by regions of Ukraine is taken into account*

There are indicators that must be included in the framework, notably safety and quality of drinking water by microbiological, radiation, and organoleptic, physicochemical and sanitarytoxicological parameters, but that it is not feasible for several reasons mainly lack regional data which cannot be imputed. Other indicators, for example, area of territories and objects of the natural reserve fund in the Black and Azov Seas are excluded since these parameters incomparable between all regions.

Content of some indicators does not need a detailed explanation, for example, «GRP carbon intensity» is CO_2 emissions in tonnes per GRP mln UAH where GRP for previous years obtained using values of consumer price index, «Water savings in industry» is the share of recycled and reused water in the total amount of water consumed for industrial needs, but some do.

The *integrated air pollution index* values are based on population-weighted values of the complex index of pollution of air (CIPA). The CIPA values are evaluated by the Boris Sreznevsky Central Geophysical Observatory using data of the network of observations of the hydrometeorological service (stationary monitoring stations). The urban population weighting is used for regions where CIPA values available for two and more cities.

The *environmental stability of the territory* is a well-known complex index

$$C_{ES} = \Sigma F_i \times A_i / \Sigma A_i,$$

where F_i is the factor of environmental stability for different types of land i (ten types in this research). F_i=1 is used for i=«*forest and other wooded lands*» land type, F_i=0,68 for i=«*pastures*», F_i=0,14 for i=«*arable land*», F_i=0 for i=«*built-up land*», etc. A_i is the area of this land type i for territory (a region in this research), ha. This avoids inclusion into the framework several indicators (share of arable land, share of area of agricultural land of extensive use, etc. in total area of the region) instead of one complex score.

The *intensity of water abstraction* is share of water abstraction from natural water bodies in the region's renewable water resources. Volumes of water abstraction from natural water objects exclude seas and estuaries and renewable water resources are explored groundwater reserves and local natural river runoff for region’s territory and reported year.

The *pressure of discharge of polluted wastewater* into water bodies is the volume of discharge of polluted (polluted without treatment or insufficiently treated) wastewater into water bodies per area of surface water resources.

The environmental dimension index is evaluated using simple three steps aggregation «indicator – category indicator – index – index of the dimension» with weights presented in Table 1. The logistical normalization is used for the obtainment of comparable indicators’ values within the framework and between regions [4].

ENVIRONMENTAL SUSTAINABILITY ASSESSMENT FOR REGIONS OF UKRAINE

The overall ranking of the regions of Ukraine by values of the index of environmental dimension is evaluated for 2004–2018 years but shown in Table 2 by year for the 2009–2018 decade. Values the index of environmental dimension of the quality and security of life components of the sustainable development index and indicators of the dimension for regions of Ukraine one can find on the WDC-Ukraine online service «*Ukraine in the sustainable development indicator analysis*» (http://sdi.wdc.org.ua/ukraine/).

The 2009–2018-decade leader of the environmental dimension of the quality of people's life for regions of Ukraine under assessment is Zakarpattia oblast. This region is also a decade leader by the index of the state of the environment. Chernivtsi oblast and Volyn oblast have the lowest load on the environment and Sumy oblast and Poltava oblast are the best performers in environmental management for the 2009–2018 decade.

Table 2. Ranking of regions of Ukraine by values of environmental dimension index (in descending order for the 2018 year)

Region	*'09*	*'10*	*'11*	*'12*	*'13*	*'14*	*'15*	*'16*	*'17*	*'18*
Zakarpattia oblast	1	1	1	1	1	1	1	1	1	*1*
Rivne oblast	2	2	4	2	2	2	2	2	2	*2*
Chernivtsi oblast	7	7	2	3	4	3	3	3	3	*3*
Volyn oblast	3	3	3	4	5	5	5	4	4	*4*
Zhytomyr oblast	4	4	5	5	3	4	4	5	5	*5*
Khmelnytsk oblast	5	6	6	6	6	6	7	6	7	*6*
Lviv oblast	6	5	7	7	7	7	6	7	6	*7*
Ternopil oblast	9	12	13	12	9	8	9	9	8	*8*
Chernihiv oblast	8	13	11	9	8	9	8	8	9	*9*
Kyiv oblast	23	23	22	22	20	21	19	11	10	*10*
Sumy oblast	12	8	8	8	12	11	10	12	11	*11*
Odesa oblast	18	18	18	16	14	15	15	18	13	*12*
Kharkiv oblast	19	20	20	20	19	20	13	14	12	*13*
Mykolaiv oblast	15	16	14	15	18	18	12	17	16	*14*
Ivano-Frankivsk oblast	11	9	10	11	11	10	11	10	14	*15*
Cherkasy oblast	14	17	15	14	17	14	17	15	15	*16*
Kirovohrad oblast	10	11	9	13	13	12	16	16	17	*17*
Kyiv	17	15	19	17	22	13	20	21	18	*18*
Vinnytsia oblast	20	21	16	19	21	19	21	19	21	*19*
Poltava oblast	13	10	12	10	10	16	14	13	20	*20*
Luhansk oblast	24	24	24	24	24	22	22	22	22	*21*
Kherson oblast	16	14	17	18	16	17	18	20	19	*22*
Dnipropetrovsk oblast	25	26	26	26	26	24	23	24	23	*23*
Zaporizhzhia oblast	26	25	25	25	25	23	24	23	24	*24*
Donetsk oblast	27	27	27	27	27	25	25	25	25	*25*
AR of Crimea	22	19	21	21	15					
Sevastopol	21	22	23	23	23					

The 2009–2018-decade outsider of the environmental dimension is Donetsk oblast. This region and Dnipropetrovsk oblast and Zaporizhzhia oblast have the lowest values of the index of the state of the environment for the 2009–2018 decade. Poor air quality, high environmental instability of territories, fires, and significant quantities of accumulated waste are major reasons. The environmental stress of Donetsk oblast and Dnipropetrovsk oblast and also the city of Kyiv are estimated as the highest among regions of Ukraine for the 2009–2018 decade. Ivano-Frankivsk oblast has the highest GRP carbon intensity, mainly due to the performance of the Burshtyn TES. It emits, in fact, more than 80 % of all air pollutants of the region and is the third (after the Illich Iron & Steel Works and the ArcelorMittal Kryvyi Rih) among the top 10 enterprises «largest pollutants» by air emissions in Ukraine. For that reason Ivano-Frankivsk oblast has the third highest «Air emissions» category indicator's value after Dnipropetrovsk oblast and Donetsk oblast for the 2009–2018 decade. Two regions, Kyiv oblast and Kherson oblast, perform the lowest water efficiency among regions of Ukraine, Kherson oblast due to the highest GRP water intensity (22 m^3 per GRP th. UAH for 2018 data year, the dominant cause is water consumption for irrigation purposes) and Kyiv oblast due to the lowest water savings in

the industry. The city of Kyiv, Chernivtsi oblast, and Zakarpattia oblast are the worst performers in waste utilization, although the last two mentioned regions are the leaders by the environmental dimension index's values.

CONCLUSIONS

The integrated indicator framework for assessment of the environmental dimension of quality of people's life is proposed. The environmental dimension index and its components assessment results in the regional context for 2004–2018 data years are obtained. Many explicit and hidden factors affect results, amongst other the specifics of regional economies, regional geographic and climate features, regional water supply, etc. Despite this, the obtained results indirectly represent the progress made towards the achievement of the nationally determined targets of the environmental dimension's SDGs on the regional level.

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