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Sustainable development of regions in Ukraine: before and after the beginning of the conflict

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Abstract
Research background: Sustainable development is the agenda for many countries including Ukraine, which adopted it at the national level and promoted through its regions. As the country is constantly struggling with the results of the military conflict and the impact of the occupation of its part by separatists, which led to economic decrease and emergence of numerous social and environmental issues, the transition of Ukraine to sustainable development path becomes especially important. At the same time, there is no official methodology adopted by the Ukrainian government, how to assess sustainable development of its regions. Availability of objective assessments would contribute to development of the relevant policy recommendations.
Purpose of the article: The purpose of the article is to assess sustainable development of the regions in Ukraine and to show the dynamics of performance of the regions before and after the beginning of the military conflict in the East of Ukraine.
Methods: We suggest the methodology of calculation of the integral index of sustainable development of the regions in Ukraine. This methodology takes into account the three pillars of sustainable development concept (economic, social and environmental) and uses the data available for all Ukrainian regions from the official statistics source. In order to determine the position of

individual regions in the development of the Ukrainian economy and to identify certain groups of regions according to their level of sustainable development, we apply the method of statistical grouping.

Findings & Value added: The conducted analyses showed the dynamics of indicators of sustainable development of the Ukrainian regions, the performance of the regions and their affiliation to the corresponding attributive groups. The situation and interrelation of the regions in Ukraine totally changed after the beginning of the military conflict in the East of Ukraine. The Luhansk and Donetsk regions, which are directly affected by the military conflict, became the outsiders among other regions in Ukraine, though before the conflict the values of sustainable development indicators had been above the average values in Ukraine. The leaders among the regions also changed, and the difference between the leaders and the following groups became significant. The results of the analyses allowed to visualize the dynamics of sustainable development of the regions in Ukraine and define the key directions for future development.

Introduction

The sustainable development concept is the paradigm adopted by almost all countries of the world. The sustainability principles become more and more popular among the policy makers while setting not only the strategies of the whole country development, but also the strategies of development of particular regions and areas. Assessment of sustainable development of these regions becomes important, as the results of the assessment allow to define the starting points for improvements.

Ukraine was among the countries that adopted the sustainable development principles at both: national and regional levels. For Ukraine transition to the sustainability path is especially important, as the country still struggles to improve its economic performance and solve numerous social issues and environmental problems. The progress of Ukraine to reach the Millennium Development Goals (which preceded the Sustainable Development Goals) was significant until 2014, when the military conflict started (*Millennium Development…, 2015*). The occupation of Crimea and parts of the Luhansk and Donetsk regions (the East of Ukraine) significantly influenced the economic, social and political life in the country. Interrelation of the Ukrainian regions' input into country's economy changed, and so did the economic ties between the industries, correlation of industries input and social institutions in the East of Ukraine. However, there were almost no research which paid attention to the change in sustainability of the regions before and after the conflict.

Thus, the purpose of the article is to assess sustainable development of the regions in Ukraine and to show the performance of the regions before and after the beginning of the conflict. As there is no official methodology for assessment of sustainable development of the regions in Ukraine, we suggest the method how to calculate the aggregate indicators and the inte-

gral index using the available data for all the regions from the official source — State Statistics Service of Ukraine. To visualize the results, we suggest using the maps which represent affiliation of each region at each year to a certain sustainability group.

The article is divided into several parts. We start with the analysis of available methods and indicators used for assessment of sustainable development of regions, and their applicability to the regions in Ukraine. Then, we present the indicators and methodology, which is based on the availability of data for all regions of Ukraine over time, takes into account all three pillars of sustainable development, and allows to compare the position of each region in Ukraine among other regions with time. Application of this methodology provides us with the results of assessment of sustainable development of the regions in Ukraine and shows us, how the situation changed before and after the beginning of the military conflict in Ukraine. The last section of the article presents the discussion of the assessment results and the main conclusions.

Literature review

The issues of sustainable development of countries and regions have gained attention in many countries, and numerous research papers suggest information on sustainability indicators, ecological footprint, measurements of natural, economic and social capital, etc. (Olawumi *et al*., 2018). There are a lot of research papers, devoted to indicators of sustainable development of various regions (countries, smaller areas inside countries, cities etc.). And among the indicators one should definitely note the 232 indicators of 169 targets of 17 Sustainable Development Goals (SDGs) (for 2015–2030) (United Nations, 2015) and the previous 60 indicators of 21 targets of 8 Millennium Development Goals (2000–2015) (UNICEF, 2014). The proposed indicators are structured according to the goals, adopted at the UN Assembly by almost all countries of the world. However, these sets of indicators do not allow to estimate the performance of the whole country on average, rather than to compare its individual achievements and progress at certain areas (corresponding to specific goals). This idea was supported by T. Hák *et al.* (2016), who mentioned the importance of SDGs for setting the policy framework by the countries and their insufficiency for assessing sustainable development, as only a part of suggested indicators was well-developed and relevant to all the countries, which accepted the SDGs.

There are a lot of research papers which present numerous sustainability indicators (Kono *et al*., 2018; Szopik-Depczyńskaa *et al*., 2018). While there is an opinion that sustainable development indicators set should be based primarily on SDGs (Wulf *et al*., 2018), different researchers, examining different areas and considering the peculiarities of certain regions and available data (and the direction of their specific research), made their own contribution to development of methodology of sustainable development assessments. For example, R. F. M. Ameenab and M. Mourshed (2019) state that the "global" indicators are not usually applicable to all the countries (which again supports the idea of inapplicability of SDGs' indicators to assessing sustainable development of specific regions), and the developing countries usually shift their attention from environmental indicators to economics and infrastructure. There are more than 500 indicators grouped into 25 categories, which are used to assess sustainable development of different territories (Kono *et al*., 2018). However, using a very big number of indicators is difficult and impractical, as it requires a lot of time and resources for assessment and interpretation of results. Thus, each region should choose their own set of indicators taking into account their peculiarities and specific needs (Valentin & Spangenberg, 2000; Mascarenhas *et al*., 2010; Allain *et al*., 2018).

A lot of researchers suggest sustainable development indicators according to the three sustainable development pillars: economic, environmental, social. W. C. Valenti *et al*. (2018) suggest 14 economic, 22 environmental and 20 social indicators to assess sustainable development of aquaculture systems. Some of the indicators require special knowledge and skills to hold laboratory analysis to measure the level of pollution and levels of efficiency of use of the resources, etc. The majority of these indicators are very subjective, as they include the results of the interviews and observations. Thus, it is problematic to use these indicators to assess and compare sustainability of a lot of systems like 24 regions in Ukraine for several years in a row.

A. Raszkowski and B. Bartniczak (2018) selected only 10 indicators to assess sustainable development of Polish regions. These indicators include GDP per capita, R&D expenditures in relation to GDP, employment and unemployment rates, percentage of collected municipal waste, a risk of poverty rate, gross fertility rate, share of renewable energy, share of legal protected area, and civil society organizations per 10 thousand people in the region. Presented indicators represent economic, social and environmental performance of regions. The authors created the indicators in accordance with the data available at Central Statistical Office of Poland, which is reasonable as it allows to assess and compare sustainable development of dif-

ferent regions in Poland (Raszkowski *et al*., 2018). It is not possible to use the same indicators for Ukraine though, as the State Statistics Service of Ukraine does not provide such detailed information about the Ukrainian regions.

Ukrainian researchers also suggest the sustainability indicators according to the three pillars of sustainable development, but their sets of indicators differ from each other. All the suggested indicators form the aggregate regional sustainable development index, which makes the comparison of different regions easier. S. Nesterenko suggested to calculate the aggregate sustainable development index of one of the Ukrainian regions using the three smaller indices of environmental, economic and social development. The ecological development index consists of indicators of ecological capacity, regional ecological management, ecological systems. The economic development index consists of economic freedom indicator and competitiveness index. The social development index includes indicators of human potential development, quality of life, knowledge-based society, institutional development (Nesterenko, 2015). These indicators are very subjective, as the State Statistics Service of Ukraine or regional statistics offices do not collect such information or define the methodology of their calculation. Therefore, calculation of the indicators and the aggregate index would require involvement of experts in economic, environmental and social development of a region. As such indicators are not wide-spread in Ukrainian practice, and experts may give different values to the same indicators, the results for the same region may also differ, and comparison of all regions in Ukraine becomes impossible.

Other researchers propose other indicators, but also within the three main constituents of sustainable development: economic, environmental and social. T. Uskova (2009) selected 10 economic, 5 environmental, and 9 social indicators for calculation of the aggregate index of sustainable development of a region. Sh. Omarov (2014) suggested to use 11 economic, 2 environmental and 6 social indicators. M. Zhurovskyi (2009) chose 15 economic, 17 social-institutional and 13 ecological indicators for calculating the aggregate index of sustainable development of the regions in Ukraine. The availability of such quantity of indicators and methods proves that there is no any publicly accepted methodology how to assess sustainable development of regions. In Ukraine as well, there is no such methodology at the official level suggested and used by State Statistics Service of Ukraine, though the SDGs have been adapted to Ukraine and the Interministerial Working Group created specially to promote and contribute to attainment of the SDGs is working towards SDGs implementation (Ministry of economic development and trade of Ukraine, 2017). It is possible to use

the suggested methods while assessing sustainable development of a specific region in a specific time period. However, the official statistics services lack the data necessary for calculations, and the structure of the data presented by statistics services changes with time. In this case, it will be difficult to calculate the indices for all the regions in Ukraine for the past decade, and to compare how the situation changed before and after the beginning of the conflict. Thus, the assessment of sustainable development of regions of Ukraine is important and requires attention.

Research methodology

To analyse sustainable development of the regions of Ukraine, we proposed to use the appropriate methodology that would fulfil certain criteria:

- take into account all three pillars of sustainable development – economic, social and environmental;
- use data available for every region, which would make them comparable;
- make the assessments of regions relative to each other without the defined borders where they should stay.

The feature of relativity is important here, because it is very difficult to say which value of each indicator is optimal and necessary. However, it is possible to compare how regions develop in relation to each other, and how this ratio changes over time.

According to these requirements, we propose to use the following indicators, which will describe sustainable development of the regions in Ukraine:

1. for the economic pillar – gross regional product per capita and net profit of enterprises of the region;
2. for the environmental pillar – the ratio of capital investment and current expenditures on environmental protection to the amount of waste generated in the region;
3. for the social pillar – average monthly wages in the region.

The number of indicators is much less than suggested by other researchers. Much data and information which deal with economic and social development, and environmental protection or energy efficiency policy, is either absent at all or available only for some individual regions. Thus, as the data for regional level in Ukraine is quite limited, and these indicators are available for all regions of Ukraine for a long period of time at the official statistics website (State Statistics Service of Ukraine, 2018), it is possible to use them to assess the sustainable development of the regions in

Ukraine for a quite long period of time and to compare the performance of the regions before and after the conflict.

According to the proposed indicators, the dynamics of absolute indicators for the period of 2008–2016 was calculated and presented. We analysed this statistical data and provided the interpretation of this analysis in order to determine the position of individual regions in the development of the Ukrainian economy and to identify certain groups of regions according to their level of sustainable development. The analysis was conducted according to the three pillars of sustainable development and for every region of Ukraine. However, some statistical information for 2017 is not yet available, so the time horizon is limited to the year 2016.

We deliberately removed the statistical data of the city of Kyiv from the calculations, because there are headquarters of many large enterprises and corporations including foreign ones in Kyiv, and the values obtained in Kyiv significantly exceed the average values in Ukraine and the values in all the regions, which makes it impossible to group and compare the regions in separate groups. Even in the official statistical reporting, the values of Kyiv indicators are separated from the Kyiv region.

In addition, the calculations omit the Autonomous Republic of Crimea, which has been occupied since 2014, and thus the statistical data starting from 2013–2014 is inaccessible.

For better and deeper understanding and tracking the dynamics of the indicators of regions' sustainable development, the method of statistical grouping was used, which foresees the assessment of the maximum and the minimum values of the indicators, definition of the range of variability and variability interval for each of the four groups, arrangement of the corresponding grouping of regions for each year.

Using this methodology, we obtained different groups of regions of Ukraine from 2004 to 2016 and assigned a corresponding group number from 1 to 4 to each region and its affiliation to the attributive groups according to the level of their sustainable development according to Table 1.

The need to track the dynamics of regions by attributive groups according to the level of their sustainable development required the calculation of an integral indicator of sustainable development for each region at each year. Integral indicator of sustainable development of a region is a generalized index, calculated by averaging standardized assessments of individual sustainable development indicators. In the most general form, the calculation of such integral index is the following:

$$I_i = \frac{\sum_{j=1}^{n} w_{ij}}{n} \quad (1)$$

where:
I_i – integral index of sustainable development of a region i;
w_{ij} – standardized assessments of individual sustainable development indicators for region i (in our case, our indicators according to the three pillars of sustainable development);
i – the number of regions;
j – the number of indicators (in our case, 4 indicators).

The standardized values of sustainable development indicators are calculated to eliminate the incompatibility of the values of actual indicators. The obtained standardized values are measured on a scale from zero to one. Bringing the indicators to a single scale of measurement is carried out by calculating the ratio of the actual value of the indicator to the maximum value in this set of indicators. Averaging of standardized indicators takes place to obtain one indicator, the value of which is also measured from zero to one.

$$w_{ij} = \frac{a_{ij}}{a_{j\,max}} \quad (2)$$

where:
a_{ij} – actual value of the indicator for region i;
$a_{j\,max}$ – maximum value in this set of indicators.

Regarding such indicator as the net profit of enterprises of the region, it should be noted that it is necessary to bring it to a positive value before obtaining a standardized value, since net profit of enterprises is negative in some regions of Ukraine. To obtain the conditional indicators of net profit of enterprises of the region whose value is equal to or greater than zero, we take the value of the minimum (lowest) value of the indicator (the largest loss) for each year as zero. Then, other conditional indicators of net profit will be calculated as the difference between the actual value of the indicator and the minimum values in each range (year).

$$w_{i2} = \frac{a^*_{i2}}{a^*_{2\,max}} \tag{3}$$

where:
w_{i2} – standardized assessment of such sustainable development indicator as the net profit of enterprises for region i;
a^*_{i2} – standardized value of the net profit of enterprises (conditional indicator) for region i;
$a^*_{i2} = a_{i2} - a_{2\,min}$;
$a^*_{2\,max}$ – maximum value in this set of standardized values of the indicator.

Affiliation to a certain integral group is also carried out by calculating the minimum (I_{min}) and maximum (I_{max}) values in the obtained aggregate of indicators, the range and interval of variability (V), and determining the lower and the upper bounds for each group.

$$V = I_{max} - I_{min}\,, \tag{4}$$

$$R = \frac{V}{k}\,, \tag{5}$$

where:
V – interval of variability,
I_{max}, I_{min} – maximum and minimum values of integral indices of sustainable development of the regions in Ukraine;
R – range of variability;
k – number of attributive groups according to the level of sustainable development of regions (in our case, 4 groups – table 1)

The upper and the lower bounds for each group can be defined using the maximum and minimum values of integral indices of sustainable development of the regions in Ukraine, and the range of variability. The upper bound for group 1 (Leaders among leaders) is the maximum value among all integral indices of the regions in Ukraine. It is possible to calculate the lower bound for group 1 by subtracting the range of variability from the upper bound for this group. The lower bound of group 1 is the upper bound for group 2. The lower bound of group 2, and the upper and lower bounds for groups 3 and 4 are calculated in the same way. The regions, the integral indices of which belong to the range within the lower and the upper values for group 1, belong to this group and are Leaders among leaders, and so forth.

As we suggest to make the assessments of regions relative to each other, then this method of assessing sustainable development of the regions in Ukraine allows to show the performance of the region compared to each other, and see how the situation changed before and after the conflict.

In order to overcome the complexity in the visual representation of the results of the analysis of sustainable development of the Ukrainian regions, it seems advisable to apply a chromatic-temporal analysis. We consider chromatic-temporal analysis as a combined use of chromatic and temporal analysis to visualize the dynamics of sustainable development of the Ukrainian regions. The chromatic analysis (from the Greek "chrōma" — colour) is very often used when visualizing data in economics, statistics, and management by assigning a certain colour to the corresponding attributive or quantitative characteristic of the phenomenon. The addition of temporal characteristics (from Latin "tempus" — time) allows us to analyse the changes that occur with this characteristic over time (Boldachev, 2009). This analysis was carried out using maps created in 3D Maps in Excel.

Results

The conducted analysis made it possible to show the dynamics of indicators of sustainable development of the Ukrainian regions and to determine how they changed after the beginning of the military conflict in the East of Ukraine. The importance of considering such a change lies in the fact that there was an opinion on the significant industrial potential of the Donbas area (which includes Luhansk and Donetsk regions), which made a significant contribution to the development of the Ukrainian economy. This can be seen in Figure 1, which shows that the gross regional product of Donetsk region significantly exceeds the average value in Ukraine and remains higher even after the beginning of the conflict (despite the occupation of significant part of the Donetsk region). Regarding Luhansk region, the value of its gross regional product slightly exceeded the average value for Ukraine, and starting from 2014, after the occupation of significant part of the Luhansk region, its gross regional product has become lower than the average for all regions of Ukraine. Starting from 2015, the values of the gross regional product in Donetsk and Luhansk regions begin to increase, but the value in Luhansk region remains less than the average in Ukraine.

If we analyse the indicators of sustainable development of the regions and the average for Ukraine, then we can obtain the contradictory graphs. For example, analysing the gross regional product per capita (Figure 2), one can again see that the value of the indicator in Donetsk region was much

higher than the average in Ukraine. The value of gross regional product per capita in Luhansk region was slightly higher than the average in Ukraine. In Donetsk region there was a sharp decline of the indicator in 2014 in the active phase of the military conflict, when industry in the occupied territory and partly in the territory under the control of the Ukrainian government ceased to work. In Luhansk region, the decline of gross regional product per capita started in 2013 (before the beginning of the military conflict in the East of Ukraine), and in 2014 we can see a rapid fall. In 2015, the value of the indicator has reached its minimum for the past 9 years, but in 2016 it has increased again.

Moreover, the average value in Ukraine is growing all the time, starting from 2009, even taking into account the sharp decline of gross regional product per capita in Donetsk and Luhansk regions.

Considering such an indicator as net profit (or loss) of enterprises of different regions, it should be noted that according to the reporting that enterprises provide to the statistical authorities, many of them receive losses (Figure 3). Even the average value of the indicator in Ukraine is negative in many years which have been analysed. As for Donetsk and Luhansk regions, it should be noted that the aggregate amount of profits of all companies is negative for all years for Luhansk region and for almost all years for Donetsk region. However, in 2014, the losses of Donbas (Luhansk and Donetsk) enterprises grew by times (almost by 8 times in Donetsk region, and almost by 5 times in Luhansk region). In 2015, the losses of enterprises in these areas became even larger. In 2016 the amount of losses has decreased, but still Donbas enterprises show losses, but not profits.

In order to assess the environmental pillar of sustainable development of regions, we proposed to use an indicator which is the ratio of capital investment and current environmental costs to the total sum of emissions of pollutants, carbon dioxide into the atmosphere and generated waste in every region. Considering the dynamics of this indicator, one can see the exceedance of its value in Luhansk region over the average value in Ukraine until 2010 (Figure 4). Since 2010, the value of this indicator in Luhansk region has fallen below the average. In Donetsk region, the value of the indicator, which reflects the ecological component of sustainable development, is much lower than the average in Ukraine, and even less than in Luhansk region. Taking into account that Donetsk region has always been an industrial region, and the gross regional product in this area was much higher than the average value in Ukraine, it can be noted that the ratio of costs to improve the environment to the generated waste is lower than in other regions in Ukraine.

Regarding the social pillar of sustainable development of the regions of Ukraine, it is very difficult to estimate the value of this indicator in every region. That is why the average monthly wage in the regions was chosen for assessing the social development of the regions and avoiding excessive calculations using a range of other indicators (Figure 5). The different values of this indicator in different regions really reflect the standard of living there, as it shows the possibility of the population to use the best medical, educational and other services, etc. The value of the average wage in Luhansk and Donetsk regions is higher than average in Ukraine (except for 2015 for Luhansk region), even with the military conflict in the East of Ukraine.

Since it is challenging to assess sustainable development of a region, using several different indicators that have different meanings and values, we suggested calculating the integral indicator of sustainable development of a region. Of course, this indicator cannot be considered ideal; however, it shows the average value of all indicators and makes it possible to easily compare the regions of Ukraine with each other. Moreover, we suggest to highlight the relevant groups of leaders among leaders, followers among leaders, leaders among followers and followers among followers. This relationship between leaders and followers can change every year. But the main thing is that the allocation of these groups occurs among the regions themselves. Even if in terms of regional development indicators all regions are ineffective, it will still be possible to identify the leaders (the best) and the outsiders (the worst ones) among them.

The values of integral indicators of sustainable development of each region in Ukraine for 2008–2016 and their affiliation to the corresponding integral groups are given in Tables 2 and 3.

In order to visually represent the results of the calculations of sustainable development of the regions in Ukraine, we suggest using chromatic-temporal analysis, according to which the corresponding maps were created (Table 4). Such maps help to visualize the calculations of these indicators and make it easier to understand the difference between regions and how situation changed over time (Figures 5, 6, 7, 8).

We chose the years 2008, 2013, 2014, 2016 to show the visual dynamics of sustainable development of the regions in Ukraine. The years 2008 and 2016 are the first and the last in the analyzed period. The year 2013 is the last year of the integral Ukraine before the occupation of Crimea and the war in Donbas region. The year 2014 is the crisis year for the whole Ukraine, and especially for Luhansk and Donetsk regions, as the majority of the industries stopped working for at least several months, and a lot of enterprises were totally closed.

If we compare the sustainable development of the regions of Ukraine in these years, we can obviously see that in 2008 the majority of the regions (15 out of 24, not taking into account the Autonomous Republic of Crimea) belonged to the group Followers among Followers, while in 2016 only two regions (Luhansk and Donetsk) are followers among followers, and the majority (17 regions) appear in group 3 — Leaders among followers. The leaders in sustainable development also changed for the past 10 years. While in 2008 the Leaders among leaders were Donetsk and Dnipropetrovsk regions, the situation changed later. Starting from 2011 (before the military conflict began in the East of Ukraine), Kiev region became the Leader among all leaders and kept this position until 2016 — the last year analyzed in the paper.

Discussion

The suggested methodology for assessment of sustainable development of regions in Ukraine uses only limited number of indicators. However, these indicators are rather capacious and testify of various factors, which influence the sustainability of the regions. The large number of indicators suggested by other researchers (Allain *et al*., 2018; Hák *et al*., 2016; Kono *et al*., 2018; Nesterenko, 2015; Omarov, 2014; Uskova, 2009; Valenti *et al*., 2018; Zhurovskyi, 2009) may seem to cover more components. At the same time, some of these indicators are very subjective and do not have any calculation, which means that different experts may have different results having the same input data. Some of them are good for other countries and inapplicable for Ukraine, because the State Statistics Service of Ukraine does not have the necessary data for calculation of these indicators. The assessment of sustainable development of regions is relative. This means that regions in Ukraine are compared to each other each analysed year, which neutralizes the issues of possible inflation and its influence on the indicators' values in the next years.

Thus, our research contributes to the current literature in regional sustainable development in the following ways. Firstly, it uses the indicators available for all regions in Ukraine over a long period of time. This allows to make the comparison of regions' performance over time. Secondly, application of chromatic-temporal analysis and creation of maps contributes to visualization of the dynamics of sustainable development of the Ukrainian regions. And to the best of our knowledge, it is the first research that visualize the comparison of dynamics of sustainable development of all regions in Ukraine for 9 years (*Chromatic-temporal…*, 2018).

The visualization allows to see the changes which happened to the performance of the regions in Ukraine before and after the conflict. It is obvious that Luhansk and Donetsk regions, which represent the East of Ukraine, suffered the most. Starting from 2014, these two regions have lost significant parts of their territories, which led to a decrease of industrial potential, mass internal migration, emergence of social issues, decrease of environmental initiatives. Exactly starting from 2014, Luhansk and Donetsk regions became the only regions, which belonged to group 4 — Followers among followers. This change proves the negative influence of the military conflict on sustainable development of regions in Ukraine.

Conclusions

The suggested methodology for assessment of sustainable development of the regions proved to be effective, as it showed the relative values of the integral indices of sustainable development of the Ukrainian regions taking into account the economic, social and environmental aspects of regional development. The results of the analyses and the visual maps showed that the conflict in the East of Ukraine significantly influenced the sustainable development of the regions in Ukraine, completely changing the situation and interrelation of the regions.

Before the conflict, the regions in the East of Ukraine (Luhansk and Donetsk regions in particular) had higher values of indicators compared to the average numbers in Ukraine, and Donetsk region was among regions — leaders among leaders. After the conflict, Luhansk and Donetsk regions became the only outsiders or followers among followers with the values of indicators lower than the average in Ukraine. Such decrease can be explained by occupation of the majority of industrial companies in Luhansk and Donetsk regions, increase of social insecurity of citizens of the regions, migration of internally displaced people and institutions, constant military activities, which influenced the sustainable development of the whole country. At the same time, such analyses allowed to visualize the change of interrelation of the regions in Ukraine and transfer the hypothetical knowledge of the bad situation in the East of Ukraine to the concrete indicators and maps, and to pay attention to the specific crisis points revealed at analyses.

This methodology of assessment of sustainable development of the regions in Ukraine can be useful for regional state administrations in Ukraine to see the performance of the specific region compared to other regions in Ukraine. Thus, the main policy implications can focus on the analyses of

the best practices of the regions — leaders among leaders, and setting the directions of sustainable development, on which the regions should focus while implementing regional policy for the next period.

By using this methodology, it is possible to see not only the dynamics of the integral index of sustainable development of the regions, but also the changes in regions' individual sustainable development indicators. Taking this into account, the future research might focus on identification of growth reserves, mobilization of resources for regional development, and development of policy recommendations depending on the most vulnerable pillar of sustainable development of a region.

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Annex

Table 1. Identification of attributive groups according to the level of sustainable development of regions

Group number	Attributive group	Group title
1	LL	Leaders among leaders
2	LF	Followers among leaders
3	FL	Leaders among followers
4	FF	Followers among followers

Table 2. Values of integral indicators of sustainable development of the regions in Ukraine

Region	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vinnytsia	0.375	0.529	0.354	0.384	0.433	0.468	0.562	0.568	0.557
Volyn	0.388	0.559	0.378	0.428	0.434	0.479	0.540	0.533	0.465
Dnipropetrovsk	0.694	0.585	0.753	0.753	0.660	0.620	0.495	0.520	0.630
Donetsk	0.720	0.597	0.606	0.638	0.599	0.554	0.473	0.362	0.412
Zhytomyr	0.377	0.541	0.407	0.420	0.433	0.470	0.564	0.542	0.491
Zakarpattia	0.385	0.574	0.538	0.503	0.475	0.559	0.653	0.603	0.514
Zaporizhia	0.538	0.699	0.561	0.583	0.620	0.674	0.658	0.656	0.674
Ivano-Frankivsk	0.374	0.547	0.378	0.366	0.421	0.463	0.539	0.507	0.445
Kiev	0.410	0.668	0.496	0.745	0.952	0.939	0.822	0.841	0.908
Kirovohrad	0.434	0.623	0.352	0.377	0.452	0.481	0.558	0.529	0.531
Luhansk	0.469	0.599	0.460	0.427	0.417	0.389	0.367	0.269	0.248
Lviv	0.376	0.560	0.424	0.434	0.498	0.558	0.566	0.544	0.519
Mykolaiv	0.462	0.665	0.625	0.590	0.548	0.586	0.657	0.709	0.585
Odessa	0.381	0.654	0.548	0.508	0.497	0.552	0.503	0.547	0.541
Poltava	0.562	0.793	0.660	0.688	0.733	0.736	0.706	0.726	0.673
Rivne	0.451	0.652	0.560	0.505	0.509	0.526	0.581	0.567	0.495
Sumy	0.404	0.602	0.448	0.491	0.528	0.545	0.594	0.610	0.539
Ternopil	0.342	0.524	0.307	0.309	0.393	0.416	0.492	0.477	0.420
Kharkiv	0.471	0.551	0.502	0.571	0.578	0.588	0.616	0.614	0.568
Kherson	0.416	0.628	0.445	0.507	0.485	0.509	0.549	0.546	0.496
Khmelnytskyi	0.397	0.564	0.376	0.383	0.458	0.490	0.561	0.540	0.489
Cherkasy	0.421	0.568	0.394	0.409	0.502	0.522	0.579	0.589	0.546
Chernivtsi	0.610	0.740	0.532	0.536	0.454	0.498	0.545	0.516	0.435
Chernihiv	0.412	0.581	0.491	0.485	0.518	0.525	0.580	0.578	0.504

Source: own calculations based on data from State Statistics Service of Ukraine (2018).

Table 3. Affiliation of the regions in Ukraine to different attributive groups according to their level of sustainable development

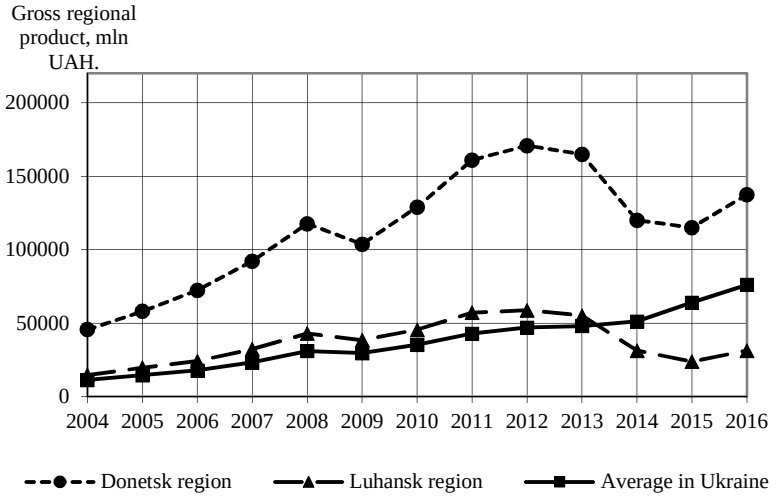
Region	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vinnytsia	FF	FF	FF	FF	FF	FF	FL	LF	FL
Volyn	FF	FF	FF	FL	FF	FF	FL	FL	FL
Dnipropetrovsk	LL	FF	LL	FF	FL	FL	FL	FL	LF
Donetsk	LL	FL	LF	LF	FL	FL	FF	FF	FF
Zhytomyr	FF	FF	FF	FF	FF	FF	FL	FL	FL
Zakarpattia	FF	FF	LF	FL	FF	FL	LF	LF	FL
Zaporizhia	LF	LF	LF	LF	FL	LF	LF	LF	LF
Ivano-Frankivsk	FF	FF	FF	FF	FF	FF	FL	FL	FL
Kiev	FF	LF	FL	LL	LL	LL	LL	LL	LL
Kirovohrad	FF	FL	FF	FF	FF	FF	FL	FL	FL
Luhansk	FL	FL	FL	FL	FF	FF	FF	FF	FF
Lviv	FF	FF	FL	FL	FF	FL	FL	FL	FL
Mykolaiv	FL	LF	LF	LF	FL	FL	LF	LL	LF
Odessa	FF	FL	LF	FL	FF	FL	FL	FL	FL
Poltava	LF	LL	LL	LL	LF	LF	LF	LL	LF
Rivne	FL	FL	LF	FL	FF	FF	FL	LF	FL
Sumy	FF	FL	FL	FL	FF	FL	FL	LF	FL
Ternopil	FF	FF	FF	FF	FF	FF	FL	FL	FL
Kharkiv	FL	FF	FL	LF	FL	FL	LF	LF	FL
Kherson	FF	FL	FL	FL	FF	FF	FL	FL	FL
Khmelnytskyi	FF	FF	FF	FF	FF	FF	FL	FL	FL
Cherkasy	FF	FF	FF	FF	FF	FF	FL	LF	FL
Chernivtsi	LF	LL	LF	LF	FF	FF	FL	FL	FL
Chernihiv	FF	FF	FL	FL	FF	FF	FL	LF	FL

Source: own calculations based on table 2.

Table 4. Transcript for the pattern of attributive groups according to the level of sustainable development of the regions

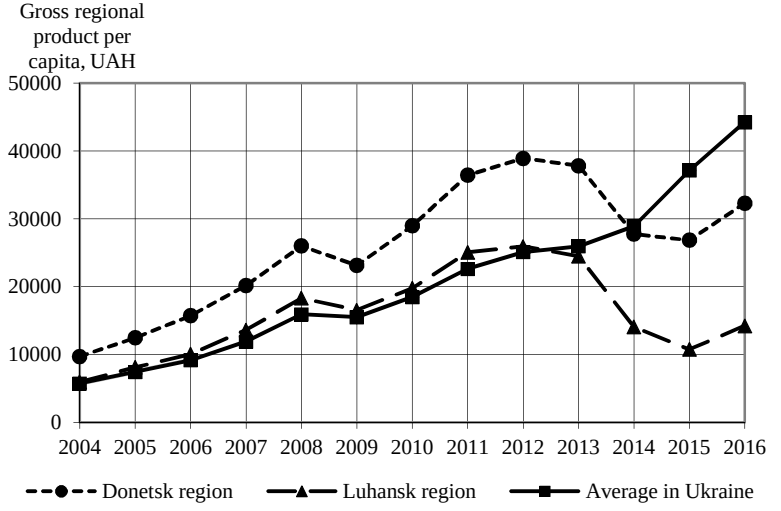
Group number	Attributive group	Pattern (colour)
1	LL	
2	LF	
3	FL	
4	FF	

Figure 1. Dynamics of gross regional product of Luhansk and Donetsk regions compared to average value in Ukraine



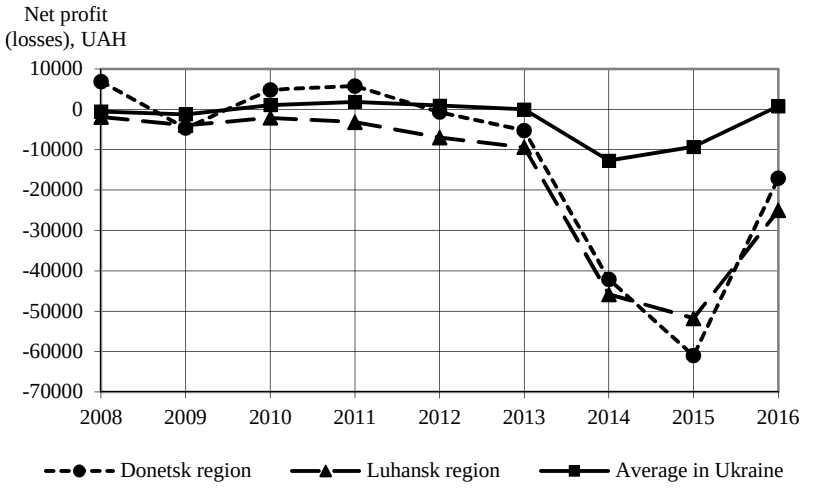
Source: own calculations based on data from State Statistics Service of Ukraine (2018).

Figure 2. Dynamics of Gross regional product per capita of Luhansk and Donetsk regions compared to average value in Ukraine



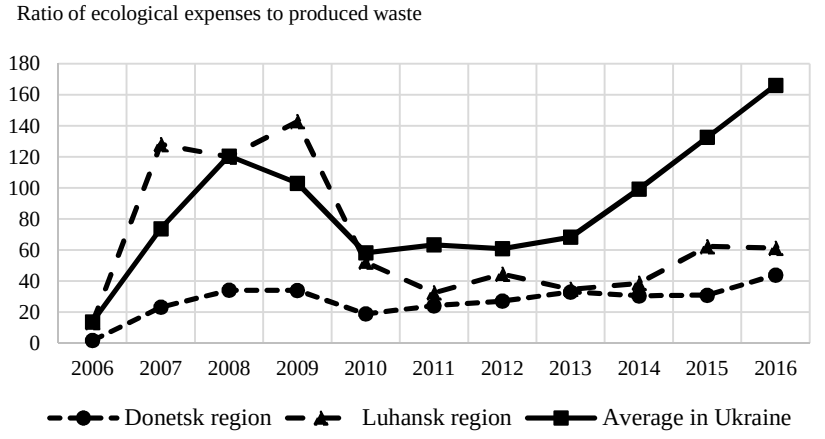
Source: own calculations based on data from State Statistics Service of Ukraine (2018).

Figure 3. Dynamics of net profit (losses) of enterprises of Luhansk and Donetsk regions compared to average value in Ukraine



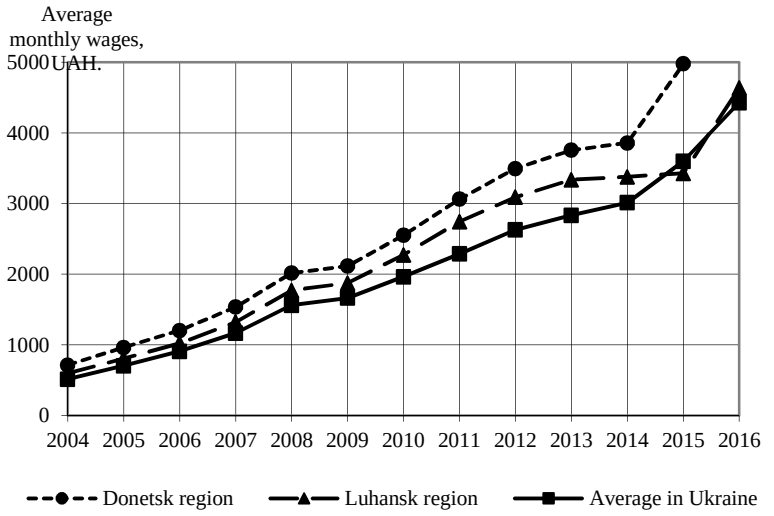
Source: own calculations based on data from State Statistics Service of Ukraine (2018).

Figure 4. Dynamics of ecological expenses to produced waste in Luhansk and Donetsk regions compared to average value in Ukraine



Source: own calculations based on data from State Statistics Service of Ukraine (2018).

Figure 5. Dynamics of average monthly wages of Luhansk and Donetsk regions compared to average value in Ukraine



Source: own calculations based on data from State Statistics Service of Ukraine (2018).

Figure 6. Mapping sustainable development of regions in Ukraine according to their affiliation to the attributive groups in 2008

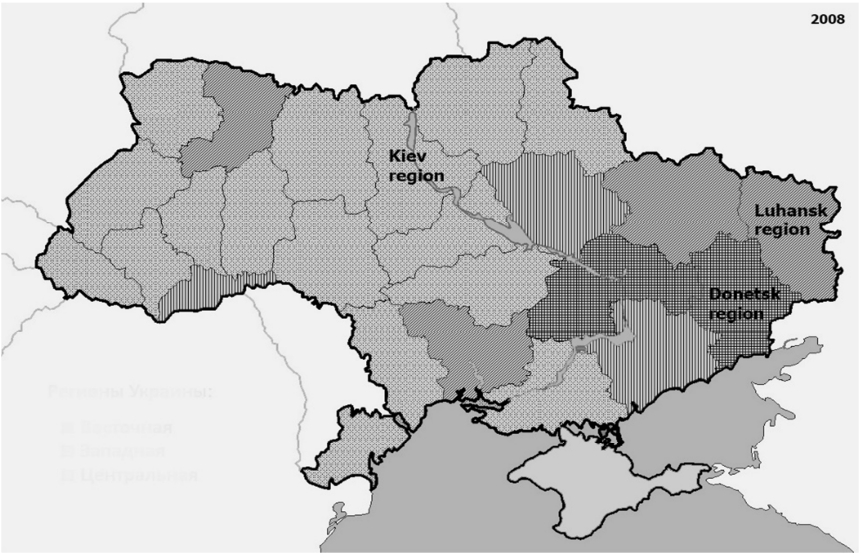


Figure 7. Mapping sustainable development of regions in Ukraine according to their affiliation to the attributive groups in 2013

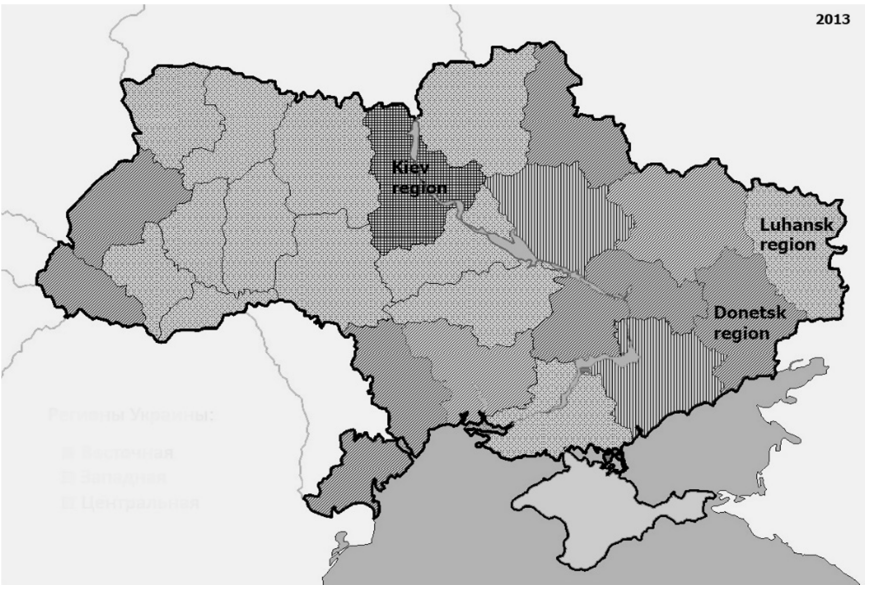


Figure 8. Mapping sustainable development of regions in Ukraine according to their affiliation to the attributive groups in 2014

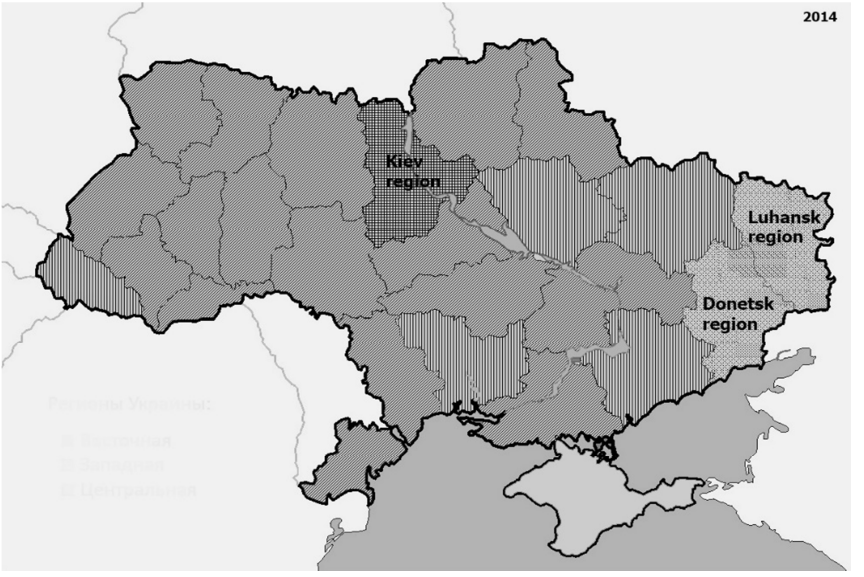


Figure 9. Mapping sustainable development of regions in Ukraine according to their affiliation to the attributive groups in 2016