

Agrarian potential of Ukraine under post-Maidan crisis and armed conflict: factors and patterns of regional unevenness

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ABSTRACT

Problem Statement. Regional socio-economic development is characterized by diversity and multifacetedness and is stipulated with different impacts of factors. Ukraine has a pronounced spatial asymmetry of socio-economic development of regions; therefore, it is an important case for study of various components of regional unevenness. In the present context of post-Maidan crisis and armed conflict, study of uneven development of agrarian potential in Ukraine is becoming increasingly important, whereas it is important to assess and monitor the agrarian potential of regions for economic and food security of the country and regions.

Research Methodology. The research focuses on assessment of the agrarian potential development of Ukraine's regions in 2015 and 2018, rather than on an empirical comparison of the agrarian potential development of regions before and during the post-Maidan crisis and armed conflict. A hierarchical model for assessing the development of the agrarian potential of Ukraine's regions has been elaborated. Based on the factor analysis results, the individual influence of each factor on the development of the agrarian potential of regions was determined. Using the method of ranking and Kohonen Self-Organizing Mapping, the changes in the uneven development of the agrarian potential of Ukraine's regions during the post-Maidan crisis and armed conflict period were investigated, and the trajectories of the development of this potential were revealed.

This paper aims to identify the regional patterns of agrarian potential development and determine the factors that influenced its regional unevenness during the post-Maidan crisis and armed conflict.

Results. The research results prove a spatial asymmetry and an increase in regional divergence in the agrarian potential development. The impact of socio-economic and production factors was revealed to grow and the impact of natural resources and macroeconomic factors on the agrarian potential development of the regions was revealed to weaken. The trajectories of agrarian potential development of the regions are determined; they are typified in nine types of trajectories of the agrarian potential development of the regions of Ukraine during the post-Maidan crisis and armed conflict. Recommendations are given on the regional policy in the agrarian sector of Ukraine in order to mitigate the uneven development of agrarian potential in the regions. Given that Ukraine is facing the problem of inconsistency of the institutional environment with the needs of agropotential development, it is very important to implement the institutional transformations, which should focus on harmonization of state and regional policy for the agrarian sector with EU principles.

Keywords: regional unevenness; agrarian potential; agropotential index; factors; patterns; Ukraine; post-Maidan crisis; armed conflict.

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1. Introduction

Upon the declaration of independence, Ukraine passed through several periods of socio-economic development – stagnation and adaptation (1991-1999), growth (2000-2008), post-crisis rehabilitation (2008-2014) and post-Maidan crisis (2014-present) [24,14]. Since 2014, Ukraine has been in an impelled armed conflict with the Russian Federation, which has led to temporary losses of territory (conflict in the east of the country and annexation of the Autonomous

Republic of Crimea), socio-economic and political ups and downs [21, 22, 41, 16]. Empirical studies indicate that regional unevenness exacerbates during economic downfalls, as they have a negative impact on various aspects of regional development [2, 15, 25, 35]. During armed conflicts, destructive processes permeate all spheres of public life. In such conditions, it is important to monitor socio-economic indicators of regional development of Ukraine, because the indicators serve as guidelines for develop-

ment and implementation of regional development strategies, decision-making within the regional policy and policy of the regions to make relevant adjustments to the General Layout of the Territory of Ukraine for the purposes of sustainable development.

By specialization, Ukraine is an industrial-agrarian country with active tertiarization processes, where the agrarian sector plays an important budget-forming role [29, 25]. Thus, the potential for the agrarian sector development largely depends on socio-economic well-being, food security and sustainable development of the country and its regions [32, 20]. Based on this, assessment and monitoring of agrarian potential of Ukraine's regions can impart an understanding of the current processes and their regional patterns, as well as practical results and recommendations for implementation by policy makers of different levels.

As a result of the full-scale Russian invasion to Ukraine on February 24, 2022, agricultural lands, agrarian infrastructure and machinery were damaged. About 22% of Ukraine's agricultural land are under occupation. The report of the Center for Food and Land Use Research of the KSE Institute together with the Ministry of Agrarian Policy and Food of Ukraine "Overview of War Damage in the Agriculture of Ukraine" states that agricultural lands have suffered two significant types of damage: mine contamination and direct physical damage from artillery shelling, missile strikes, soil damage by military equipment, unexploded ammunition. This made it impossible to carry out agricultural work and caused the decrease in agriculture production. In Ukraine, only 75% of last year's sown area was cultivated. At the same time, the maritime export of agricultural products was blocked. This reduced export earnings, caused global food inflation and could lead to famine in some countries. To solve these problems, it is important to identify regional patterns of agrarian potential development and the factors that influenced its regional unevenness during the post-Maidan crisis and armed conflict.

2. Literature Review

Unevenness of development is one of the main subjects of research in the regional studies. It is not a new problem. The traditions of study of uneven regional development were set up by such scholars as Gunnar Myrdal [30], Albert O. Hirschman [11], Walter Isard [13], and John Friedmann [7].

Study of regional unevenness is important for the countries of any level of development. After the collapse of the communist system in Central-Eastern Europe (CEE) and the former Soviet Union (FSU), a post-communist transition occurred, which aggravated all existing disparities in development and unveiled ineffectiveness of mechanisms applied for social governance, economic and regional policy [31, 6,

50, 49, 39, 38]. As noted by Michael Dunford [5], transition to capitalism in CEE and FSU had similar effects everywhere (with the difference in quality and quantity): transitional recession, demographic stagnation, increased social and territorial inequality, growth of the irregular economy, and the emergence of islands of striking modernization.

Ukraine has a pronounced spatial asymmetry of socio-economic development of regions; therefore, it is an important case for study of various components of regional unevenness. In the present context of post-Maidan crisis and armed conflict, study of uneven regional development of agrarian potential in Ukraine is becoming increasingly important, whereas it is important to assess and monitor the agropotential of regions for economic and food security of the country [8, 9]. Today, Ukraine is characterized with significant territorial differentiation of food security [26].

It is advisable to review the previously identified patterns of uneven regional development in Ukraine. Understanding of these inequalities is important for study of the uneven development of agropotential at the regional level.

Uneven regional development in Ukraine in the post-Soviet period has a number of features. First of all, Ukraine has inherited significant regional imbalances from the Soviet planned economy [10, 29, 15, 25]. Secondly, East-West patterns have a negative impact on regional socio-economic development in Ukraine [37, 4, 14]. The vast majority of powerful industrial enterprises in Ukraine are concentrated in the eastern and northern regions, while the western regions face a significant shortage of jobs. As a result, the lowest incomes of the population are reported mainly in the western regions of Ukraine, the highest – in the eastern and central regions. This polarization in the development of the eastern and western regions within the country causes a significant outflow of labor from the latter to more developed regions of the country or abroad [36].

The result of uneven development is socio-spatial polarization, which has positive and negative aspects. On the one hand, the gap between the pole and the periphery may intensify in terms of economic and social indicators. On the other hand, the poles can act as the centers that impart revival of economic development and improvement of living conditions to the surrounding. In Ukraine, at all spatial levels, the prevailing manifestation of socio-spatial polarization is negative [25].

Finally, the rapid polarization of agrarian production: in the northern regions of Ukraine, the principle of this polarization is 'the best vs the worst natural conditions', and in the southern regions – 'suburban areas vs peripheral areas'. The consequence of polarization in the agrarian production is an increased concentration of rural population in suburban areas,

which is growing over the years [1]. Thus, we can assume that the above manifestations of uneven regional development in Ukraine, whether stronger or weaker expressed, are relevant during the post-Maidan crisis and armed conflict.

In the current paper, the agrarian potential is understood as the maximum possible output of agricultural production of a certain quality subject to comprehensive interaction of natural, production, infrastructure and labor resources and management system.

Analysis of previous studies focusing on the concept of 'agrarian potential' and the agropotential of Ukraine in particular indicates that these studies can be thematically divided into several groups:

- studies that supplement the theoretical framework of the concept of agrarian potential [18, 17, 44, 8];
- studies of agrarian potential of regions of Ukraine from the standpoint of resource and effective approaches [9, 48, 46];
- studies of the trends in agrarian potential development at the regional level in Ukraine [3, 12];
- studies of certain aspects of agrarian potential development [47, 45, 42, 19, 23, 34, 43].

Consequently, the analysis of studies relating to agrarian potential in the regions of Ukraine revealed their fragmentary nature, as these studies do not analyze the regional trends and regional trajectories of agrarian potential in Ukraine, in particular in the post-Maidan period, when this topic is highly burning. Therefore, this paper aims to conduct a comprehensive assessment of the trends and regional trajectories of Ukraine's agrarian potential in the post-Maidan period with a possibility of long-term monitoring.

3. The Main Purpose and Research Questions

The main purpose of this paper is to determine the regional patterns of agrarian development and identify the factors that influenced its uneven regional development during the post-Maidan crisis and armed conflict. This study focuses on assessment of the agrarian potential development of Ukraine's regions in 2015 and 2018, rather than on an empirical comparison of the agropotential development of regions before and during the post-Maidan crisis and armed conflict.

Within the purpose of the paper, and taking into account the gaps in the above studies, the authors attempt to answer the following key research questions:

(RQ1) What patterns are specific to the development of agrarian potential of the regions of Ukraine in 2015 and 2018?

(RQ2) What factors did influence the uneven development of agrarian potential of Ukraine's regions of in 2015 and 2018?

(RQ3) What changes took place in the uneven development of agricultural potential and its components among the regions of Ukraine in 2015-2018?

(RQ4) What are the trajectories of the agrarian potential development in the regions of Ukraine during the post-Maidan crisis and armed conflict?

4. Methodology: Data and Methods

The choice of indicators that can assess the development of agrarian potential of the regions of Ukraine is widely discussed. The materials of numerous relevant studies show a wide range of indicators and approaches used to build models for assessing the development of agrarian potential at the regional level [17, 9, 12, 46, 48]. The choice of indicators of agrarian potential development mainly depends on the objectives of the study, the methods applied and the availability of statistical data for various territorial scales. Considering the availability of data and the structure of agrarian potential described in previous empirical studies, a hierarchical model of assessing the agrarian potential development of the regions of Ukraine in 2015 and 2018 was developed (Table 1). This model is based on available official data provided by the State Statistics Service of Ukraine broken down by 24 regions (oblasts) without taking into account the city of Kyiv and the territories that are temporarily occupied and not controlled by the Government of Ukraine.

To answer the first research question (RQ1), it is necessary to conduct an integrated assessment of the agrarian potential development (Table 1) in the regions of Ukraine in 2015 and 2018.

The general level of agrarian potential development of the region is expressed through the value of the cumulative index, which is based on the calculation of four indices of different components of agropotential, which - in their turn - are calculated by 15 indicators using the normalizing method. This approach is the best for the hierarchical model given above, because each calculation stage of the cumulative index of agrarian potential takes into account the stimulating or disincentive effect of indicators within each component of agropotential, which is well interpreted during calculation of component indices and cumulative agrarian index. Normalization of indicators and calculation of cumulative indices are widely used in studies of uneven regional development [28, 29].

$$Z_{ij} = (X_{ij} - X_{min}) / (X_{max} - X_{min}) \quad (1)$$

Those indicators that discourage the agrarian potential development (the higher the indicator value, the worse) were calculated with the formula below:

$$Z_{ij} = (X_{max} - X_{ij}) / (X_{max} - X_{min}) \quad (2)$$

All values of 15 indicators for 2015 and 2018 were normalized to relative indicators with a scale from 0 to 1. Indicators that stimulate the agrarian potential development (the higher the indicator value, the better) were normalized according to the formula below:

Hierarchical model of assessing the agrarian potential development
at the regional level in Ukraine in 2015 and 2018

		Indicators in 2015	Indicators in 2018
AGROPOTENTIAL	Production Subpotential	Labor productivity in agricultural enterprises (per 1 employed in agricultural production, at constant prices in 2010; UAH) 2015	Labor productivity in agricultural enterprises (per 1 employed in agricultural production, at constant prices in 2010; UAH) 2018
		Share of agricultural production by households (% of total) in 2015	Share of agricultural production by households (% of total) in 2018
		Generating capacities in agricultural enterprises of the region (generating capacity per 100 hectares of sown area; kW) at the end of 2014 (actually 01.01.2015)	Generating capacities in agricultural enterprises of the region (generating capacity per 100 hectares of sown area; kW) at the end of 2017 (actually 01.01.2018)
		Volumes of capital investment per 1 hectare of agricultural land, UAH 2015	Volumes of capital investment per 1 hectare of agricultural land, UAH 2018
	Natural Resource Subpotential	Area of agricultural land (at the end of 2015; thousands of hectares)	Area of agricultural land (at the end of 2017; thousands of hectares)
		Application of mineral and organic fertilizers per hectare of the redefined sown area of agricultural crops by regions (kg) in 2015	Application of mineral and organic fertilizers per hectare of the redefined sown area of agricultural crops by regions (kg) in 2018
		Provision of agricultural land for economically active population (ha per 100 people) in 2015	Provision of agricultural land for economically active population (ha per 100 people) in 2018
	Macroeconomic Subpotential	Share of GRP of the region in the total GRP of all regions,% 2015	Share of GRP of the region in the total GRP of all regions,% 2018
		Percentage of agricultural lands of the region in relation to their total volume in the country,% 2015	Percentage of agricultural lands of the region in relation to their total volume in the country,% 2018
		Percentage of economically active population of the region in relation to the total volume of the country,% 2015	Percentage of economically active population of the region in relation to the total volume of the country,% 2018
		Percentage of capital investments of the region in relation to the total volume of the country,% 2015	Percentage of capital investments of the region in relation to the total volume of the country,% 2018
	Socio-Economic Subpotential	The level of ruralization of the region (the specific weight of rural population in the total available population of the region),% as of January 1, 2015	The level of ruralization of the region (the specific weight of rural population in the total available population of the region),% as of January 1, 2018
		Average monthly salary per full-time employee, UAH 2015	Average monthly salary per full-time employee, UAH 2018
		Average monthly nominal salary of full-time employees of agricultural enterprises, UAH 2015	Average monthly nominal salary of full-time employees of agricultural enterprises, UAH 2018
		Share of the region's population employed in agriculture, forestry and fisheries,% of the total employed population in 2015	Share of the region's population employed in agriculture, forestry and fisheries,% of the total employed population in 2018

Source: based on available official statistics of the State Statistics Service of Ukraine and on a literature review.

X_{ij} = the value of indicator i in a region j ;

X_{max} = the top value in the set of the given indicator;

X_{min} = the bottom value in the set of the given

indicator.

Thereafter, the normalized values of Z_i in the region j were aggregated in four synthesized variables (component indices):

1. Natural resource subpotential index (NRSI)

$$NRSI_j = \frac{1}{3} \sum_{i=1}^3 Z_{ij} \quad (3)$$

2. Production subpotential index (PSI)

$$PSI_j = \frac{1}{4} \sum_{i=1}^4 Z_{ij} \quad (4)$$

3. Socio-economic subpotential index (SESI)

$$SESI_j = \frac{1}{4} \sum_{i=1}^4 Z_{ij} \quad (5)$$

4. Macroeconomic subpotential index (MSI)

$$MSI_j = \frac{1}{4} \sum_{i=1}^4 Z_{ij} \quad (6)$$

$\sum_{j=1}^4 Z_{ij}$ = the sum of values of Z_i , which characterize development of one of four components (subpotentials) in the agrarian potential (see above Table 1) in the region j .

Finally, the values of the natural resource subpotential index, the production subpotential index, the socio-economic subpotential index and the macroeconomic subpotential index serve as a basis for calculating the cumulative index or the agropotential index (API):

$$API_j = \frac{1}{4} (NRSI_j + PSI_j + SESI_j + MSI_j) \quad (7)$$

Thus, the calculation of the agropotential index for 2015 and 2018, based on the above algorithm, enabled to identify the inequalities in the agropotential development of the regions of Ukraine by building the trend surfaces.

The method for building a trend surface is a variety of the cartographic interpolation method, which is based on the data obtained as a result of spatial regression modeling [33, 40]. In this study, a linear multiple regression given below was used to establish patterns of uneven development of agropotential of the Ukraine's regions in 2015 and 2018:

$$P(x, y) = \beta_0 + \beta_1 x + \beta_2 y \quad (8)$$

$P(x, y)$ = dependent variable (agropotential index);

x та y = independent variable (rectangular coordinates of points localized in the regions);

β_1 та β_2 = regression coefficients;

β_0 = constant term of the regression equation.

First of all, to build the trend surfaces of agropotential development in 2015 and 2018, 748 points with rectangular coordinates were digitized, which are territorially tied to 24 regions of Ukraine. Then, a geospatial database was created, consisting of 24 regions to which 748 points are linked, where each of these points is given the value of the agropotential index for 2015 and 2018, depending on the region of Ukraine to which this point belongs. Thereafter, with this database in *Statistica* program, two regression models of agropotential index dependence on spatial position of regions were created (Table 2). Finally, the predicted values and residuals obtained for these multiple linear regression models for each of the 748 points were used to build the trend surfaces and to map the residuals in *Surfer* program. Thus, the calculation of the cumulative index and the building of trend surfaces of agropotential development in 2015

Table 2

Regression results

Regression Summary for Dependent Variable: Agropotential index (2015)						
MODEL 1	Multiple R=0.29762590; R ² =0.08858117; Adjusted R ² =0.08613441; F(2.745)=36.203; p<0.00000; Std. Error of estimate: 0.07731					
	No. of cases: 748	Beta	Std. Err. of Beta	B	Std. Err. of B	t (745)
Intercept			0.363608	0.013252	27.43823	0.000000
X-coordinate	0.296187	0.035769	0.000111	0.000013	8.28045	0.000000
Y-coordinate	-0.006543	0.035769	-0.000004	0.000024	-0.18291	0.854919
(significant results are highlighted, p<0.05)						
Regression Summary for Dependent Variable: Agropotential index (2018)						
MODEL 2	Multiple R=0.22560669; R ² =0.05089838; Adjusted R ² =0.04835046; F(2.745)=19.976; p<0.00000; Std. Error of estimate: 0.08062					
	No. of cases: 748	Beta	Std. Err. of Beta	B	Std. Err. of B	t (745)
Intercept			0.382557	0.013820	27.68214	0.000000
X-coordinate	0.229534	0.036501	0.000088	0.000014	6.28835	0.000000
Y-coordinate	0.025213	0.036501	0.000017	0.000025	0.69074	0.489942
(significant results are highlighted, p<0.05)						

Source: calculated in *Statistica*

and 2018 will give answers to the first research question (RQ1) on regional patterns of uneven development of agrarian potential in Ukraine during the post-Maidan crisis and armed conflict.

In order to find and explain the factors that influenced the uneven development of agricultural potential of the regions of Ukraine in 2015 and 2018 (RQ2), the method of factor analysis was used. Factor analysis was performed in *Statistica* program, which used the values of natural resource subpotential index, production subpotential index, socio-economic subpotential index and macroeconomic subpotential index for 24 regions to identify the factors that influenced the regional unevenness the most. Moreover, upon calculation of the factor scores, the individual impact of each of the selected factors on the agrarian potential development of this or that region of Ukraine during the post-Maidan crisis and armed conflict was determined.

In order to answer the research questions RQ3 and RQ4, the ranking method and the Kohonen self-organizing maps were used. The ranking method was needed to find out how the uneven development of agricultural potential and its subpotentials among the regions of Ukraine in 2015-2018 has changed. Ranking of 24 regions by the values of the natural resource subpotential index, the production subpotential index, the socio-economic subpotential index, the macroeconomic subpotential index and the agropotential index for 2015 and 2018 (Table 3) allowed to calculate the difference between the values of the ranks of identical indicators in 2015 and 2018, where 2015 is the base year. These differences of ranks for 2015-2018 are indicative of such changes as growth, decline or stability in the development of agropotential and subpotentials. Elaboration of the Kohonen self-organizing maps in *Deductor Studio* program based on the value of agropotential index in 2015 and 2018 enabled to classify the regions of Ukraine by the level of agropotential development during the post-Maidan crisis and armed conflict (Figure 1). Thus, the ranking method combined with the method of the Kohonen self-organizing maps helped to capture the trajectories of the agrarian potential of Ukraine's regions during the post-Maidan crisis and armed conflict (RQ4).

5. Results

5.1. General Patterns of Regional Unevenness of Agropotential in 2015 and 2018

The calculated index of agropotential of the regions in Ukraine indicated an increase in regional divergence in the agropotential development during 2015-2018. This is evidenced with the fact that in 2015, in 14 of 24 regions, the value of the agropotential index was much higher than the average value in Ukraine ($mean\ API = 0.399$), and in 2018, in contrast to the results of 2015, the value of the agropotential

index, which exceeds the average value in Ukraine ($mean\ API = 0.417$), were only in 11 of 24 regions (Table 3).

Cartographic analysis of agropotential development in the regions during the post-Maidan crisis and armed conflict showed significant spatial asymmetry (Figure 2). According to the trend surface modeling of agropotential development in 2015, Regional unevenness of agropotential in Ukraine follows the trend that fits into the framework of the 'West-East' pattern. It is a well-known phenomenon of regional development in Ukraine and is quite expectable, as it was identified in previous studies devoted to uneven regional development in Ukraine [37, 4, 14]. In 2015, the West-East gradient illustrates an increase in the agropotential of the regions in Ukraine in the direction from the west to the east (Figure 2A, 2B). In its turn, the model of the trend surface of the regional agropotential development in 2018 demonstrates a slight change in the orientation of the West-East gradient. In 2018, the agropotential development of Ukraine's regions is already increasing along the Southwest-Northeast axis.

Undoubtedly, the shift in orientation of the West-East gradient from the clear direction of West-East to the South-West-North-East is a consequence of reinforced effect of the center-peripheral inequalities on the agropotential development in Ukraine, the manifestation of which intensifies in the context of a crisis (Figure 2C). Probably, the shifts in the 'West-East' pattern during the post-Maidan crisis and armed conflict are due to the incrementing concentration of agrarian potential in the capital region and neighboring regions (partial manifestation of the 'center-periphery' effect).

Thus, the above trend surfaces demonstrate the growing polarization of agrarian potential development in Ukraine. This manifests with the lower level of agrarian potential development in the western regions than in the eastern regions, and, in the post-Maidan crisis and armed conflict, a center-periphery pattern is observed as a result of perturbation processes.

5.2. Factors of Regional Inequality of Agropotential Development in 2015 and 2018

The outcomes of the factor analysis demonstrated that the agropotential development in Ukraine during 2015-2018 was influenced by the factors of various power and character (Table 4).

In 2015, unevenness in the agropotential development in the regions of Ukraine was influenced by two factors (determined by the Kaiser criterion). Their interpretation indicated that the first factor by its character is a natural resource-macroeconomic factor, and the second factor is a socio-economic-production factor. In 2015, the natural resource-macroeconomic factor had a stronger influence on the agro-

potential development of the regions than the socio-economic-production factor (41.7% vs. 37.0% of the total variance).

In 2018, the polarization of agropotential in Ukraine, just like in 2015, was most influenced by two factors (determined by the Kaiser criterion), but the power and character of these factors differ in 2015 and 2018. Interpretation of two factors in 2018 is as follows: the socio-economic factor had the strongest impact, which explains almost 42% of the total variance; the second strongest factor was the production factor, which explains a third of the total variance.

Thus, over the period 2015-2018, the impact of socio-economic and production factors actually increased, and the impact of natural resources and macroeconomic factors decreased.

In order to investigate the territorial differentiation of the impact made by the above factors on the

agropotential development in Ukraine during the post-Maidan crisis and armed conflict, the regional distribution of factor scores was analyzed (Figure 3).

Figure 3 shows that in 2015 the natural resource-macroeconomic factor had the greatest influence on the agropotential development in Kyiv, Dnipropetrovsk and Kharkiv regions, due to the highly diversified economy of these regions and availability of large areas of suburban agricultural specialization within them, which significantly contribute to intensification of agricultural production. Meanwhile, the socio-economic-production factor had the greatest impact on the agropotential development in Kyiv, Cherkasy, Vinnytsia and Ivano-Frankivsk regions, with the last three of them having agro-industrial specialization.

In 2018, the socio-economic factor strongly influenced the agropotential development of Dniprope-

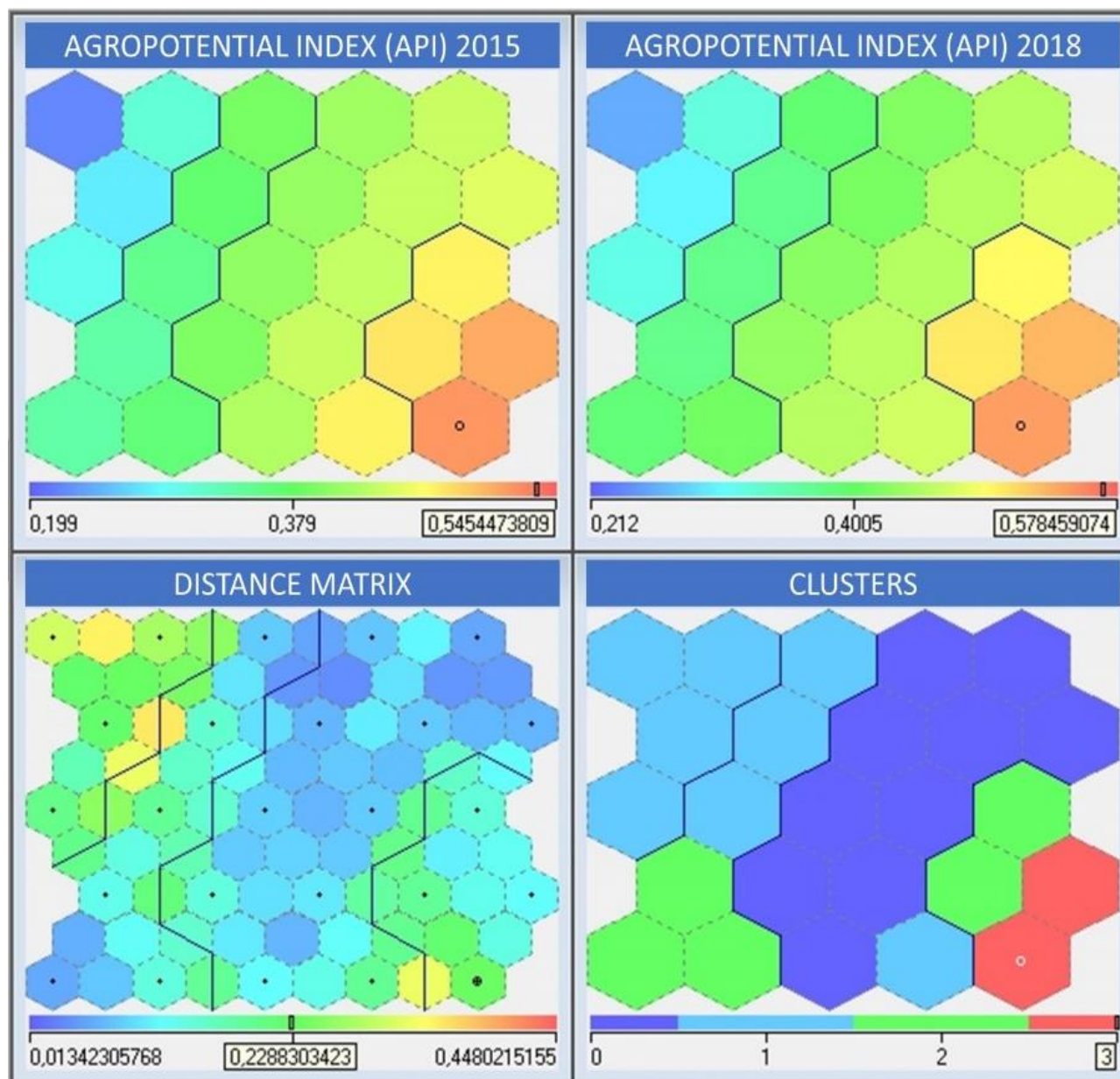


Fig. 1. Results of construction of the Kohonen self-organizing maps (Source: calculated in *Deductor Studio*)

Table 3

Ranking Results

Regions	2015										2018									
	PSI	rank	NRSI	rank	MSI	rank	SESI	rank	API	rank	PSI	rank	NRSI	rank	MSI	rank	SESI	rank	API	rank
Vynnytsia	0.686	1	0.418	14	0.368	9	0.625	2	0.524	3	0.669	3	0.45026	9	0.382	9	0.661	2	0.540	3
Volyn	0.417	10	0.419	13	0.146	20	0.4613	14	0.361	18	0.677	2	0.417	12	0.127	20	0.397	17	0.404	14
Dnipropetrovsk	0.502	5	0.417	15	0.991	1	0.326	22	0.559	1	0.667	4	0.402	16	0.991	1	0.298	22	0.589	1
Donetsk	0.316	18	0.409	17	0.479	5	0.405	18	0.402	14	0.468	14	0.45032	8	0.517	5	0.344	20	0.445	8
Zhytomyr	0.275	21	0.377	19	0.212	17	0.385	20	0.312	21	0.382	18	0.336	19	0.2281	16	0.364	18	0.328	20
Zakarpattia	0.202	23	0.034	24	0.076	23	0.483	11	0.1986	24	0.354	21	0.003	24	0.076	23	0.636	3	0.267	23
Zaporizhia	0.312	19	0.435	11	0.454	7	0.393	19	0.398	15	0.353	22	0.419	10	0.445	7	0.358	19	0.394	17
Ivano-Frankivsk	0.604	3	0.380	18	0.185	18	0.745	1	0.478	5	0.518	10	0.3769	18	0.136	19	0.740	1	0.443	9
Kyiv	0.643	2	0.455	8	0.571	4	0.4608	15	0.532	2	0.873	1	0.408	15	0.525	4	0.468	10	0.568	2
Kirovohrad	0.357	15	0.549	4	0.246	13	0.495	10	0.4116	12	0.453	15	0.529	4	0.240	15	0.430	14	0.4133	13
Luhansk	0.252	22	0.584	2	0.178	19	0.256	24	0.318	20	0.371	19	0.560	1	0.170	18	0.205	24	0.327	21
Lviv	0.472	6	0.292	20	0.468	6	0.537	6	0.442	7	0.660	5	0.238	22	0.483	6	0.542	6	0.481	5
Mykolaiv	0.321	16	0.465	6	0.300	10	0.530	7	0.404	13	0.361	20	0.458	6	0.286	10	0.483	9	0.397	16
Odesa	0.295	20	0.456	7	0.583	3	0.349	21	0.421	10	0.401	17	0.453	7	0.598	3	0.315	21	0.442	10
Poltava	0.409	11	0.583	3	0.426	8	0.519	8	0.484	4	0.567	7	0.547	3	0.437	8	0.533	7	0.521	4
Rivne	0.320	17	0.268	22	0.138	21	0.433	17	0.290	22	0.433	16	0.268	20	0.1258	21	0.400	16	0.307	22
Sumy	0.463	7	0.443	10	0.225	16	0.436	16	0.392	16	0.538	9	0.409	14	0.2280	17	0.418	15	0.398	15
Ternopil	0.391	12	0.283	21	0.118	22	0.562	3	0.338	19	0.556	8	0.255	21	0.1256	22	0.615	4	0.388	18
Kharkiv	0.422	9	0.444	9	0.657	2	0.313	23	0.459	6	0.500	12	0.418	11	0.677	2	0.250	23	0.461	7
Kherson	0.363	14	0.473	5	0.233	14	0.474	13	0.386	17	0.348	23	0.471	5	0.247	12	0.443	11	0.377	19
Khmelnyskyi	0.444	8	0.415	16	0.250	12	0.541	4	0.4123	11	0.517	11	0.3770	17	0.242	14	0.518	8	0.4135	12
Cherkasy	0.507	4	0.429	12	0.229	15	0.540	5	0.427	9	0.647	6	0.411	13	0.243	13	0.553	5	0.463	6
Chernivtsi	0.197	24	0.081	23	0.018	24	0.500	9	0.1991	23	0.337	24	0.054	23	0.018	24	0.438	13	0.212	24
Chernihiv	0.375	13	0.623	1	0.254	11	0.481	12	0.433	8	0.483	13	0.548	2	0.268	11	0.442	12	0.436	11

Source: developed by the authors

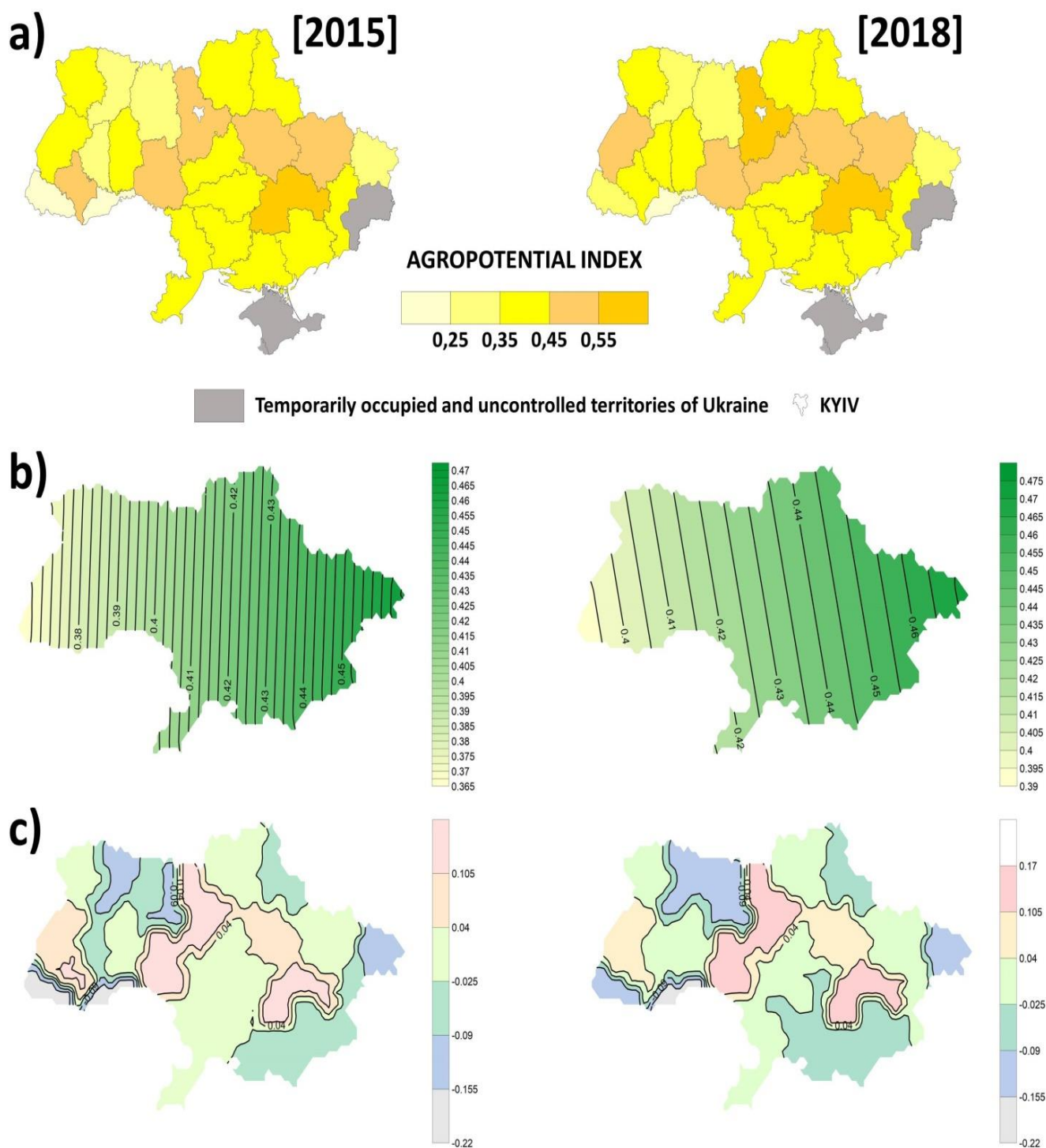


Fig. 2. Unevenness of regional agropotential development in Ukraine in 2015 and 2018 (a – differentiation of regions by agropotential index; b – trend surfaces of regional agropotential development; c – regional division of regression residuals (difference between the predicted values and actual value of agropotential index) (Source: developed by the author)

trovsk, Donetsk, Luhansk, Kharkiv and Odessa regions (Figure 3), where the index of socio-economic

subpotential development had a negative factor loading (Table 4). Meanwhile, the production factor had

Factor Analysis Results

	FACTOR ANALYSIS (2015)		FACTOR ANALYSIS (2018)	
	Determining the number of factors			
	Extraction: Principal components		Extraction: Principal components	
Value	Eigenvalue	Cumulative %	Eigenvalue	Cumulative %
1	1.668459	41.7115	1.760575	44.0144
2	1.479907	78.7091	1.251436	75.3003
3	0.690269	95.9659	0.679892	92.2976
4	0.161365	100.0000	0.308097	100.0000
	Rotation procedure and Interpretation of factors			
	Factor Loadings (Varimax raw) Extraction: Principal components (Marked loadings are > 0.700000)		Factor Loadings (Varimax raw) Extraction: Principal components (Marked loadings are > 0.700000)	
Variable	Factor 1	Factor 2	Factor 1	Factor 2
Production subpotential index	0.466411	0.837320	-0.063739	0.950100
Natural resource subpotential index	0.739171	0.057849	0.685649	0.246737
Macroeconomic subpotential index	0.858544	-0.079752	0.679004	0.522665
Socio-economic subpotential index	-0.408959	0.877095	-0.859882	0.317240
Expl.Var	1.668259	1.480107	1.674622	1.337390
Prp.Totl	0.417065	0.370027	0.418655	0.334347

Source: calculated in *Statistica*

the greatest influence on the agropotential development of such regions as Dnipropetrovsk, Kyiv, Vinnytsia and Lviv. Obviously, it is associated with the polarization of agrarian production in Ukraine, which gives rise to the centers of efficient agricultural production with high-quality products around the cities, and in the case of Vinnytsia region, it is reinforced with agro-industrial specialization of the region.

Summing up the above, we can say that the dual influence of factors on the development of two regions with the best development of agropotential was identified. In 2015, Kyiv region was exposed to the dual influence of factors, and in 2018 the dual influence of factors was observed in Dnipropetrovsk region.

5.3. Trajectories of Change in Regional Agropotential during Post-Maidan Crisis and Armed Conflict

Ranking of Ukraine's regions by the values of natural resource subpotential index, production subpotential index, socio-economic subpotential index, macroeconomic subpotential index and agropotential index for 2015 and 2018 (Table 3) enabled to calculate the rank difference for each index over the period 2015-2018. Mapping of the results (Figure 4) shows that during the post-Maidan crisis and armed conflict,

the agropotential components had the following features of their development in the regions of Ukraine:

- in 2015-2018, the macroeconomic subpotential had a relatively sustainable development, as there were no sharp ups or downs in the positions of the regions in terms of their macroeconomic subpotential development. Zhytomyr, Cherkasy, Kherson and Luhansk regions were the leaders in terms of macroeconomic subpotential growth. Such regions as Sumy, Kirovohrad, Khmelnytskyi and Ivano-Frankivsk showed a decline in macroeconomic subpotential development;

- development of natural resource, production and socio-economic subpotentials over 2015-2018 was more heterogeneous in the trends of regional positions. The best positive trend in the production subpotential development was reported in Volyn, Ternopil, Poltava and Luhansk regions. Vinnytsia and Donetsk regions were the leaders in terms of positive trend of natural resource subpotential development. The worst trend of natural resource potential development was reported in Kyiv and Sumy regions. The most negative trend of socio-economic subpotential development was intrinsic to the regions of agrarian specialization (Kirovohrad, Khmelnytskyi and Chernivtsi), and the best positive trend was reported in

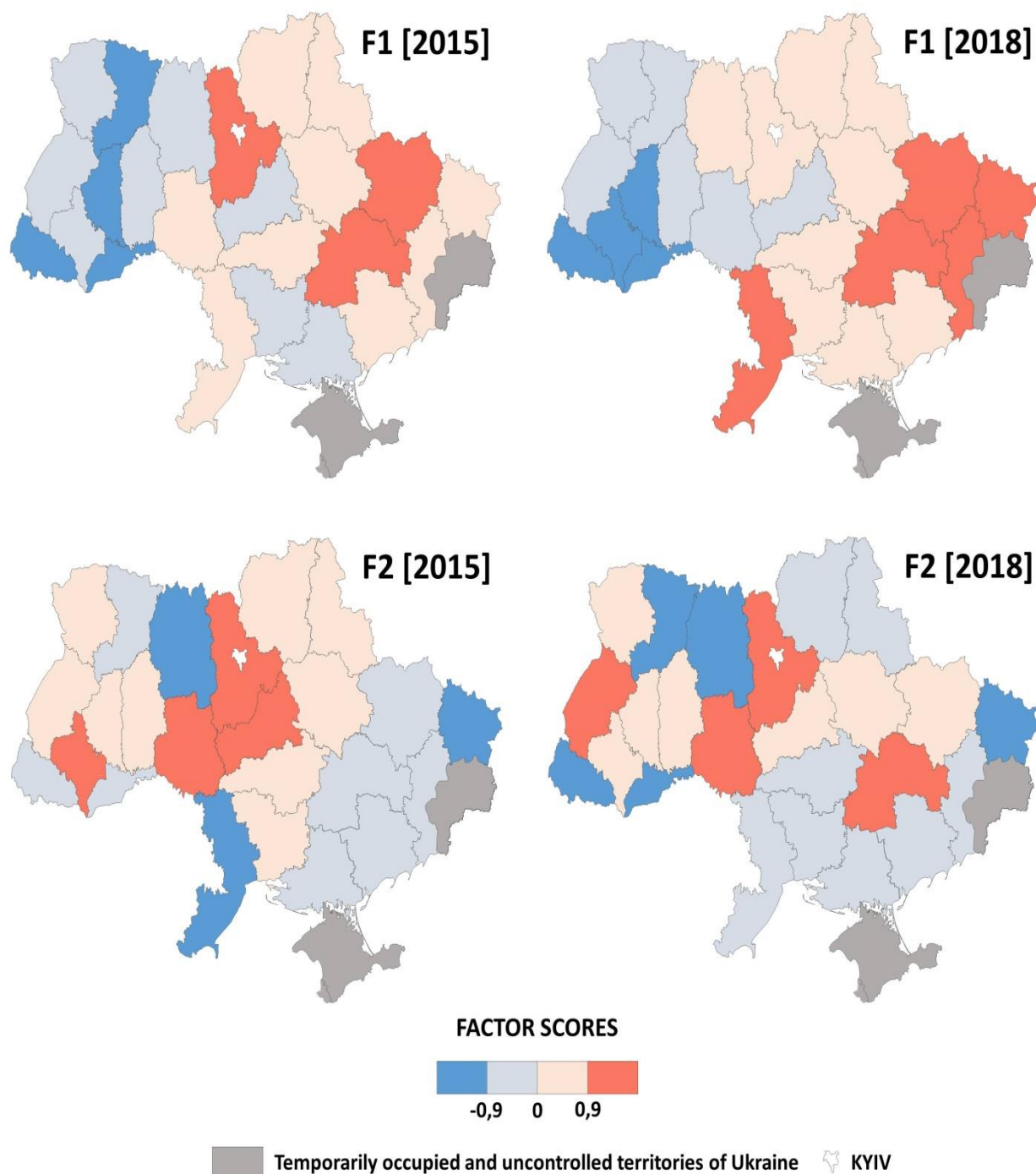


Fig. 3. Impact of factors on the unevenness of regional agropotential development in Ukraine in 2015 and 2018 (Source: developed by the authors)

Kyiv and Chernivtsi regions.

Through combination of the outcomes of building the Kohonen self-organizing maps (four clusters of agropotential development were identified) and the results of calculating the difference of ranks according to the agropotential index among the regions of Ukraine for the period 2015-2018 (Figure 1, 4), an empirical typification of the trajectories of agropotential of the regions during the post-Maidan crisis and armed conflict was developed (Table 5).

Table 5 shows that nine types of trajectories for agropotential development of the regions of Ukraine

have been identified in total. This number of trajectories of agropotential development in Ukraine, as well as all the results described above are indicative of a significant regional divergence. Chernivtsi and Luhansk regions had the most depressive trajectories of agropotential development in 2015-2018; Vinnytsia, Kyiv, Dnipropetrovsk and Poltava regions played the role of a core of agropotential development. The practical value of the selected types is that they can be used as guidelines in the formation of agrarian policy in the regions of Ukraine.

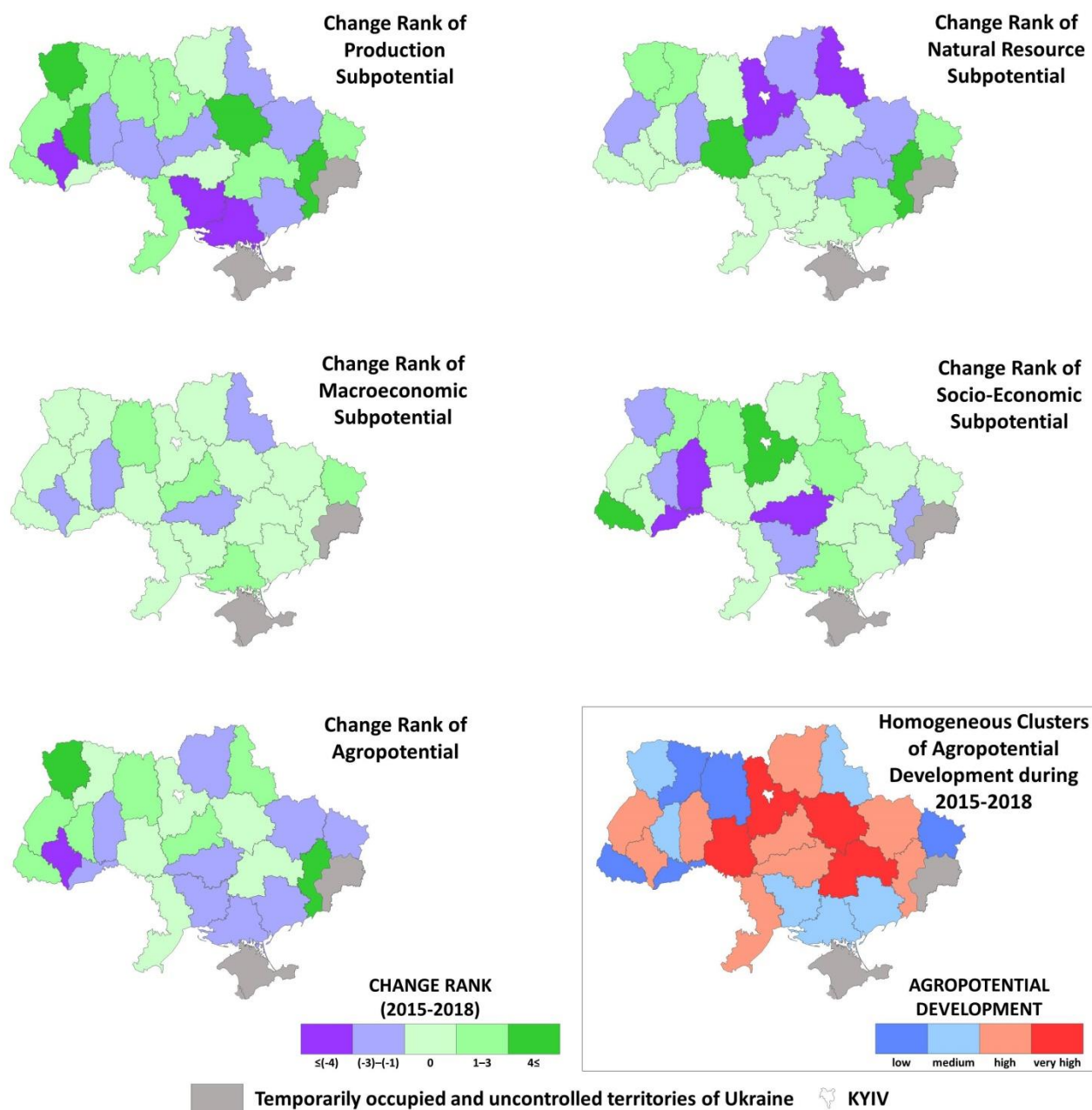


Fig. 4. Changes in Regional Agropotential Development in 2015 and 2018. Classification of Regions: Homogeneous Clusters of Agropotential Development during Post-Maidan Crisis and Armed Conflict (in frame) (Source: developed by the authors)

Table 5

Empirical typification of agropotential development trajectories in the regions of Ukraine during post-Maidan crisis and armed conflict

Types of Regional trajectories (T)	Regions
T1: Stable with a very high agropotential	Vinnitsia; Kyiv; Dnipropetrovsk; Poltava
T2: Growth with high agropotential	Lviv; Cherkasy; Donetsk
T3: Stable with high agropotential	Odesa
T4: Decline with high agropotential	Ivano-Frankivsk; Chernihiv; Kharkiv; Khmelnytskyi; Kirovohrad
T5: Growth with medium agropotential	Sumy; Ternopil; Volyn
T6: Decline with medium agropotential	Mykolaiv; Kherson; Zaporizhia
T7: Growth with low agropotential	Zakarpattia; Zhytomyr
T8: Stable with low agropotential	Rivne
T9: Decline with low agropotential	Chernivtsi; Luhansk

Source: developed by the authors

6. Conclusions

The above results of the study of the unevenness of regional agropotential development in Ukraine correspond to the previously presented theoretical basis and resonate with the results of previous researches. Empirical results demonstrate that during the post-Maidan crisis and armed conflict, the growth of regional polarization is explained with the 'West-East' pattern and the partial manifestation of the 'center-periphery' pattern. The main drives of uneven agropotential development in the regions in 2015 were natural resource-macroeconomic and socio-economic-production factors, and in 2018 the latter factor had the strongest impact and was divided into socio-economic and production factors. Multiplicity of trajectories for the agropotential development of the regions and the uneven development of its components during 2015-2018 indicated the regional divergence in the agropotential development in Ukraine

during the post-Maidan crisis and armed conflict.

Based on the empirical results given above, recommendations for agricultural regional policy can be offered. One of the recommendations is to stimulate regional convergence of agropotential development to achieve uniformity of regional development under the condition of maximum use of the resource potential available in the territory in combination with successful regional policy measures. Another recommendation is to assess and monitor the agropotential of the regions of Ukraine, which would improve the efficiency of use and stimulate its development. Given that Ukraine is facing the problem of inconsistency of the institutional environment with the needs of agropotential development, it is very important to implement the institutional transformations, which should focus on harmonization of state and regional policy for the agrarian sector with EU principles.

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Аграрний потенціал України в період пост-Майданної кризи та військового конфлікту: фактори та паттерни регіональної нерівномірності

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Регіональний соціально-економічний розвиток характеризується різноспрямованістю та поліваріантністю і зумовлюється відмінностями у впливі факторів. У період військових конфліктів загострюється регіональна нерівномірність. В таких умовах важливим є моніторинг соціально-економічних індикаторів розвитку регіонів України, адже індикатори слугують орієнтирами для створення і реалізації стратегій розвитку регіонів, прийняття рішень в межах регіональної політики та політики регіонів для внесення актуальних коректив у Генеральну схему

планування території України задля досягнення сталого розвитку. Оцінка та моніторинг агропотенціалу регіонів України може надати розуміння сучасних процесів та їх регіональних паттернів, а також практичні результати та рекомендації для імплементацій полісімейкерами різних масштабних рівнів. Метою даної статті є визначення регіональних паттернів розвитку аграрного потенціалу та ідентифікація факторів, що вплинули на його регіональну нерівномірність у період пост-Майданної кризи та військового конфлікту. Дослідження фокусується на оцінці розвитку аграрного потенціалу регіонів України у 2015 та 2018 рр. Результати дослідження підтверджують, що спостерігаються просторова асиметрія та зростання регіональної дивергенції розвитку агропотенціалу. Виявлено, що відбулося посилення впливу соціально-економічного і виробничого факторів, та послаблення природно-ресурсного і макроекономічного факторів на розвиток агропотенціалу регіонів. Визначено траєкторії розвитку аграрного потенціалу регіонів, здійснено їх типізацію та виділено дев'ять типів траєкторій розвитку агропотенціалу регіонів України протягом пост-Майданної кризи та військового конфлікту. Запропоновано рекомендації щодо регіональної політики в аграрній сфері України для пом'якшення регіональної нерівномірності розвитку агропотенціалу. Враховуючи те, що в Україні існує проблема невідповідності інституційного середовища потребам розвитку аграрного потенціалу, важливого значення набувають інституційні трансформації, які мають орієнтуватись на гармонізацію ведення державної та регіональної політики в аграрній сфері з принципами ЄС.

Ключові слова: *регіональна нерівномірність; аграрний потенціал; індекс агропотенціалу; фактори; паттерни; Україна; пост-Майданна криза; військовий конфлікт*

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