Arakelova Inna Oleksandrivna,
Candidate of Economic Sciences, Docent,
Doctoral candidate of Donetsk State Univer-
sity of Management, 87513, Mariupol, Str.
Karpinskoho, 58, e-mail: iarakelova@gmail.
com, tel.: +38 050 608 76 04, https://orcid.
org/0000-0001-9582-793X

Аракелова Інна Олександрівна,
кандидат економічних наук, доцент, док-
торант Донецького державного універ-
ситета управління, м. Маріуполь, 87513,
м. Маріуполь, вул. Карпінського, 58, e-mail:
iarakelova@gmail.com, тел.: +38 050 608
76 04, https://orcid.org/0000-0001-9582-
793X

Аракелова Инна Александровна,
кандидат экономических наук, доцент, докторант Донецкого государственного уни-
верситета управления, г. Мариуполь, 87513, ул. Карпинского, 58, e-mail: iarakelova@
gmail.com, тел.: +38 050 608 76 04, https://orcid.org/0000-0001-9582-793X

THE STUDY OF THE INFLUENCE OF FORCED MIGRATION PROCESSES ON PARTICULAR SOCIO-DEMOGRAPHIC INDICATORS OF TERRITORY SECURITY BASED ON NEURAL NETWORKS

Annotation. The paper deals with the topical problem of studying the impact of migration processes of internally displaced persons on certain socio-demographic indicators of regional security. This problem became particularly important after the beginning of armed aggression on the territory of Ukraine in 2014, which led to a rapid increase in internal migration processes. In particular, the dynamics of change of the following indicators was analysed: demographic burden, unemployment rate, the volume of remittances and proximity to the line of demarcation.

As a result of the study, the author constructed a neural network of the Korhonen map type. The model divided the training sample from the regions of the country into six clusters according to the level of four indicators of socio-demo-

graphic security. This allowed us to assess the impact of forced internal migration on some aspects of socio-economic security of the regions. Based on the obtained Korhonen map, it is shown that the Donetsk and Luhansk Oblasts, which directly border the Joint Forces Operation (JFO) zone, had a catastrophic increase in the demographic burden and unemployment rate during the study period. The volume of remittances of migrants has also decreased several times. The level of socio-economic security of the regions of the sixth cluster was selected as dangerous according to the selected indicators. The obtained results can be used for the formation of regional socio-economic policy and the corresponding national demographic and migration policy. The cluster analysis process and the proposed system of indicators make it possible to constantly monitor and assess the impact of forced internal migration processes on certain aspects of socio-economic security of regions.

Keywords: socio-demographic security, demographic burden, unemployment rate, demarcation line, Korhonen map, cluster.

ДОСЛІДЖЕННЯ ВПЛИВУ ПРОЦЕСІВ ВИМУШЕНОЇ МІГРАЦІЇ НА ОКРЕМІ СОЦІАЛЬНО-ДЕМОГРАФІЧНІ ПОКАЗНИКИ БЕЗПЕКИ ТЕРИТОРІЙ НА ОСНОВІ НЕЙРОННИХ МЕРЕЖ

Анотація. Роботу присвячено актуальній проблемі дослідження впливу процесів міграції внутрішньо переміщених осіб на окремі соціально-демографічні показники безпеки регіонів. Особливого значення ця проблема набула після початку збройної агресії на території України у 2014 р., що призвело до стрімкого зростання процесів внутрішньої міграції. Зокрема, проаналізовано динаміку зміни наступних показників: демографічне навантаження, рівень безробіття, обсяг грошових переказів, близькість розташування до лінії розмежування.

У результаті проведеного дослідження автором було побудовано нейронну мережу типу карти Кохонена. Модель розподілила навчальну вибірку з регіонів країни на шість кластерів за рівнем чотирьох показників соціально-демографічної безпеки. Це дозволило оцінити вплив процесів вимушеної внутрішньої міграції на деякі аспекти соціально-економічної безпеки регіонів. На основі отриманої карти Кохонена показано, що Донецька та Луганська області, які безпосередньо межують із зоною ООС, мали катастрофічне зростання демографічного навантаження та рівня безробіття протягом досліджуваного періоду. Також у кілька разів скоротились обсяги грошових переказів мігрантів. Рівень соціально-економічної безпеки регіонів шостого кластеру за обраними показниками був визначений як небезпечний. Отримані результати можуть бути використані для формування регіональної соціально-економічної політики і відповідних національної демографічної та міграційної політик. Процес кластерного аналізу та запропонована система показників дозволяють здійснювати постійний моніторинг та оцінку впливу процесів вимушеної внутрішньої міграції на окремі аспекти соціально-економічної безпеки регіонів.

ИССЛЕДОВАНИЕ ВЛИЯНИЯ ПРОЦЕСОВ ВЫНУЖДЕННОЙ МИГРАЦИИ НА ОТДЕЛЬНЫЕ СОЦИАЛЬНО-ДЕМОГРАФИЧЕСКИЕ ПОКАЗАТЕЛИ БЕЗОПАСНОСТИ ТЕРИТОРИЙ НА ОСНОВЕ НЕЙРОННЫХ СЕТЕЙ

Аннотация. Работа посвящена актуальной проблеме исследования влияния процессов миграции внутренне перемещенных лиц на отдельные социально-демографические показатели безопасности регионов. Особое значение эта проблема приобрела после начала вооруженного конфликта на территории Украины в 2014 г., который привел к стремительному росту процессов внутренней миграции. В частности, проанализирована динамика изменения следующих показателей: демографическая нагрузка, уровень безработицы, объем денежных переводов, близость расположения к линии разграничения.

В результате проведенного исследования автором было построено нейронную сеть типа карты Кохонена. Модель распределила обучающую выборку из регионов страны на шесть кластеров по уровню четырех показателей социально-демографической безопасности. Это позволило оценить влияние процессов вынужденной внутренней миграции на некоторые аспекты социально-экономической безопасности регионов. На основе полученной карты Кохонена показано, что Донецкая и Луганская области, которые непосредственно граничат с зоной ООС, имели катастрофический рост демографической нагрузки и уровня безработицы в течение исследуемого периода. Также в несколько раз сократились объемы денежных переводов мигрантов. Уровень социально-экономической безопасности регионов шестого кластера по выбранным показателям был определен как опасный. Полученные результаты могут быть использованы для формирования региональной социально-экономической политики и соответствующих национальной демографической и миграционной политик. Процесс кластерного анализа и предложенная система показателей позволяют осуществлять постоянный мониторинг и оценку влияния процессов вынужденной внутренней миграции на отдельные аспекты социально-экономической безопасности регионов.

Ключевые слова: социально-демографическая безопасность, демографическая нагрузка, уровень безработицы, линия разграничения, карта Кохонена, кластер.

Problem statement. The annexation of the Crimea and the deployment of armed aggression in the East in 2014 caused significant demographic and social changes in the life of the regions: led to a significant destruction of industrial, transport and social infrastructure, increased environmental risks. Particularly large changes have taken place in the oblasts directly bor-

dering the JFO zone (Luhansk and Donetsk). There have been dramatic changes in the state of the economy of these regions, which accounted for about a quarter of industrial production and a large share of Ukraine's exports. These processes have negatively affected the overall and safe life of millions of people. The decline in production and the massive closure of small and medium-sized businesses resulted in large-scale job cuts. In Ukraine, the processes of internal forced migration have begun.

Consequently, the problem of studying the impact of forced migration processes on certain socio-demographic indicators of territorial security remains relevant, but not sufficiently studied.

Analysis of recent researches and publications. The processes of forced migration of Internally Displaced Persons (IDP) have an impact on almost all spheres of society, and most of all on the demographic, social, economic, labour and financial markets. Undoubtedly, these processes affect the level of socio-economic security of the country and regions, in particular its socio-demographic component. But, despite the significant amount of research to study the IDP social or demographic, the issue of quantifying the impact of forced migration on the level of socio-economic security in the regional context remains beyond the attention of scientists.

O. Homra argued that migration is a natural manifestation of human mobility, motivated by the desire to improve the conditions of their existence, fuller and more reliable satisfaction of their needs, is migration [1].

Research of problems of freedom of movement of the person, reproduction of the population, migration processes, legal, political, demographic, social aspects of these processes and methods of management were studied at different times by such domestic scientists as O. Hladun, T. Hnatiuk, T. Dragunova, O. Ivankova-Stetsiuk, O. Piskun, I. Prybytkova, Y. Rymarenko, U. Sadova, and P. Shushpanova. E. Libanova studied human development, primarily its socio-demographic problems.

Among foreign scholars who have made a significant contribution to the study of the theory of regional migration processes should be mentioned: W. Beck W. Sombart, E. Lee, N. Luhmann, P. Pedersen, J. Ravenna, O. Stark and A. Schutz.

Quantitative assessment of the scale of migration flows in the world is carried out by specialized organizations, in particular: The Department of Economic and Social Affairs of the United Nations (New York, USA) [2] and the Institute of Migration Policy (Washington, USA) [3]. In Ukraine, these issues are dealt with by the State Statistics Service [4].

Formulating goals (aim) of the article. The aim of this study is a thorough analysis of the impact of forced migration on certain socio-demographic indicators of security of territories and the subsequent formalization of the results based on the tools of artificial intelligence, including neural networks.

Presentation of the main research material. However, aspects of the impact of forced internal migration processes on the level of socio-economic security of the regions remain insuf-

ficiently studied. First of all, this issue concerns oblasts that share borders with them (Ukraine-controlled parts of Donetsk and Luhansk Oblasts, Kharkiv, Zaporizhzhia Oblasts), and Kyiv, where IDP see greater prospects for employment and social protection. To confirm this thesis, we present the structure of the distribution of IDP between the regions of Ukraine as of April 13, 2020 (Fig. 1).

The level of economic security of the country is characterized by many indicators. Therefore, in practice, integrated assessments are used, which would describe the change in the level of economic security of the country in the dynamics in comparison with the threshold values. It is the comparison of the quantified level of economic security of the country with the threshold values is the main task of the analysis of economic security.

The threshold value is a limit value, non-compliance with the values of which leads to the beginning of destructive actions and unregulated processes in various spheres of life of the country and its territories, to the formation of destabilizing tendencies, or even puts the system in crisis.

To determine the threshold values of indicators usually use the following methods [6–8]:

• Functional dependencies (macroeconomic/microeconomic analytical or statistical equations, Akhiezer-Goltz methods, information theory);

• Macroeconomic models that adequately reflect the effects of destabilizing factors for a particular country in the current period;

• Methods of expert assessments; taking into account the assessments of international organizations (comparison of the main macroeconomic indicators with the threshold values, which are accepted as values not lower than the world average);

• Assessment of the growth of economic growth of the country according to the main macroeconomic indicators and the dynamics of their change;

• Expert assessment methods and heuristic methods ('snowball'; analogue approach; calibration; scoring of the level of economic security and ranking of territories according to the degree of threats based on the analysis of actual indicators of economic security);

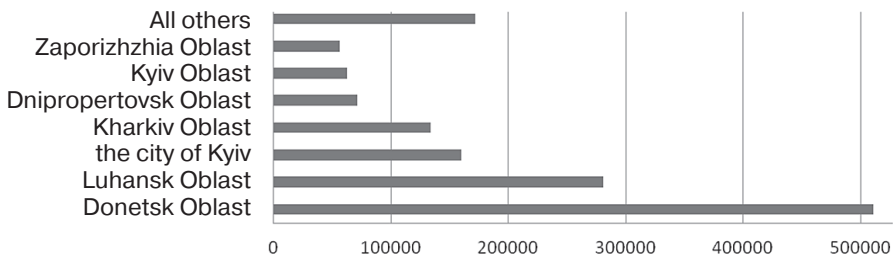• Method of analysis and processing of scenarios;

Fig. 1. **The IDP distribution by oblasts of Ukraine as of April 13, 2020**
Built by the author according to the data of the Office of the UN High Commissioner in Ukraine [5]

• Nonlinear dynamics (Wavelet analysis);

• Stochastic (Diagnosis: cluster analysis, fuzzy sets; t-criterion; logistic regression, multidimensional statistical analysis);

• Game-theoretical methods;

• Methods of utility theory;

• Image recognition methods;

• Legislative approach (setting thresholds at the legislative level) [9].

Usually, the first two methods are used, the others are used only in case of impossibility of their application.

Today in Ukraine at the legislative level there are methodological recommendations for calculating the level of economic security of the country, which essentially implements an indicative approach to assessing the vulnerability of the national economy and ultimately provide for the calculation of integrated assessment [10]. Compared to the abolished methodology, since 2007, the new development has a number of advantages, namely:

• Determination of the vector of limit values of integrated indicators;

• Setting weights to calculate the contribution of each sub-index to the integrated indicator by the principal components' method;

• Substantiation of the method of rotation of factor axes [6].

This technique has several known methodological and technical problems in determining the integrated indicator of economic security [6].

The classical indicative method is based on a comprehensive analysis of economic security indicators and consists of the following stages:

• Formation of a set of indicators;

• Determination of characteristic (optimal, threshold and limit) values of indicators;

• Normalization of indicators;

• Determination of weighting factors;

• Calculation of the integrated index.

To adequately describe the dynamics and assess the socio-economic security of the region because of the ongoing military conflict in the East, it is necessary to expand the relevant system of basic indicators. Let's define a set of indicators that will allow us to quantify the impact of forced internal migration on the socio-demographic component of security in the region. The author proposes to use the following specific criteria, namely:

• The growth rate of the demographic burden since the JFO beginning;

• The growth rate of unemployment, since the JFO beginning;

• The proximity of the region to the JFO zone;

• The growth rate of remittances from abroad, since the JFO beginning.

Let's analyse separately the impact of selected indicators on the level of socio-economic security of the region and their dynamics under the influence of forced internal migration.

In terms of the impact on the region's economy, the growing burden of the elderly population on the working population leads to a decrease in the natural recovery of labour resources and is a problem for the development of social production. If the share of retirees in the total population is growing, it causes the need for additional care for the elderly, leads to an increase in the economic cost of providing ser-

vices to support this category of people. To maintain and serve the elderly, it is necessary to increase unproductive costs [11].

According to the Office of the UN High Commissioner in Ukraine [5], the age structure of IDP varies greatly by region. The highest number of disabled people in the structure of IDP falls on the regions directly bordering the JFO zone and neighbouring regions. This significantly affects the level of demographic burden on the economically active population and the level of socio-economic security of these regions.

According to the definition of the State Statistics Committee, Demographic Burden (DB) is a generalized quantitative characteristic of the age structure of the population, which shows the load on society by unproductive population. The DB is given per thousand population, i.e. in permille (‰). Accordingly, the DB is calculated by the following formula:

$$DB = \frac{\text{Number of people aged 60 and over}}{\text{Population aged } 16-59}.$$

To confirm the assumption of a significant impact of forced internal migration processes after 2014 on the level of socio-economic security of individual regions, we construct a comparative table of the total DB and compare the dynamics of its change during the JFO period (Table).

Comparison of the Regions of Ukraine by the Level of Demographic Burden in the Period 01.01.2014 to 01.01.2019

The Region, in the DB Descending Order (01.01.2014)	The DB (01.01.2014)	The DB (01.01.2019)	The Region, in the DB Descending Order (01.01.2019)
1	2	3	4
Chernihiv Oblast	421	489	Luhansk Oblast
Cherkasy Oblast	393	480	Donetsk Oblast
Kirovohrad Oblast	385	459	Chernihiv Oblast
Donetsk Oblast	384	425	Cherkasy Oblast
Vinnytsia Oblast	378	421	Sumy Oblast
Poltava Oblast	376	416	Kirovohrad Oblast
Sumy Oblast	375	415	Zaporizhzhia Oblast
Luhansk Oblast	370	403	Poltava Oblast
Khmelnytskyi Oblast	365	402	Vinnytsia Oblast
Zaporizhzhia Oblast	364	399	Khmelnytskyi Oblast
Zhytomyr Oblast	355	396	Dnipropetrovsk Oblast
Dnipropetrovsk Oblast	354	385	Kharkiv Oblast
Kharkiv Oblast	346	384	Mykolaiv Oblast
Mykolaiv Oblast	338	383	Zhytomyr Oblast
Kyiv Oblast	337	380	Kherson Oblast
Kherson Oblast	334	361	Odesa Oblast
Ternopil Oblast	331	357	Kyiv Oblast

1	2	3	4
Odesa Oblast	326	357	Ternopil Oblast
Lviv Oblast	306	344	the city of Kyiv
Chernivtsi Oblast	302	343	Lviv Oblast
Ivano-Frankivsk Oblast	299	330	Ivano-Frankivsk Oblast
the city of Kyiv	295	327	Chernivtsi Oblast
Volyn Oblast	285	314	Volyn Oblast
Rivne Oblast	273	303	Rivne Oblast
Zakarpattia Oblast	258	286	Zakarpattia Oblast

Source: Built by the author based on data [4]

According to Table, we conclude that the areas that are geographically located in the immediate vicinity of the JFO zone during the period under review had rapid dynamics to the DB growth. In particular, the maximum growth rate is observed in Luhansk (+32,2 %) and Donetsk (+25 %) oblasts, which account for more than 50 % of the IDP total number. In comparison: the DB average growth rate in the country during this period was 11,7 %.

The growing demographic burden has adverse consequences, which in particular lead to a scattered investment as a result of their redistribution from manufacturing to social infrastructure, a reduction in savings as a result of increased household consumption.

Consider the following of the selected indicators: the Unemployment Rate (UR) among the IDP. It is quite natural that a significant increase in the IDP number leads to a proportional increase in the unemployment rate in the region. Analysis of data on the unemployment rate according to the methodology of the International Labour Organization (determines unemployment rate as a ratio (as a percentage) of the number of unemployed aged 15 and over to the labour force of the specified age or the relevant socio-demographic group) by regions during the JFO indicates the UR significant increase by regions bordering on the JFO zone. In particular, we have unprecedented growth of the indicator during the period under review in Luhansk (202 %) and Donetsk oblasts (59,5 %), with the UP average growth rate at 9,5 %, and in half of the oblasts, there was the UR reduction.

The third indicator that needs to be taken into account to assess the impact of forced internal migration processes on the level of socio-economic security of the region is the Proximity of the Location (PL) to the demarcation line, to the JFO zone. The objectivity and the need to take this indicator into account is unquestionable. However, the quantification of territories by distance from the line of demarcation is complicated by the lack of a clear methodology in international law for determining areas of armed tension in countries with military conflict [12]. Therefore, as part of this study, the author offers an expert assessment of this indicator, which will be determined in points. The scale of the PL indicator varies from 1 to 4 and is adjusted according to the regions ac-

cording to the geographical distance from the demarcation line from the maximum value for regions directly bordering the JFO zone (Donetsk and Luhansk oblasts) to the minimum for regions far from the JFO zone. The PL level is equal to three in the regions bordering on regions with the PL level equal to 4 (Dnipropetrovsk, Zaporizhzhia and Kharkiv Oblasts). The PL = 2 for the regions adjacent to the data (Kirovograd, Mykolaiv, Poltava, Sumy and Kherson Oblasts) and PL = = 1 for all others.

The last indicator that the author proposes to take into account in the process of cluster analysis of the dynamics of individual indicators of socio-economic security of regions under the influence of forced migration of the IDP is the Growth Rate of Remittances (GRR). This is the only selected indicator that reflects the positive impact of IDP migration on regional security.

The realities of today show that in the context of declining investment attractiveness, as well as military-political conflict, the growing rate of remittances and investments of the IDP forced to work abroad can become a stable and long-term resource for regional economic development [13].

The available data of the National Bank of Ukraine allows us to study the regional distribution of only part of remittances to Ukraine that comes through international payment systems (Western Union, Golden Crown, MoneyGram, etc.). Therefore, this study is limited to official statistics and will not make assumptions about the number of remittances through other revenue channels. This approach will form a statistical sample to build a mathematical model that meets the principles of comparability.

Based on the analysis of available statistical information, we see a tendency to increase the GRR in the regions that account for the IDP majority. An important exception is Donetsk and Luhansk Oblasts. They show a decrease in the GRR revenues. Therefore, it means that there is no positive effect from the processes of forced internal migration in this indicator. This is due to the IDP highest levels in regions where more than half of the IDP are retired. Conversely, the majority of the IDP economically active population was registered in Kyiv, where the GTT grew by 309 % during the period under review.

Let's generalize the obtained data. Based on statistical information about the dynamics of the selected indicators, we will conduct a cluster analysis of their impact on the level of socioeconomic security of regions based on a neural network such as the Korhonen map. Korhonen map implements one of the methods of cluster analysis [14].

This neural network is a single layer of neurons organized in the form of a two-dimensional matrix. This makes it possible to obtain a visual image of multidimensional input data. The Korhonen map allows clustering of research objects and further analysis of neuronal weights and distribution of examples by clusters.

According to the simulation results, the author obtained a Korhonen map, which divides the sample of 25 elements (24 oblasts and the city of Kyiv) into clusters according to the level of selected indicators that characterize certain aspects of the impact of forced

internal migration on socio-economic security of regions (Fig. 2) [15].

Let's analyse the results. Regions of Ukraine were distributed by clusters according to the values of the selected indicators on 01.01.2014 as follows:
- Cluster #1: Magarpatta Oblast, Zaporizhzhia Oblast, Ivano-Frankivsk Oblast, Kyiv Oblast, Mykolaiv Oblast, Sumy Oblast, Ternopil Oblast;
- Cluster #2: Volyn Oblast, Rivne Oblast, Kherson Oblast, Khmelnytskyi Oblast, Cherkasy Oblast, Chernivtsi Oblast;
- Cluster #3: Dnipropetrovsk Oblast, Donetsk Oblast, Lviv Oblast, Luhansk Oblast, Odessa Oblast, Kharkiv Oblast;
- Cluster #4: Kirovograd Oblast, Chernihiv Oblast;
- Cluster #5: the city of Kyiv; and
- Cluster #6: Vinnytsia Oblast, Zhytomyr Oblast, Poltava Oblast.

Consider the obtained clusters following the selected indicators of socio-economic security and compare the change in the cluster structure of the training sample under the influence of forced internal migration (Fig. 2).

The highest level of security according to the selected indicators as of 01.01.2014 was observed in the city of Kyiv (Cluster #1), Dnipropetrovsk, Donetsk, Lviv, Luhansk, Odesa and Kharkiv Oblasts (Cluster #3). They were characterized by a combination of the lowest and average values of demographic burden, unemployment and remittances. This result is quite justified: the core of the third cluster consists of historically formed industrial regions of Ukraine, and the city of Kyiv is the financial and administrative centre of the country with all the relevant advantages and opportunities.
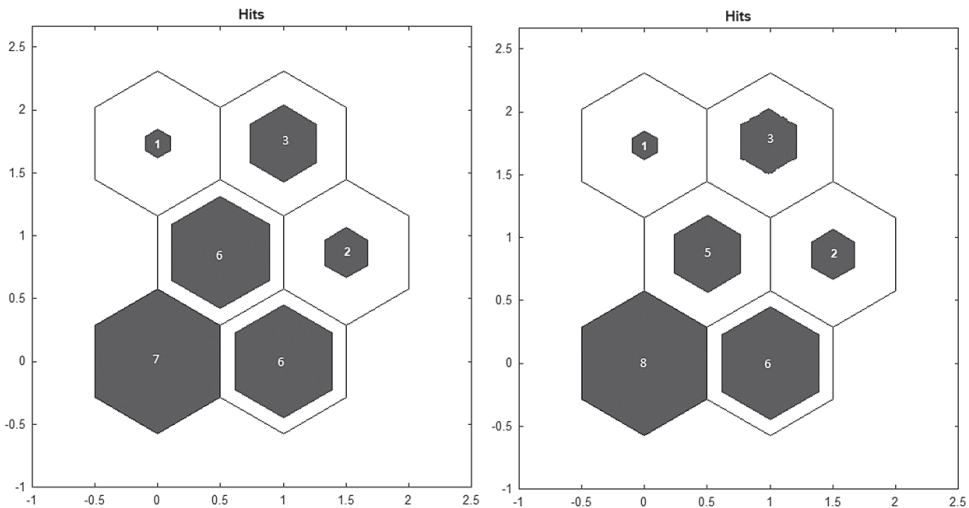

Fig. 2. **From left to right: Korhonen map, obtained as a result of modelling the distribution of regions of Ukraine by individual indicators of socio-economic security according to the data on 01.01.2014; Korhonen map, obtained as a result of modelling the distribution of regions of Ukraine by individual indicators of socio-economic security according to data as of 01.01.2019**
Source: Made by the author.

Cluster #1 is characterized by a stable level of security: it is the largest and includes areas with low unemployment, the demographic burden on the economically active population and the GRR high values, which significantly exceed the corresponding flows of foreign investment in the regions.

Slightly worse values of the studied indicators correspond to Cluster #2. The level of security of the areas included in it, according to the selected indicators, the author defines as below average. The worst situation with the DB, UR and GRR. They were typical on 01.01.2014 for Vinnytsia Oblast, Zhytomyr Oblast, Poltava Oblast (Cluster #6), Kirovohrad and Chernihiv Oblasts (Cluster #4). The latter two have the worst values of indicators, and therefore the level of socio-economic security is defined by the author as 'dangerous'. The level of socio-economic security of the regions of Cluster #6 was threatening.

Under the influence of the processes of forced internal migration in the cluster structure of the educational sample, there were changes. Regions of Ukraine were distributed by clusters according to the values of the selected indicators on 01.01.2019 as follows:

• Cluster #1: Vinnytsia Oblast, Zhytomyr Oblast, Zakarpattia Oblast, Rivne Oblast, Ternopil Oblast, Khmelnytskyi Oblast, Cherkasy Oblast, Chernivtsi Oblast;

• Cluster #2: Ivano-Frankivsk Oblast, Kyiv Oblast, Lviv Oblast, Mykolaiv Oblast, Odesa Oblast, Kherson Oblast;

• Cluster #3: Volyn Oblast, Kirovohrad Oblast, Poltava Oblast, Sumy Oblast, Chernihiv Oblast;

• Cluster #4: Donetsk Oblast, Luhansk Oblast;

• Cluster #5: the city of Kyiv; and

• Cluster #6: Zaporizhzhia Oblast, Dnipropetrovsk Oblast, Kharkiv Oblast.

According to the selected set of indicators, Donetsk and Luhansk Oblasts have a dangerous level of social and economic security (Cluster #4). Since the beginning of the military aggression in the east, which caused the IDP significant influx to these regions, their status has changed from 'the highest level of security' to 'dangerous'. The high share of the IDP in the structure of the IDP has led to a catastrophic increase in the demographic burden and the unemployment rate in the oblasts. Instead, there was no increase in remittances, the positive dynamics of which also directly depends on the number of the economically active population in the region. Besides, the regions directly border the JFO zone, which according to the proposed algorithm gives the territories the highest values of the PL indicator and reflects the additional risks associated with it.

According to the distribution, the level of security in Volyn Oblast, Kirovohrad Oblast, Poltava Oblast, Sumy Oblast and Chernihiv Oblasts remains threatening.

Under the influence of forced internal migration, the indicators of demographic burden and unemployment have increased significantly in Zaporizhzhia, Dnipropetrovsk and Kharkiv Oblasts. Also, the UR = 3 for these regions. Because of this, the trained neural network assigned them to one cluster. However, the level of socio-economic security of these regions re-

mains above average, in particular, due to the growth of remittance flows and low unemployment. The results obtained allow us to conclude that despite the proximity of the location to the demarcation line, the IDP significant number did not lead to a catastrophic decrease in the level of socio-economic security. One reason is the difference in the demographic structure of the IDP. Compared to Donetsk and Luhansk Oblasts, the regions of Cluster #6 have a ratio between people of working age and the retirement age of 80–90 % (8–9 people of working age per 10 pensioners), while in the fourth cluster the same figure is 24 % (Donetsk Oblast) and 17 % (Luhansk Oblast).

Cluster #5 has the highest level of security. It consists of one element of the educational sample as the city of Kyiv. Although the status of the safest region according to the chosen system of indicators has not formally changed; the positive effect of the IDP flow, since 2014 can be observed on the example of the city of Kyiv. The reason for this is again the demographic structure: the previously reported ratio between people of working age and retired person in IDP is 231 %. This means that one retired person has two people of working age. As a result, cash flows from migrants, low unemployment and the demographic burden have more than tripled.

Cluster #1 and Cluster #2 are characterized by a medium and high level of socio-economic security according to selected indicators.

Based on the generalized characteristics in the form of average values of characteristics within each of the six clusters, the author constructed a scattering diagram in the coordinate system 'unemployment rate-demographic burden', which clearly demonstrates the component of socio-demographic security of each group. The size of the item on the chart corresponds to the average amount of remittances in the cluster. The arrow indicates the vector of deterioration of the level of the socio-demographic component of security in the regions that make up the corresponding cluster (Fig. 3).

The obtained average values of indicators of the unemployment rate, demographic burden, the volume of remittances of migrants and the proximity of their location to the demarcation line confirm the conclusions obtained by the author regarding the impact of forced internal migration processes on certain aspects of the level of socio-demographic security of regions.

The situation in the east of the country requires additional research on the conceptual approach to assessing the level of economic security of the regions. In the light of these events, it becomes clear that adequate management of the security of the regional economy is impossible without taking into account the risks of significant fluctuations in its indicators under the influence of forced internal migration processes.

Conclusions and prospects for further researches. As a result of the study, the author constructed a neural network of the Korhonen map type. The model divided the training sample from 25 regions (24 oblasts and the city of Kyiv) into six clusters according to the level of four indicators of social and demographic security. This allowed us to assess the impact of forced internal
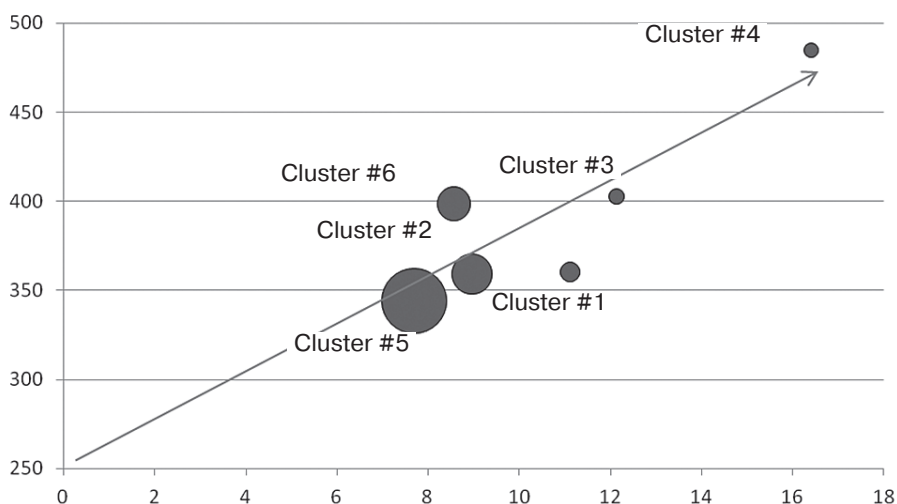
Fig. 3. **Diagram of scattering of the generalized characteristics of separate indicators of social and economic safety of regions on clusters of the Korhonen map on data of 2019**

Source: Made by the author.

migration on some aspects of socio-economic security of the regions. Based on the obtained Korhonen map, it is shown that the Donetsk and Luhansk Oblasts, which directly border the JFO zone, had a catastrophic increase in the demographic burden and unemployment rate during the study period. The volume of remittances of migrants has also decreased several times. The level of socio-economic security of the regions of the sixth cluster was selected as dangerous according to the selected indicators. In contrast, in the city of Kyiv, which has significant volumes of the IDP arrivals, an increase in the level of socio-economic security was recorded in the selected indicators. This is due to the demographic structure of IDP in the region. The ratio between people of working age and retired persons in IDP is 231 %. As a result, the volume of cash flows from migrants, low unemployment and demographic burden have more than tripled.

The level of security of the oblasts bordering Donetsk Oblast and Luhansk Oblast remains consistently high during the period under review. They did not record the catastrophic impact of forced internal migration processes, but there was an increase in the demographic burden indicator.

The obtained results can be used for the formation of regional socio-economic policy and the corresponding national demographic and migration policy. The cluster analysis process and the proposed system of indicators make it possible to constantly monitor and assess the impact of forced internal migration processes on certain aspects of socio-economic security of regions.

REFERENCES

1. Khomra O. U. (2005) Migranty Ukrayiny v socialno-ekonomichnomu vymiri [Migrants of Ukraine in the socio-economic dimension]. *Strategichna*

panorama — *Strategic panorama*, 3, 171–179 [in Ukrainian].

2. United Nations Department of Economic and Social Affairs Retrieved. *www.un.org*. from: //www.un.org/en/development/desa/index.html. [in English].

3. Migration policy institute. http://*www. migrationinformation.org*. Retrieved from: //www. migrationinformation.org/programs/data-hub/maps-immigrants-and-emigrants-around-world. [in English].

4. Sajt Derzhavnoyi sluzhby statystyky Ukrayiny. *http://www.ukrstat.gov.ua*. Retrieved from: //www.ukrstat.gov.ua. [in Ukrainian].

5. Sajt agentstvo OON u spravax bizhenciv v Ukrayini. *https://www.unhcr.org*. Retrieved from: //www.unhcr.org/ua/resources. [in Ukrainian]

6. Yu. M. Xarazishvili, A. I. Suxorukov & T. P. Krupelnyczka. (2013). Shhodo vdoskonalennya metodologiyi integralnogo ocinyuvannya rivnya ekonomichnoyi bezpeky` Ukrayiny: Analitychna zapyska [Regarding the improvement of the methodology of integrated assessment of the level of economic security of Ukraine: Analytical note]. *http://www.niss.gov.ua*. Retrieved from: //www.niss.gov.ua/articles/1358/. [in Ukrainian]

7. Intrylygator M. (1975). *Matematycheskye metody optymyzacyy y ekonomycheskaya teoryy*. [*Optimization Mathematical Methods and Economic Theory*]. Moscow: Progress. [in Russia].

8. Strelchenko I. I. (2015). Modelling an effective sales strategy of enterprise, that selling products at the domestic market and abroad. *Actual Economic Problem*. 6, 469–475. [in English]

9. Olejnykov E. A. (Eds.) (1997). *Osnovy ekonomycheskoj bezopasnosty (Gosudarstvo, regyon, predpryyatye, lychnost)*. [*Fundamentals of economic security (State, region, enterprise, personality)*]. Moscow: By'znes-shkola "Intel-Syntez". [in Russia].

10. Pro zatverdzhennya Metodychnyh rekomendacij shhodo rozraxunku rivnya ekonomichnoyi bezpeky Ukrayiny. № 1277 vid 29.10.2013. [About the consolidated Methodical Recommendations for the development of the level of economic security of Ukraine. № 1277 of 29.10.2013] p. n.d. *http://ligazakon.ua*. Retrieved from: //search.ligazakon.ua/l_doc2.nsf/link1/ME131588.html. [in Ukrainian]

11. Stativka N. V. & A. A. Smaglyuk. (2011). Demografichna skladova ekonomichnoyi bezpeky Ukrayiny. [Demographic component of economic security of Ukraine]. *Teoriya ta praktyka derzhavnogo upravlinnya*. [*Theory and practice of public administration*]. 1, 280–287. [in Ukrainian]

12. Bartels R. (2009). Timelines, borderlines and conflicts. The historical evolution of the legal divide between international and non international armed conflicts. *International Review of the Red Cross*. 873, 35–67. [in English]

13. Gajduczkyj A. (2015). Z tretogo svitu v pershyj — zavdyaky groshovym perekazam migrantiv. [From the third world to the first — due to remittances of migrants]. n.d. *http://dt.ua/finances*. Retrieved from: //dt.ua/finances/z-tretogo-svitu-v-pershiy-zavdyaki-groshovim-perekazam-migrantiv-_.html. [in Ukrainian].

14. Kohonen T. (2001). Self-Organizing Maps. New York. [in English]

СПИСОК ВИКОРИСТАНИХ ДЖЕРЕЛ

1. *Хомра О. У.* Мігранти України в соціально-економічному вимірі / О. У. Хомра // Стратегічна панорама. 2005. № 3. С. 171–179.

2. United Nations Department of Economic and Social Affairs [Електронний ресурс]. Режим доступу: http://www.un.org/en/development/desa/index.html

3. Migration policy institute [Електронний ресурс]. Режим доступу: http://www. migrationinformation.org/programs/data-hub/maps-immigrants-and-emigrantsaround-world

4. Державна служба статистики України. Офіційний веб-сайт. [Електронний ресурс]. Режим доступу: http://www.ukrstat.gov.ua

5. Агентство ООН у справах біженців. Офіційний веб-сайт [Електронний ресурс]. Режим доступу: https://www.unhcr.org/ua/resources

6. *Харазішвілі Ю. М.* Щодо вдосконалення методології інтегрального оцінювання рівня економічної безпеки України: Аналітична записка / Ю. М. Харазішвілі, А. І. Сухоруков, Т. П. Крупельницька. НІСД, вересень 2013 р. [Електронний ресурс]. Режим доступу: http://www.niss.gov.ua/articles/1358/

7. *Интрилигатор М.* Математические методы оптимизации и экономическая теория: пер. с англ. / под ред. А. А. Конюса. М. : Прогресс, 1975. 599 с.

8. *Strelchenko I. I.* Modelling an effective sales strategy of enterprise, that selling products at the domestic market and abroad / I. I. Strelchenko // Actual Economic Problem. 2015. № 6.

9. Основы экономической безопасности (Государство, регион, предприятие, личность) / под ред. Е. А. Олейникова. М.: ЗАО "Бизнес-школа "Интел-Синтез", 1997. 288 с.

10. Про затвердження Методичних рекомендацій щодо розрахунку рівня економічної безпеки України № 1277 від 29.10.2013 р. [Електронний ресурс]. Режим доступу: http://search.ligazakon.ua/l_doc2.nsf/link1/ME131588.html

11. *Статівка Н. В.* Демографічна складова економічної безпеки України / Н. В. Статівка, А. А. Смаглюк // Теорія та практика державного управління. 2011. Вип. 1. С. 280–287.

12. *Bartels R.* Timelines, borderlines and conflicts. The historical evolution of the legal divide between international and non international armed conflicts / International Review of the Red Cross, Volume 91, n°873, March 2009, p. 35–67.

13. *Гайдуцький А.* З третього світу в перший — завдяки грошовим переказам мігрантів / А. Гайдуцький // Зеркало недели. 2015. Вип. 19 [Електронний ресурс]. Режим доступу: https://dt.ua/finances/z-tretogo-svitu-v-pershiy-zavdyaki-groshovim-perekazam-migrantiv-_.html

14. *Kohonen T.* Self-Organizing Maps (Third Extended Edition), New York, 2001, 501 p.

15. *Arakelova I.* (2020). The influence of the internally displaced persons forced migration on the dynamics of regional social and economic security indicators // Economic Annals-XXI, 182(3–4), 4–14. [in English].