ПРОБЛЕМИ ПРИЙНЯТТЯ РІШЕНЬ ТА УПРАВЛІННЯ В ЕКОНОМІЧНИХ, ТЕХНІЧНИХ, ЕКОЛОГІЧНИХ І СОЦІАЛЬНИХ СИСТЕМАХ

UDC 338.27:311.16
DOI: 10.20535/SRIT.2308-8893.2023.2.04

ASSESSMENT OF THE ECONOMICAL DIMENSION OF SUSTAINABLE DEVELOPMENT OF THE UKRAINE'S REGIONS BASED ON THE BRIGHTNESS OF NIGHT LIGHTS

M. ZGUROVSKY, K. YEFREMOV, S. GAPON, I. PYSHNOGRAIEV

Abstract. When assessing the level of development of territories, the problem of finding objective qualitative data that will characterize it arises. One of the possible sources of such data is the remote sensing of the Earth (RSE). The article is devoted to the analysis of the possibility of using the product of RSE – the map of night lights, for modeling the economical dimension of the sustainable development of the regions of Ukraine. Using the regression and correlation analysis and neural networks, appropriate models for assessing the level of economic development of the Kherson region, Donetsk region, and the AR of Crimea were obtained. The study was carried out by the team of the World Data Center for Geoinformatics and Sustainable Development of the Igor Sikorsky Kyiv Polytechnic Institute. It was part of research on the analysis of the behavior of complex socio-economic systems and processes of sustainable development in the context of the quality and safety of people's lives.

Keywords: sustainable development, spatial data analysis, economical development, night lights, mathematical modeling.

INTRODUCTION

The effectiveness and quality of management decisions regarding the behavior of complex socio-economic and security systems depends on the completeness and adequacy of the assessment of the management situation. For the construction of such an estimate, an important factor is the quality of the data used during the study.

In this study, a system is understood as a territory that is either an object of management or an environment for a certain management situation. During the assessment of the level of development of territories, the problem of finding objective qualitative data that will characterize it arises. One of the possible sources of such data is the application of remote sensing of the Earth (RSE).

The study is devoted to the analysis of the possibility of using one of the products of the RSE — the map of night lights, for modeling the economical dimension of sustainable development of the regions of Ukraine and other administrative-territorial entities.

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The possibilities of using the map of night lights were considered by various scientists. In particular, at the global level, Jiansheng Wu et al. [1] investigated the relationship between GDP and night lights using 15 years of observations. In [2], the authors reviewed the indicators determining Human Well-Being for 2006 and showed the existing relationship with night lights. At the regional level, there were similar studies for the population of Japan [3] and Ukraine [4], the level of urbanization and GRP of the regions of China [5; 6], etc.

In a previous study [7], the spatial correlation of indicators of sustainable development and the brightness of night lights according to the data of 2011 was considered. The preservation of zonal trends with the components of the quality and safety of people's lives, the Index of the economical dimension, the Competitiveness Index and the Sustainable Development Index of Ukraine's regions was confirmed.

This study, in contrast to the results of foreign scientists, investigates the possibility of an integral assessment of the level of economic development based on maps of night lights at the regional level in dynamics, and also presents models for determining the level of economic development of the regions of Ukraine for the first time.

The study was carried out by the team of the World Data Center for Geoinformatics and Sustainable Development of the Igor Sikorsky Kyiv Polytechnic Institute and was part of research on the analysis of the behavior of complex socio-economic systems [8] and sustainable development processes in the context of the quality and safety of people's lives [9; 10; 11].

METHODOLOGY FOR CALCULATING THE INDEX OF BRIGHTNESS OF NIGHT LIGHTS OF THE UKRAINE'S REGIONS

The maps of night lights (Fig. 1) used in the study are the result of data processing by the Department of Geological and Atmospheric Sciences, Iowa State University [12] on artificial illumination of the Earth's surface at night from the sources of the Earth Observation Group, Colorado School of Mines [13].

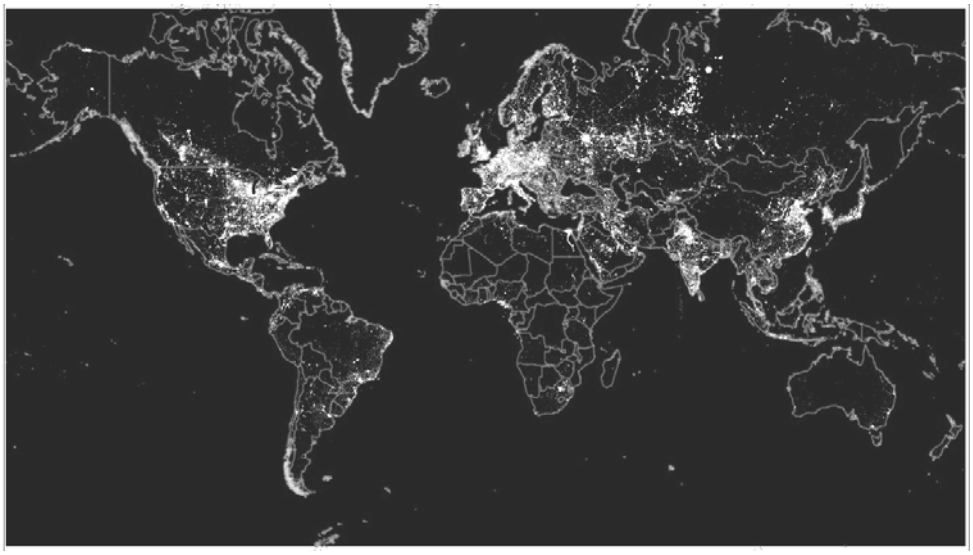


Fig. 1. Map of night lights (raster image (composite) of artificial night luminosity of the Earth's surface) for 2013

The Night Light Brightness Index was calculated for the territory of Ukraine and each of its regions for the period 2004 — September 2022 (monthly available data is presented for 2022). For this, a vector mask of the borders of countries and regions and their urbanized territories was created on the night luminance maps. Geospatial calculation functions averaged indicators within each urbanized area of each region. The Night Light Brightness Index of an administrative-territorial formation is the sum of the values for the illumination of each cell of the map within the urbanized territories reduced to the area of the administrative-territorial formation:

$$I_i^j = \frac{\sum_{k=1}^{K_i} L_{i,k}^j}{S_i},$$

where i — number of the administrative-territorial formation; j — year of calculation; I_j^i — the value of the Night Lights Brightness Index; S_i — the area of the administrative-territorial formation in km^2; K_i — the number of cells, the brightness of which is counted to the i-th administrative-territorial formation; $L_{i,k}^j$ — the brightness of the k-th cell of the i-th administrative-territorial entity for the j-th year, which is measured in the range from 0 to 63.

Thus, the regions with the highest values of luminosity in their urbanized territories received the highest values of the Night Lights Brightness Index, and vice versa, the regions with the lowest values of luminosity in their urbanized territories — the lowest. The method of zonal statistics was used to calculate the sum of the values of the raster cells within the vector masks.

The result of calculations of the Night Lights Brightness Index for regions of Ukraine is presented in the Table 1 and in Fig. 2.

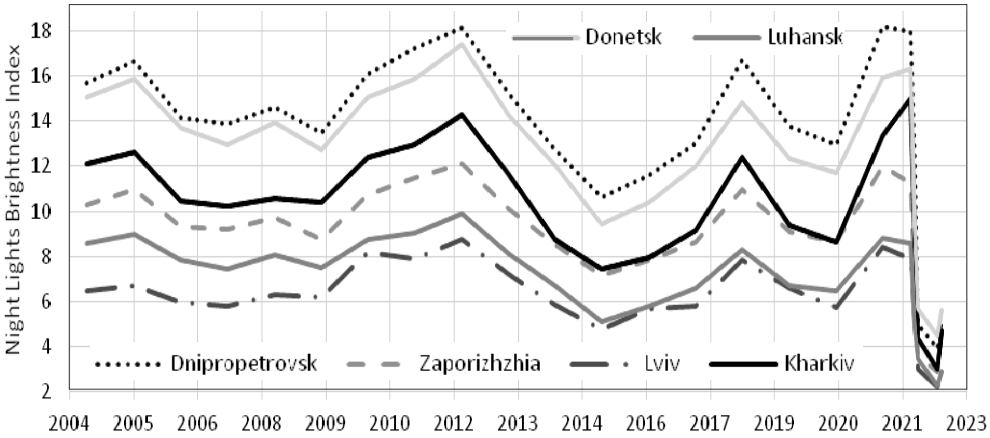


Fig. 2. Evaluation of the brightness of the urbanized territories of the regions of Ukraine from 2004 to September 2022 (monthly available data is presented for 2022)

THE NIGHT LIGHTS BRIGHTNESS INDEX ANALYSIS

The Night Lights Brightness Index had a decreasing trend several times:

– global economic crises (2006–2009);
– annexation of territories of Ukraine in 2014;
– the pandemic of COVID-19;
– the Russia's invasion on the territory of Ukraine in 2022.

Table 1. Evaluation of the brightness of the urbanized territories of the regions of Ukraine from 2007 to 2022*

Region	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022/1	2022/2	2022/3	2022/8	2022/9
AR of Crimea	5.15	5.41	4.78	5.99	6.16	6.88	5.74	4.60	3.87	4.22	4.90	6.01	5.46	5.22	7.40	7.44	5.73	4.31	3.33	4.14
Cherkasy	5.66	5.85	5.51	7.57	7.45	8.66	7.08	4.96	3.92	4.51	4.95	7.02	5.31	4.84	7.65	6.92	4.68	2.66	1.96	2.55
Chernihiv	6.94	7.36	6.97	8.87	9.12	9.90	8.18	6.69	5.43	6.08	6.65	8.65	7.14	6.52	9.36	8.67	5.35	2.57	1.89	2.97
Chernivtsi	4.15	4.56	4.83	5.73	5.64	6.46	5.43	3.14	2.30	2.96	2.96	4.51	3.55	3.04	4.40	3.64	2.80	1.38	1.12	1.39
city Sevastopol	10.55	10.78	10.16	11.39	12.07	13.13	11.81	10.97	10.30	10.51	11.38	12.93	11.97	11.55	13.92	25.52	27.37	20.63	16.91	18.28
Dnipropetrovsk	13.88	14.61	13.48	16.07	17.23	18.14	15.24	12.71	10.63	11.61	13.04	16.70	13.77	12.95	18.22	17.99	12.16	5.02	3.91	5.20
Donetsk	12.93	13.90	12.76	15.09	15.86	17.42	14.26	12.07	9.42	10.39	11.98	14.86	12.34	11.74	15.93	16.34	9.26	5.68	4.51	5.64
Ivano-Frankivsk	4.74	5.36	5.68	6.93	6.28	7.69	6.06	3.53	2.81	3.32	3.39	5.25	4.03	3.65	5.70	5.76	3.83	1.83	1.21	1.79
Kharkiv	10.25	10.60	10.40	12.38	12.97	14.26	11.64	8.75	7.44	7.96	9.17	12.37	9.40	8.64	13.38	15.00	8.74	4.35	3.01	4.71
Kherson	6.87	7.27	6.49	7.97	8.46	8.95	7.57	6.34	5.45	5.83	6.49	8.11	6.88	6.55	8.93	8.99	5.54	2.53	2.09	2.89
Khmelnytskiy	6.39	6.69	6.40	8.87	8.91	10.19	8.43	5.91	4.81	5.45	6.00	8.55	6.58	5.95	9.27	8.28	5.88	3.25	2.41	3.10
Kirovohrad	9.68	9.99	9.19	11.51	11.97	13.46	11.00	8.77	7.25	8.05	9.00	11.63	9.39	8.75	12.93	12.67	7.85	3.74	2.93	4.19
Kyiv	7.02	7.34	7.03	9.67	9.60	11.24	9.33	7.11	5.75	6.64	7.10	10.00	7.88	7.10	10.82	10.38	7.54	3.11	2.27	4.50
Kyiv city	77.62	76.17	72.72	84.49	84.41	91.10	85.63	86.35	79.17	85.33	84.16	96.83	91.22	87.62	97.84	127.43	110.01	41.59	36.05	35.65
Luhansk	7.46	8.05	7.48	8.78	9.05	9.91	8.13	6.68	5.09	5.80	6.61	8.30	6.71	6.45	8.83	8.61	4.77	3.45	2.25	2.90
Lviv	5.77	6.32	6.19	8.16	7.89	8.75	7.23	5.84	4.78	5.69	5.77	7.86	6.59	5.72	8.42	7.90	5.08	3.02	2.20	2.64
Mykolayiv	8.24	8.49	7.91	9.98	10.53	11.58	9.46	7.28	6.03	6.57	7.52	9.97	7.87	7.33	11.15	11.72	7.50	4.02	3.12	4.23
Odesa	6.74	6.85	6.46	8.17	8.62	9.52	7.91	5.86	4.92	5.28	6.01	8.20	6.55	6.13	9.09	10.03	6.72	3.53	2.84	3.97
Poltava	7.51	7.66	7.75	9.81	9.92	11.22	9.09	6.65	5.57	6.16	6.82	9.41	7.43	6.58	10.45	8.87	6.63	3.25	2.42	3.13
Rivne	4.21	4.41	4.02	5.88	5.80	6.89	5.48	3.87	2.99	3.64	3.83	5.90	4.40	3.97	6.31	5.51	3.90	2.21	1.63	2.14
Sumy	7.04	7.28	7.33	9.12	9.20	10.39	8.37	6.33	5.23	5.76	6.38	8.75	6.88	6.25	9.70	11.20	6.79	3.20	2.36	4.87
Ternopyl	4.97	5.33	5.35	7.11	7.06	8.43	6.74	4.36	3.44	4.11	4.33	6.56	4.91	4.40	7.05	6.20	4.23	2.26	1.66	2.25
Vinnytsya	6.58	6.81	6.53	8.70	8.68	10.23	8.36	5.98	4.74	5.39	5.95	8.50	6.47	5.81	9.26	8.84	6.52	3.51	2.40	3.34
Volyn	3.89	4.15	3.80	5.50	5.36	6.16	5.00	3.58	2.83	3.45	3.63	5.26	4.20	3.78	5.85	5.24	3.51	2.07	1.55	1.94
Zakarpattya	3.60	3.95	3.92	4.55	4.72	5.32	4.41	3.06	2.53	3.13	3.22	4.09	3.72	3.24	4.66	4.84	3.64	2.33	1.82	1.93
Zaporizhzhya	9.19	9.75	8.75	10.73	11.47	12.14	10.12	8.52	7.17	7.84	8.62	10.97	9.08	8.66	12.02	11.23	6.93	3.56	2.92	3.92
Zhytomyr	5.27	5.41	5.15	7.04	7.11	8.39	6.65	4.89	3.95	4.53	4.94	7.20	5.36	4.94	7.76	8.13	5.41	2.50	1.79	2.90

* Monthly available data is presented for 2022

The Night Lights Brightness Index for the territory of Ukraine in 2018 (Fig. 3) grew by 64% compared to 2015 and amounted to 9.225 and 5.599, respectively. In 2021, the historical maximum of the index for the studied period was observed and amounted to 10.083. The minimum is 2.577 in August 2022 which was reached due to consequences of the Russia's military actions.

Fig. 3. Map of night lights (raster image (composite) of artificial night luminosity of the Earth's surface) of the regions of Ukraine for 2015

Only in four regions (Kyiv city, Sevastopol city, Kherson and Kyiv regions) the brightness of night lights was the lowest in 2009 as a result of the global economic crisis, and in all other regions — in 2015 (if we excluded 2022).

In Kyiv city, unlike other regions, had a growing trend till January 2022. The dynamics of the brightness index is shown in Fig. 4, 5.

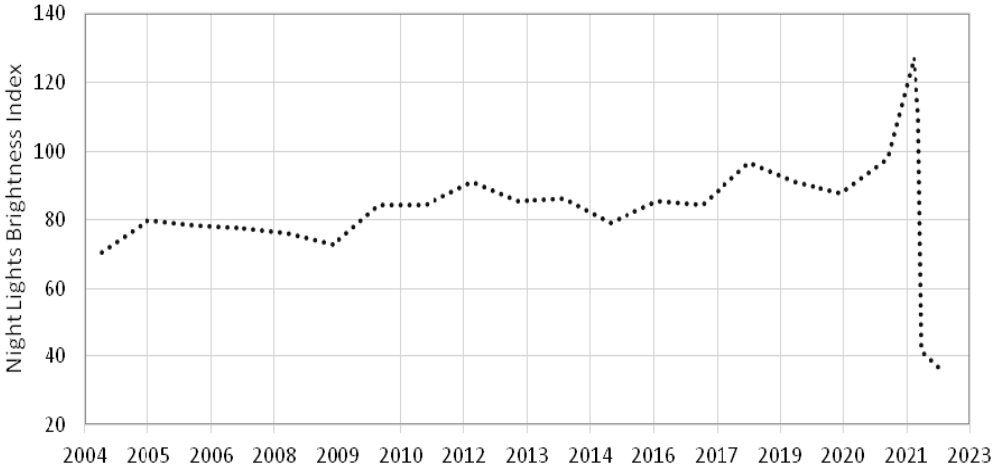
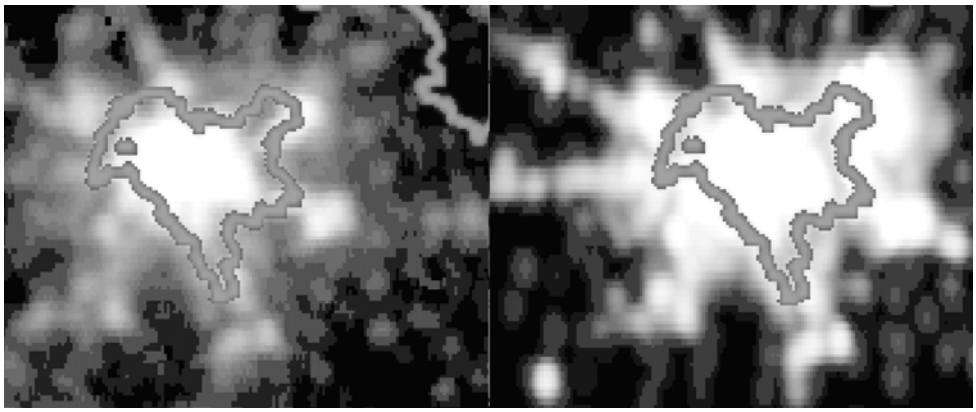


Fig. 4. Evaluation of the brightness of the territory of the Kyiv city from 2005 to 2018

Let's consider Donetsk and Luhansk regions. In 2015, the value of the Night Lights Brightness Index was affected greatly (Fig. 2). Fig. 6 shows the change in the intensity of night lights between 2013 and 2015 in the territory of these regions. Places of decrease in intensity are marked in dark grey on the map, and places of increase are marked in light grey. As can be seen from the figure, a decrease in the indicator is observed in most of the territories of the regions, which also indicates a decrease in economic activity.



2005 2018

Fig. 5. Comparison of the brightness of the territory of the Kyiv city in 2005 and 2018.

As for August 2022, the most affected regions are Kharkiv, Sumy, Ivano-Frankivsk, Dnipropetrovsk. The decreasing was 78–80%. The less one is Sevastopol city (33%). It should be noted here that along with the unconditional impact of Russian aggression, this month is accompanied by a seasonal decrease in economic activity.

In order to verify the possibility of using night lights maps to assess the level of economic development of territories, a correlation-regression analysis of the Index of the economical dimension of sustainable development — an integral indicator calculated according to the methodology [9], and the Night Lights Brightness Index for the regions of Ukraine was conducted.

Fig. 6. Changes in the intensity of night lights between 2013 and 2015 in Donetsk and Luhansk regions

In the Table 2 the results of calculating the correlation coefficient of the studied indicators for each region are shown. The obtained results indicate that the relationship between economic development and the brightness of night lights is uneven for different regions of the country. The value of the correlation coefficient for the Kyiv city stands out from a number of data due to the specifics of the functioning of the capital. If we consider the entire data set (except for the Kyiv city), the correlation coefficient for the Index of the economical dimension of sustainable development and the Night Lights Brightness Index is 0.716 (Fig. 7), which indicates the presence of a connection.

T a b l e 2 . Correlation coefficients of the Index of the economical dimension of sustainable development of the regions of Ukraine and the level of brightness of night lights

Region	Correlation coefficient
AR of Crimea	0.744
city Sevastopol	0.732
Donetsk	0.721
Odesa	0.689
Poltava	0.660
Luhansk	0.636
Ivano-Frankivsk	0.616
Zhytomyr	0.605
Dnipropetrovsk	0.590
Kherson	0.563
Khmelnytskiy	0.530
Cherkasy	0.519
Rivne	0.478
Kharkiv	0.476
Ternopyl	0.464
Kirovohrad	0.457
Vinnytsya	0.432
Mykolayiv	0.397
Chernihiv	0.390
Chernivtsi	0.355
Volyn	0.279
Zaporizhzhya	0.267
Zakarpattya	0.252
Sumy	0.235
Kyiv	0.000
Lviv	-0.028
Kyiv city	-0.227

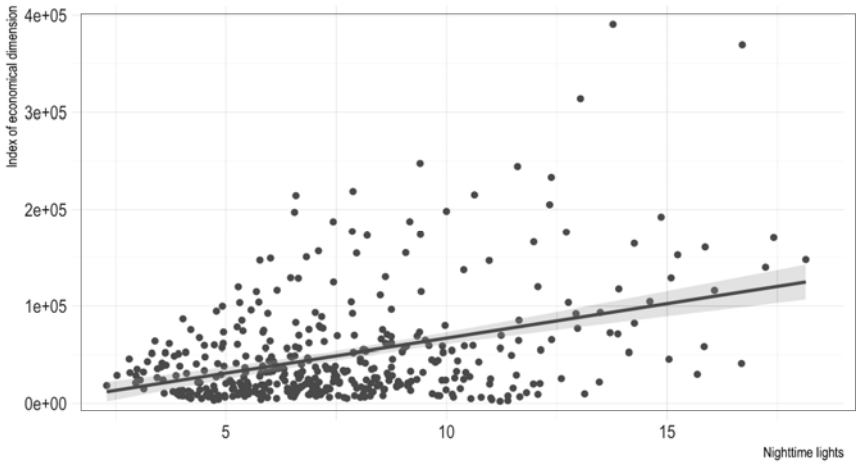


Fig. 7. Dependence of the Index of the economical dimension of sustainable development of the regions of Ukraine and the level of brightness of night lights

The presence of such a connection allows building models for assessing the level of the economic component of sustainable development based on satellite data for territories in the absence of the necessary statistical information.

ASSESSMENT OF THE LEVEL OF ECONOMIC DEVELOPMENT OF THE KHERSON REGION AND THE AUTONOMOUS REPUBLIC OF CRIMEA BASED ON THE NIGHT LIGHTS BRIGHTNESS INDEX

Three regions were selected for modeling:

– Kherson region (to check the methodology of building models);

– Autonomous Republic of Crimea (due to the absence of the objective statistical information since 2014);

– Donetsk region (due to the absence of the objective statistical information since 2014).

After the analysis of the relevant time series, the presence of a lag in 1 period was determined. The models are built in the form of nonlinear regression [14] and neural network [15] and have the following form:

1. Regressions:

a. Kherson region

$$I_{ec}(t) = 0{,}0763 * ln(I_{nl}(t-1)) + 0{,}00551,$$

where $I_{ec}(t)$. — Index of the economical dimension of sustainable development at a moment in time t, $I_{nl}(t-1)$. — the Night Lights Brightness Index at a moment in time $t-1$;

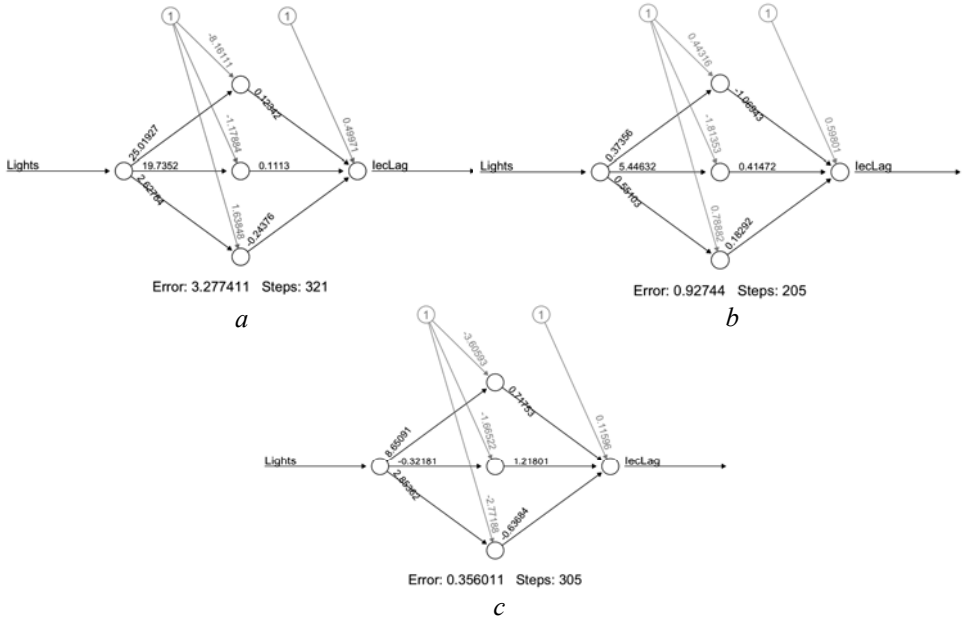
b. AR of Crimea

$$I_{ec}I_{nl}(t) = 0{,}30658 * LN(I_{nl}(t-1)) - 0{,}2856,$$

where $I_{ec}(t)$ — Index of the economical dimension of sustainable development at a moment in time t, $I_{nl}(t-1)$ — the Night Lights Brightness Index at a moment in time $t-1$.

c. Donetsk region

$$I_{ec}(t) = 0{,}0019647232 * I_{nl}(t-1)^{2{,}0489917756},$$



a *b* *c*

Fig. 8. Weights and structure of CNN for the: *a* — Kherson region; *b* — AR of Crimea; *c* — Donetsk region (*Iec* — Index of the economical dimension of sustainable development at a moment in time *t*, *Lights* — the Night Lights Brightness Index at a moment in time (*t*–1)

where $I_{ec}(t)$ — Index of the economical dimension of sustainable development at a moment in time t, $I_{nl}(t-1)$ — the Night Lights Brightness Index at a moment in time $t-1$.

2. Convolutional Neural Network (CNN):

a. The weights and structure of the CNN for the Kherson region are presented in Fig. 8, *a*;

b. The weights and structure of the CNN for AR of Crimea are presented in Fig. 8, *b*;

c. The weights and structure of the CNN for the Donetsk region are presented in Fig. 8, *c*;

The model for the Kherson region has an average relative error of 7,6% for nonlinear regression and 6.4% for convolutional neural network. The results are presented in Fig. 9 and in Table 3. According to the built model, in 2021 the region showed growth and fall in 2022.

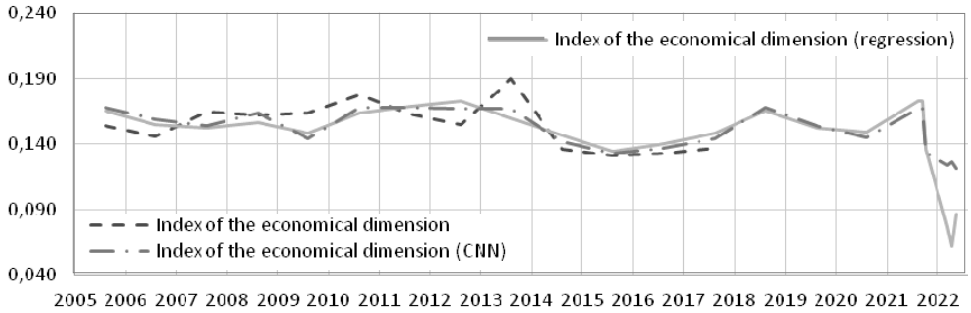


Fig. 9. Calculation of the Index of the economical dimension based on the brightness of night lights for the Kherson region

Table 3. Calculation of the Index of the economical dimension based on the brightness of night lights for the Kherson region

Year	The Index of the economical dimension	The Night Lights Brightness Index	The values of the Index of the economical dimension are modeled using non-linear regression	The values of the Index of the economical dimension are modeled using CNN
2009	0.162	6.487	0.157	0.164
2010	0.164	7.966	0.148	0.144
2011	0.178	8.455	0.164	0.168
2012	0.163	8.950	0.168	0.168
2013	0.155	7.570	0.173	0.167
2014	0.190	6.338	0.160	0.167
2015	0.136	5.447	0.146	0.141
2016	0.131	5.832	0.135	0.133
2017	0.133	6.490	0.140	0.137
2018	0.137	8.109	0.148	0.144
2019		6.883	0.165	0.168
2020		6.549	0.153	0.154
2021		8.930	0.149	0.145
01.2022		8.991	0.173	0.167
02.2022		5.542	0.173	0.167
03.2022		2.535	0.136	0.134
08.2022		2.094	0.076	0.124
09.2022		2.893	0.062	0.126
10.2022			0.087	0.122

The model for the Autonomous Republic of Crimea can be used to assess the level of economic development of the region after 2013. The average relative error of the obtained models is no more than 10.2%. The results are presented in Fig. 10 and in Table 4.

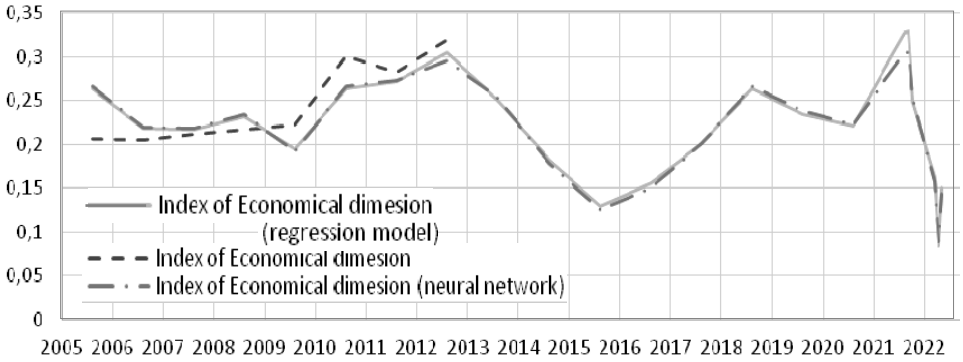


Fig. 10. Calculation of the Index of the economical dimension based on the brightness of night lights for AR of Crimea

Table 4. Calculation of the Index of the economical dimension based on the brightness of night lights for AR of Crimea

Year	The Index of the economical dimension	The Night Lights Brightness Index	The values of the Index of the economical dimension are modeled using non-linear regression	The values of the Index of the economical dimension are modeled using CNN
2009	0.216	4.778	0.194	0.192
2010	0.223	5.994	0.263	0.266
2011	0.301	6.161	0.272	0.273
2012	0.282	6.879	0.306	0.296
2013	0.320	5.739	0.250	0.254
2014		4.600	0.182	0.178
2015		3.872	0.129	0.124
2016		4.224	0.156	0.150
2017		4.900	0.202	0.201
2018		6.011	0.264	0.267
2019		5.461	0.235	0.238
2020		5.216	0.221	0.222
2021		7.398	0.328	0.305
01.2022		7.439	0.330	0.305
02.2022		5.731	0.250	0.253
03.2022		4.311	0.162	0.157
08.2022		3.335	0.084	0.089
09.2022		4.139	0.150	0.144
10.2022		4.778	0.194	0.192

According to the simulation results, after a certain economic growth in 2011–2013, the Autonomous Republic of Crimea fell in 2014–2016. In 2016–2021, there is an upward trend in the Index of the economical dimension of sustainable development.

The model for the Donetsk region has an average relative error of 19.4% for nonlinear regression and 18.2% for convolutional neural network. This is due to increased uncertainty in partial annexation and hostilities. The results are presented in Fig. 11 and in Table 5. According to the built model, the region has decreasing economic dimension trend after 2013 and after 2018. The models show even greater level of falling during 2022.

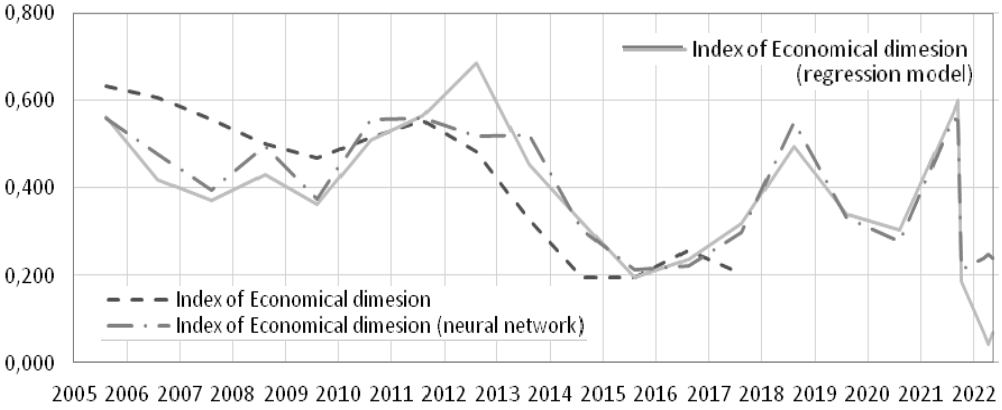


Fig. 11. Calculation of the Index of the economical dimension based on the brightness of night lights for the Donetsk region

Table 5. Calculation of the Index of the economical dimension based on the brightness of night lights for the Donetsk region

Year	The Index of the economical dimension	The Night Lights Brightness Index	The values of the Index of the economical dimension are modeled using non-linear regression	The values of the Index of the economical dimension are modeled using CNN
2009	0.503	12.762	0.432	0.495
2010	0.468	15.090	0.363	0.375
2011	0.517	15.862	0.511	0.558
2012	0.554	17.416	0.566	0.561
2013	0.482	14.255	0.685	0.520
2014		12.071	0.455	0.522
2015		9.425	0.323	0.305
2016		10.390	0.195	0.214
2017		11.977	0.238	0.222
2018		14.864	0.318	0.297
2019		12.337	0.495	0.552
2020		11.736	0.338	0.330
2021		15.934	0.305	0.279
01.2022		16.338	0.571	0.560
02.2022		9.257	0.601	0.553
03.2022		5.683	0.188	0.214
08.2022		4.510	0.069	0.238
09.2022		5.639	0.043	0.247
10.2022			0.068	0.239

CONCLUSIONS

In the course of the research, data on the luminosity of night lights on the territory of Ukraine was collected and processed. Based on the processed data, the Night Lights Brightness Index for the regions of Ukraine was formed and analyzed. The conducted correlation-regression analysis confirmed the possibility of using the specified index to determine the economic component of sustainable development on the territory of Ukraine.

Built for the Kherson region, the Autonomous Republic of Crimea and the Donetsk region, the assessment models of Index of the economical dimension of sustainable development showed an error of no more than 7.6%, 10.2% and 19.4%, which, among other things, allowed us to assess the level of economic development for the territory of the Autonomous Republic of Crimea and the Donetsk region for 2014–2022.

Using developed approach, we showed that the annexation of territories significantly affected the level of economic development of the territories of Crimea and Donbas. So, the Crimea fell by 0.174 points (57.8%), and the Donetsk region lost almost twice as much – 0.398 points (66.1%). At the same time, the pandemic period affected these regions in different ways. Crimea, after the restoration of its economic processes, lost only 0.044 points (16.6%), while the Donetsk region lost 0.232 points (44.3%).

And without having time to strengthen the trend towards economic recovery from the consequences of Covid-19, due to the full-scale invasion, these regions also suffered significantly. Not being a highly developed region, by the third decade of 2022 Crimea lowered its level of economic development by 0.230 points, when the Donetsk region lost much more – 0.432 points.

Thus, according to the results of the study, it was established that the degree of brightness of night lights can be used to assess the economic component of sustainable development of the regions of Ukraine, and in particular, the level of economic activity of the territories. This will help to make an assessment in the absence of ready-made qualitative statistical information, for example, for newly formed administrative units, or for regions for which, for various reasons, it is impossible to obtain sets of economic indicators.

Generally, with the application of the proposed approach, it was possible to identify and confirm the decrease in the economic activity of the regions of Ukraine during the pandemic and a full-scale invasion of Russia.

Further research is planned to be directed to the creation of a set of models for assessing the level of economic development of any territory within Ukraine with the aim of creating appropriate applications within the Information and Analytical Situational Center of the Igor Sikorsky Kyiv Polytechnic Institute.

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Received 12.02.2023

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ОЦІНЮВАННЯ ЕКОНОМІЧНОГО ВИМІРЮВАННЯ СТАЛОГО РОЗВИТКУ РЕГІОНІВ УКРАЇНИ НА ОСНОВІ ЯСКРАВОСТІ НІЧНИХ ВОГНІВ / М.З. Згуровський, К.В. Єфремов, С.В. Гапон, І.О. Пишнограєв

Анотація. Під час оцінювання рівня розвитку територій виникає проблема пошуку об'єктивних якісних даних, що будуть її характеризувати. Одним з можливих джерел таких даних є застосування методів дистанційного зондування Землі (ДЗЗ). Проаналізовано можливості використання одного з продуктів ДЗЗ – карти нічних вогнів, для моделювання економічного вимірювання сталого розвитку регіонів України. У результаті за допомогою регресійно-кореляційного аналізу та нейронних мереж отримано відповідні моделі оцінювання рівня економічного розвитку Херсонської області, Донецької області та АР Крим. Наведене дослідження виконано командою Світового центру даних «Геоінформатика та сталий розвиток» КПІ ім. Ігоря Сікорського і є частиною досліджень з аналізу поведінки складних соціально-економічних систем та процесів сталого розвитку в контексті якості та безпеки життя людей.

Ключові слова: сталий розвиток, просторовий аналіз даних, економічний розвиток, нічні вогні, математичне моделювання.