Acta Geographica Silesiana, 17. WNoZ UŚ, Sosnowiec, 2014
s. 33–39

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MODELING OF THE DEVELOPMENTAL TRAJECTORY OF REGIONAL SOCIOGEOSYSTEMS OF UKRAINE: ANALYSIS AND VISUALIZATION OF THE RESULTS

Niemiec K., Pogrebski T., Telebieniewa Je., Lichwan W. **Modelowanie trajektorii rozwoju regionalnych geosystemów społecznych na Ukrainie: analiza i wizualizacja wyników.** W artykule omówiono problemy metodologiczne wykorzystania przestrzeni wielowymiarowej do analizy procesu rozwoju geosystemów społecznych. Proponuje się łączenie ogólnej analizy wektora rozwoju z badaniem jego projekcji na osi przestrzeni. Przedstawiono konkretne przykłady zastosowania wspomnianej metodyki badań.

Немец К., Погребский Т., Телебенева Е., *Лихван* В. **Моделирование траектории развития региональных социогеосистем Украины: анализ и визуализация результатов.** В статье рассматриваются методологические вопросы использования многомерного пространства для анализа процесса развития социогеосистем. Предлагается вместе с общим анализом вектора развития исследовать его проекции на оси пространства. Приводятся конкретные примеры использования методики.

Key words: multidimensional attribute space, sociogeosystem, developmental trajectory, developmental vector
Słowa kluczowe: przestrzeń wielowymiarowa, geosystem społeczny, trajektorie rozwoju, wektor rozwoju
Ключевые слова: многомерное признаковое пространство, социогеосистема, траектории развития, вектор развития

Abstract

The article deals with methodological issues of using multi-dimensional space to analyze the development process of sociogeosystems. It is proposed together with a common vector analysis to explore its projection on the axis of space. The specific examples of using this method are given.

INTRODUCTION

Geographical space, as a fundamental concept of modern geography, has a dual character. On the one hand, its elements are discrete geographic objects (GO), which form a spatial structure and interact within it. On the other hand, the reaction in GO is carried out by means of continual fields of different nature which are presented, in particular, by mathematical models. Thus, depending on the representation of GO quantitative characteristics, two types of tasks are solved. In the first case, if the parameters of GO are treated as deterministic values and do not contain random errors, the task of their fields modeling is reduced to interpolation – minimizing errors analogy. In the second case, when the value of the field at the reference points is presented as random variables, approximation methods are used with varying degrees of model approximation to the true values of the field. Thus, the epistemological problem of the geographical space study is that between the epistemological representation of the spatial structure of GO fields parameter and its ontological essence there is a conflict due to the methodological limitations of science. Therefore, in geographical study it is important to find in existing episteme the approximation method that is most appropriate for the research purpose and the most clearly spatial structure reflects the studied fields (NIEMETS K., NIEMETS L., 2013a).

RESEARCH METHODOLOGY

Nowadays, spatial analysis and spatial models gained significant values in geographical research. Modern geography can analyze objects not only in the usual physical three-dimensional space, but also in the vir-

tual multidimensional attribute space. One example of such spatial modeling synthesis is the modeling of developmental trajectory.

Modeling of the developmental trajectory of sociogeosystem in normalized multidimensional attribute space (all coordinates are in the range from 0 to 1) based on the idea of vector displacement of movement of sociogeosystem in this space. The developmental trajectory of sociogeosystem is constructed by placing of consecutive time points from current location and connection of the vectors. Thus, at each time point is shown the position of sociogeosystem in space and motion (displacement, development) – oriented vector connecting neighboring time point trajectory (NIEMETS, 2009; NIEMEC K., NIEMETS L., 2013b).

Modeling of the developmental trajectory of sociogeosystem makes it possible to determine the direction of their motion in normalized multidimensional attribute space relative to the optimal developmental trajectory. Main figures of the movement: the projection on an optimal developmental trajectory (displays speed and direction of development), the deviation from an optimal developmental trajectory (reflecting the efficiency of development) and the projection progress coefficient – positions the current point of location in the space of possible events or advancement in development. The developmental trajectory of sociogeosystem is convenient to display on the phase plane in coordinates "projection on an optimal developmental trajectory" – "deviation from an optimal developmental trajectory" (NIEMETS, 2005; NIEMETS K., NIEMETS L., 2013c).

THE RESULTS OF RESEARCH

First we carried out the simulation of developmental trajectory of the health care system in districts sociogeosystems of Volyn region. According to a comparative analysis the geographical distribution of districts sociogeosystems of Volyn region due to the development of the health care system in the period from 2007 to 2012 is shown in the table 1 and in a fig. 1.

Table 1. Average trajectory parameters of the health care system in sociogeosystems of Volyn region for the entire study period (2007–2012 years)
Tabela 1. Średnie parametry trajektorii rozwoju systemu ochrony zdrowia w społecznych geosystemach obwodu wołyńskiego w okresie badań (2007–2012)

District	Projection on an optimal developmental trajectory	Deviation from an optimal developmental trajectory	Projection progress coefficient
Vladimir-Volynskiy district	5,952	3,203	0,536
Gorokhiv district	5,381	3,349	0,484
Ivanichi district	5,483	2,93	0,523
Kivertsi district	5,675	3,279	0,516
Kovel district	6,255	2,818	0,495
Kamin-Kashirsky district	5,452	3,405	0,555
Lokachi district	5,824	3,953	0,561
Lutsk district	5,373	3,446	0,484
Lyubeshiv district	5,435	3,676	0,518
Lyuboml district	5,414	3,461	0,514
Manevychi district	5,404	3,757	0,485
Ratne district	5,616	3,424	0,554
Rozhysche district	5,606	3,577	0,513
Starovyzhivski district	5,24	3,832	0,49
Turiysk district	5,888	3,934	0,561
Shatsk district	5,416	4,257	0,499
The city of Lutsk	5,583	3,187	0,499

An average distribution of sociogeosystems shows that for the projection vector of health care system on an optimal developmental trajectory the worst conditions are observed in Starovyzhivskiy district, Lutsk district and Gorokhiv district. The best conditions of health care system development are in Kovel district, Vladimir-Volynskiy district, Turiysk district and Lokachi district.

To identify a generalized trajectory of health care system development in Volyn region was used centrographic method. Its essence is that on each current time were calculated the projection vectors of health care system on an optimal developmental trajectory

and deviations from it. That is, sociogeosystems were virtually replaced by imaginary objects with average coordinates on the phase plane. Thus, for each current time we got the coordinates of objects that reflect the average value of sociogeosystem due to the entire billing period. Later, consistently connecting these coordinates, we obtained an average trajectory of health care system development in sociogeosystems, which is represented in fig. 2.

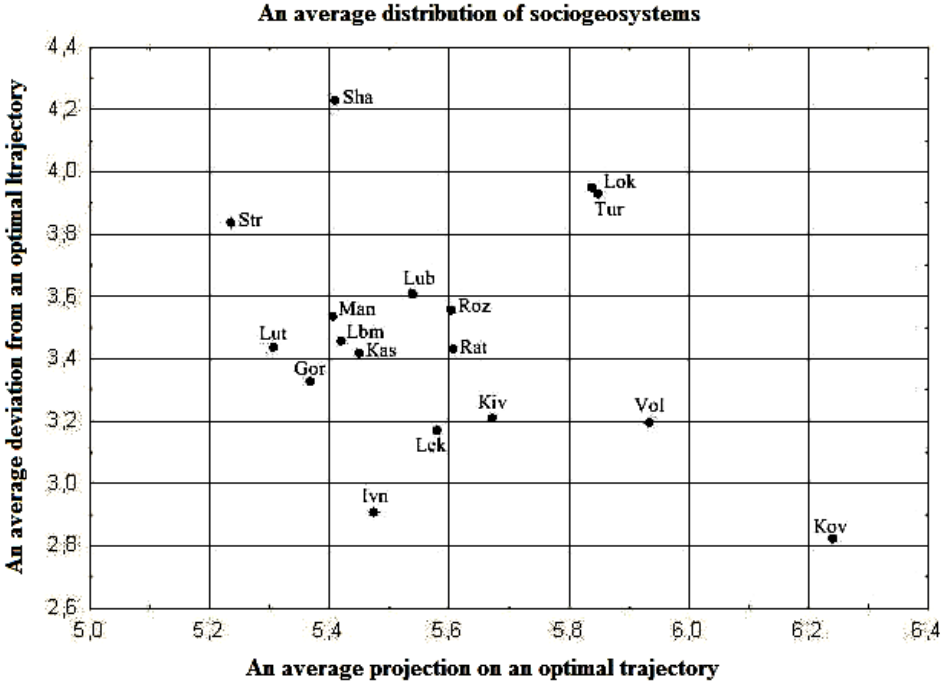

Fig. 1. Average distribution of sociogeosystems on the phase plane due to the development of health care system in Volyn region for the entire period (2007–2012 years)

Rys. 1. Średnie rozmieszczenie geosystemów społecznych na płaszczyźnie fazowej rozwoju systemu ochrony zdrowia w obwodzie wołyńskim w badanym okresie (2007–2012)

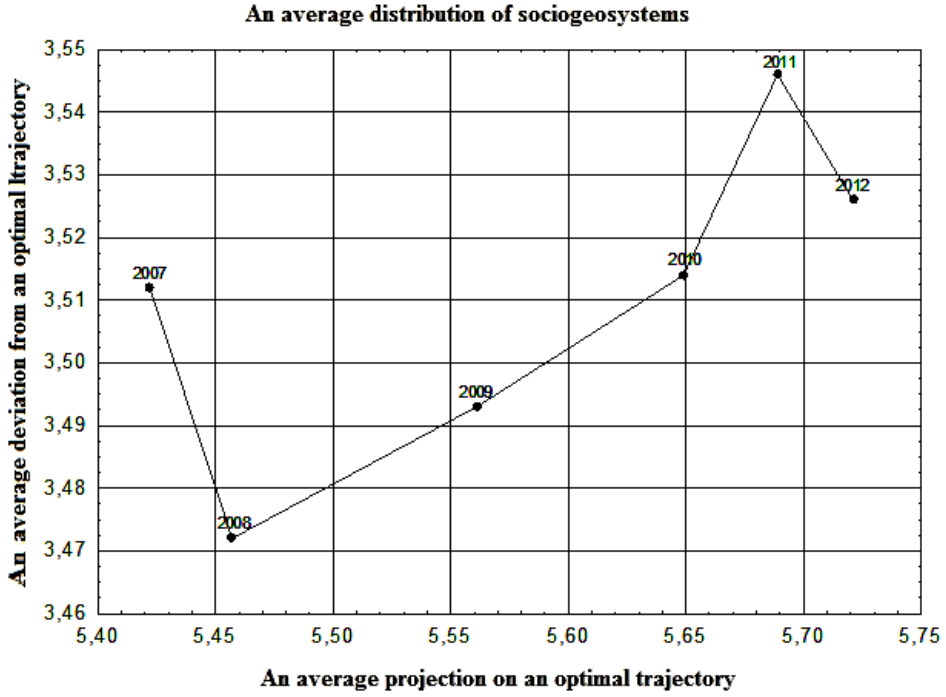

Fig. 2. An average trajectory of health care system development in sociogeosystems of Volyn region

Rys. 2. Średnia trajektoria rozwoju systemu ochrony zdrowia w geosystemach społecznych obwodu wołyńskiego

From the above graph we can see that an average trajectory of health care system development in sociogeosystems has a continuous trend of progressive development (2007–2012 years). Accordingly, the best level of development health care system reached in the end of the study period. The greatest efficiency of sociogeosystems movement is observed in 2008, and the lowest – in 2011. An average speed of sociogeosystems movement for all billing periods is approximately the same, indicating a balanced development of health care system.

Along with the trajectory of the whole region, you can also explore the development of its individual components, including districts and cities sociogeosystems. For example, we have determined the trajectory of agricultural development in Krasnogradskyi district of Kharkiv region for the period 2005–2012 years (table 2; fig. 3, 4) and the trajectory of socio-economic development of the city of Kharkov in the period 2006–2012 years (table 3, fig. 5, 6).

Table 2. The parameters of developmental trajectory of agriculture in Krasnogradskyi district of Kharkiv region for the entire study period (2005–2012 years)
Tabela 2. Parametry trajektorii rozwoju rolnictwa rejonu krasnogradzkiego w obwodzie charkowskim w badanym okresie (2005–2012)

Years	Projection on an optimal developmental trajectory	Deviation from an optimal developmental trajectory	Projection progress coefficient
2005	4,202	3,267	0,414
2006	4,34	3,231	0,428
2007	4,361	3,159	0,43
2008	4,484	3,184	0,442
2009	4,403	3,289	0,434
2010	4,406	3,409	0,434
2011	4,672	3,557	0,46
2012	4,524	3,525	0,446

From this table and chart can be divided 4 stages of agricultural development of Krasnogradskyi district of Kharkiv region. The first period of progressive development 2005–2008 years. It is characterized by the smallest deviation from the optimal trajectory. Second, the regressive period of agriculture development covers 2008 and 2009 years. It is characterized by worsening in economic and financial situation of Kharkiv region and consequently in agriculture of Krasnogradskyi district. Next period covering 2009 and 2011. In 2011, the trajectory of agricultural development reached its peak in the last 8 years. Changing of the vector in 2012 is associated with a significant financial drain of assets allocated to agricultural development in connection with Euro 2012 in Ukraine and Kharkiv in particular.

Trend line for the period 2005–2012 has growing character because, despite the changing in vectors of agricultural development in Krasnogradskyi district in recent years has better agricultural performance compared to the early years of the period.

As shown in the table and on the chart developmental trajectory of the socio-economic development of the city of Kharkiv displays only periods of progressive development. From 2009 to 2011 there is no significant development, because it was difficult socio-economic situation, which is associated with the economic crisis. But we can say that the best socio-economic development the city of Kharkiv achieved in 2012. Trend line has also growing character.

CONCLUSIONS

Today geography is very quickly progresses in the application of formal logic and simulation. On the basis of geographical integrative conceptual apparatus creates new information technologies, which are widely used in other fields of science. The main diffe-

rence of the geographical research is a spatial analysis in which the trend toward the combination of physical (three-dimensional) and a multidimensional feature space. Physical space serves as a reflection, multi-dimensional as an operating.

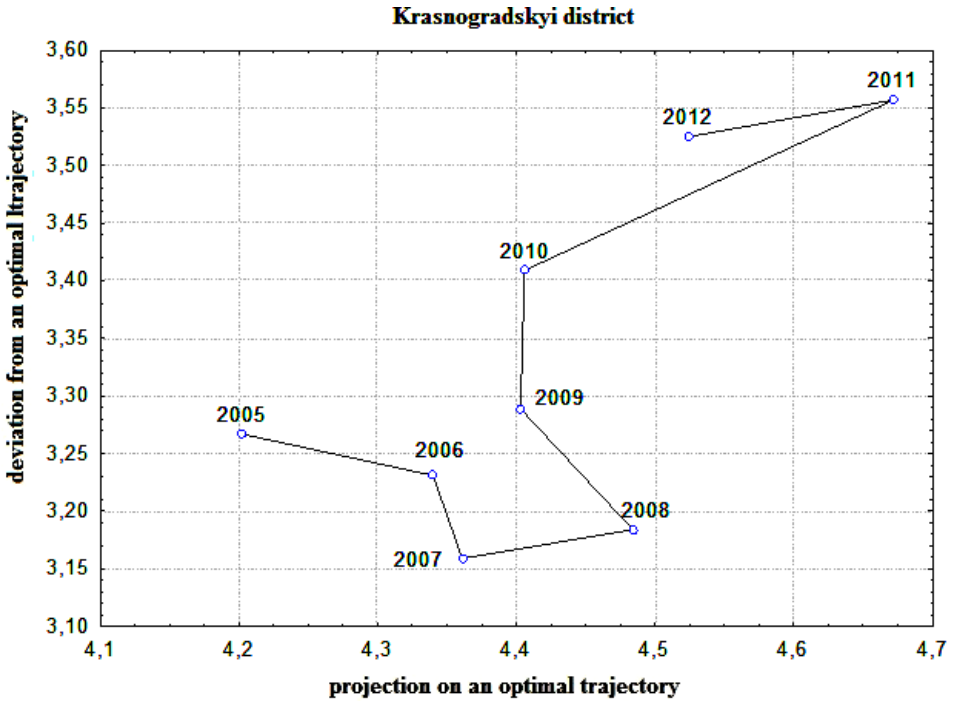

Fig. 3. Developmental trajectory of agriculture in Krasnogradskyi district of Kharkiv region for the entire study period (2005–2012 years)

Rys. 3. Trajektoria rozwoju rolnictwa rejonu krosnogradzkiego w obwodzie charkowskim w okresie badawczym (2005–2012)

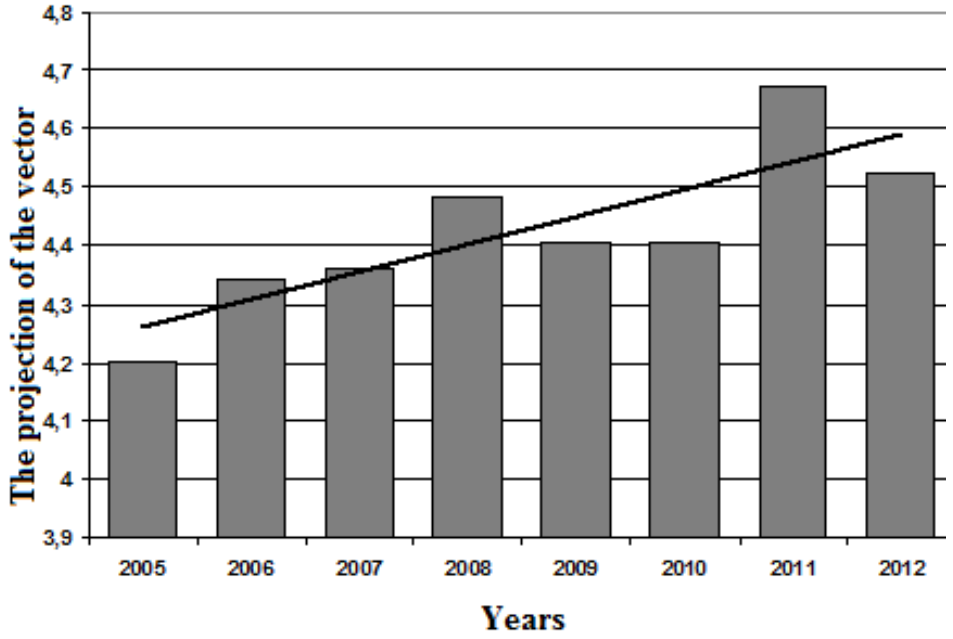

Fig. 4. The dynamic of the projection of the developmental vector of agriculture in Krasnogradskyi district of Kharkiv region on an optimal developmental trajectory

Rys. 4. Dynamika projekcji wektora rozwoju rolnictwa rejonu krasnogradzkiego w obwodzie charkowskim na optymalną trajektorię rozwoju

Table 3. The parameters of trajectory of the socio-economic development in the city of Kharkiv for the entire study period (2006–2012 years)
Tabela 3. Parametry trajektorii rozwoju społeczno-ekonomicznego Charkowa w okresie badań (2006–2012)

Years	Projection on an optimal developmental trajectory	Deviation from an optimal developmental trajectory	Projection progress coefficient
2006	5,005	2,873	0,611
2007	5,49	2,758	0,671
2008	5,62	2,823	0,687
2009	5,743	2,762	0,702
2010	5,747	2,783	0,702
2011	5,792	2,82	0,708
2012	6,27	2,697	0,766

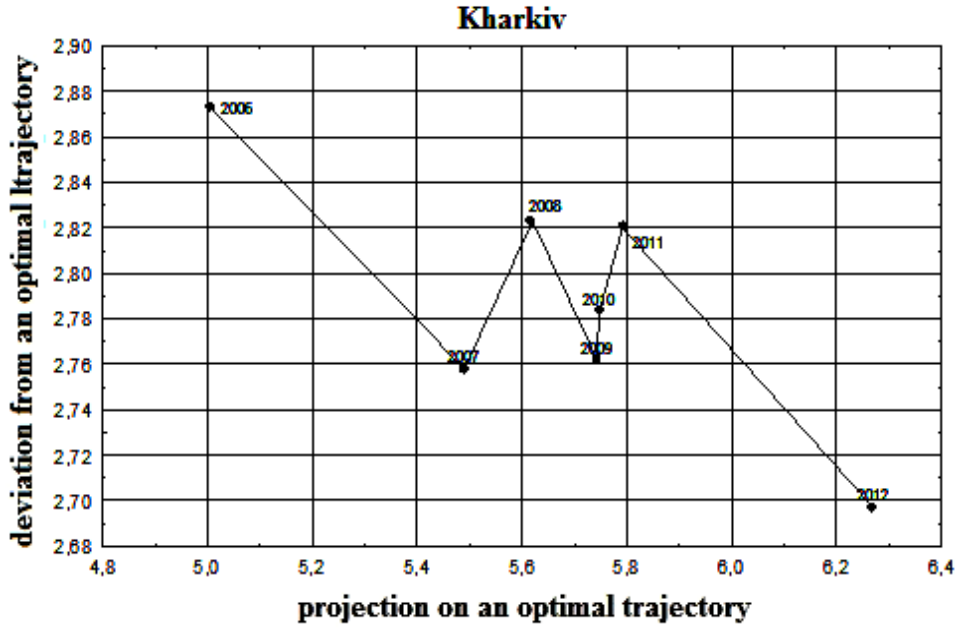

Fig. 5. Developmental trajectory of the socio-economic development of the city of Kharkiv for the entire study period (2006–2012 years)
Rys. 5. Trajektoria rozwoju społeczno-ekonomicznego Charkowa w okresie badawczym (2006–2012)

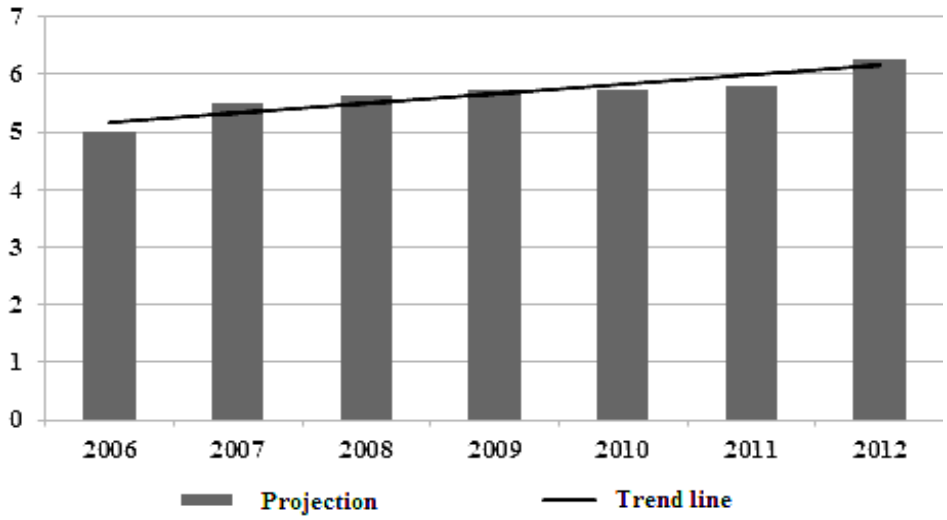

Fig. 6. The dynamic of the projection of the socio-economic development of the city of Kharkiv on an optimal developmental trajectory

Rys. 6. Dynamika projekcji wektora rozwoju społeczno-ekonomicznego Charkowa na optymalną trajektorię rozwoju

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