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SPATIAL RELATIONSHIP BETWEEN ENVIRONMENTAL IMPACT AND WELFARE OF POPULATION IN UKRAINIAN REGIONS

The article examines the relationship between environmental impact of population of Ukrainian regions calculated as ecological footprint per capita and economic welfare using graphical method for determining the correlation coefficient. The obtained isocorrelation map is analyzed and the conclusion is made that the spatial distribution of studied values gives unique research opportunities.

Keywords: isocorrelation map, ecological footprint, GIS, region.

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ПРОСТОРОВА ЗАЛЕЖНІСТЬ МІЖ НАВАНТАЖЕННЯМ НА ДОВКІЛЛЯ ТА ДОБРОБУТОМ НАСЕЛЕННЯ ЗА ОБЛАСТЯМИ УКРАЇНИ

У статті розглядається взаємозв'язок між впливом на навколишнє середовище населенням регіонів України, розрахованому як екологічний слід на душу населення, і економічним добробутом, з використанням графічного методу для визначення коефіцієнта кореляції. Отримана карта ізокорелят проаналізована і зроблено висновок про те, що просторовий розподіл досліджуваних значень дає унікальні можливості для наукових досліджень.

Ключові слова: карта ізокорелят, екологічний слід, ГІС, регіон.

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ПРОСТРАНСТВЕННАЯ ЗАВИСИМОСТЬ МЕЖДУ НАГРУЗКОЙ НА ОКРУЖАЮЩУЮ СРЕДУ И БЛАГОСОСТОЯНИЕМ НАСЕЛЕНИЯ ПО ОБЛАСТЯМ УКРАИНЫ

В статье рассматривается взаимосвязь между воздействием на окружающую среду населения регионов Украины, рассчитанном как экологический след на душу населения, и экономическим благосостоянием, с использованием графического метода для определения коэффициента корреляции. Полученная карта изокоррелят проанализирована и сделан вывод о том, что пространственное распределение исследуемых значений даёт уникальные возможности для научных исследований.

Ключевые слова: карта изокоррелят, экологический след, ГИС, регион.

Introduction. In the scope of sustainable development, the importance of responsible consumption of the population becomes vital. In 2008, the OECD prepared a "Promoting Sustainable Consumption" publication [1] where they claimed that people should use natural resources and ecosystem services keeping environmental impacts involved in mind. The general trend shows the growth of consumption of population in Ukraine (see [2]). OECD forecasts that households' consumption will grow rapidly in non-OECD countries, including Ukraine, by 2030, particularly for energy consumption, transport, residential water use and waste management [3].

Growth of consumption causes growth of production that increases amount of natural resources and ecosystem services that are used by every person. Consumer choices influence environment heavily and, as some authors argue [4], can alleviate most environmental problems.

Study background. One of the ways of evaluation of environmental impacts of population resulted from the consumption is to apply methodology of environmental footprint (EF) developed by M. Wackernagel and W. E. Rees [5]. EF is defined as the total amount of biologically productive area required to sustain consumption of the population calculated based on the local productivity. As an indicator, EF shows a further increase of human dependence from the environment. Since most of the significant decisions concerning economic development and environment are made at the regional level, this methodology was improved and used to calculate the values of EF at the regional level in Ukraine [6, 7].

In general, economic growth causes an increase of consumption [8], which leads to an increase in demand. Most studies, e.g. [9], show that relationship between the consumption level and extent of environmental impact are being influenced by income, education, and social status.

Goal and objectives of research. However, to be able to decrease the level of environmental impact, local authorities and scientists need to find out what influences the value of EF and how these values are distributed spatially. So, the main goal of the current research is to find the relationship between the level of population welfare as the key factor that causes changes in consumption of certain populations and the level of environmental impact in spatial dimension.

Methodology. Correlation analysis is one of the most popular methods of data analysis. In most cases, its application is used to calculate the correlation coefficients or determine correlation relationships that allow researchers to determine the degree of linear or non-linear relationship between indicators.

When the data has a spatial binding, the researchers have completely new possibilities for the analysis by adding a spatial component. However, in this case, the characteristic of correlation coefficient is insufficient since the calculation of a single value of the coefficient

does not allow to consider the spatial variation of the relationship within the research area. To resolve this problem, the isocorrelation maps are used. The examples of these maps can be often found in the works that analyze synoptic processes and their impact on various environmental and socio-economic indicators [10, 11] as well as in the works related to nature protection [12, 13]. The main problem of the construction of these maps in GIS is lack of ready-made software modules for such kind of a simulation.

To map relationship phenomena, we decided to use a graphical method for determining the correlation coefficient that is described in [14]. The essence of the method is to determine the cosine of the angle between the isolines of the studied parameters at the intersection points. For partial automation, we have developed software modules to automate the creation of point objects at the points of intersection of isolines, as well as to convert the angles in the value of the correlation coefficient. According to the values calculated at the intersection points, interpolation method is employed to construct the surface of relationship of the studied parameters.

GIS MapInfo Professional 9.5 and MapBasic 9.5 software is used.

The current research is based on data provided by the State Statistics Service of Ukraine [2] and the results obtained in [15].

Results. In 2012, the correlation between the values of EF and GRP per capita in Ukrainian regions is $r = 0.71$, at a significance level of $p = 0.0001$. Thus, this factor explains almost half of the variation of the dependent variable (value EF); the remaining variation rate is related to the influence of other factors. However, the trend is clear: when income of the residents of the regions increases, pressure on the environment increases as well (Figure 1).

The plot above shows the power of correlation relationship between the values of EF and GRP per capita. To get the spatial distribution of this relationship, the isocorrelation map is created (Figure 2).

It is interested to mention that the connection strength between these two values differs significantly. The correlation is strong; values are in the interval $0.15 - 0.99$.

The strongest relationship is observed in Ivano-Frankivs'k, Khmelnytsky, Kyiv, Chernihiv, Donets'k, Zaporizhzhya, and Luhans'k regions.

The weakest relationship is observed in Volyn, Rivne, and Kherson regions.

Therefore, the local authorities in different regions should consider that the increase of income in northwestern and southwestern regions of Ukraine would cause less increase of environmental impact comparing to those in northeastern and southeastern parts of the country.

There are three main reasons that might partially explain the situation described above.

Firstly, in western part of Ukraine the level of population welfare leaves out of account a large amount of income generated because of labour migration to countries of Western and Southern Europe. As a result, the level of consumption of goods, especially foodstuff, is even higher there than is Eastern Ukraine, but it does not depend on GRP per capita.

Secondly, the level of income determines the lifestyle. The higher the income the bigger amount of resources and ecological services the population uses. Traditionally, eastern regions consume more goods and services than western regions do. Therefore, the typical lifestyle influences the strength of relationship between environmental impact and level of welfare of a typical citizen of different Ukrainian regions.

Thirdly, the cultural preferences of populations in the regions determine different consumption patterns of the citizens who represent different nationalities. In Ukraine, the ethnical structure of population varies significantly; it is not surprising that Russian minority in eastern Ukraine has the same consumption preferences than in northeastern Ukraine, but it is not the same as in Lviv, Volyn, and Odesa regions, where other cultural minorities form a large percent of local populations.

Conclusions. Population of a country or region itself cannot decrease environmental impacts caused by the lifestyles, but many individuals together can make right choices and soften their environmental impacts. EF indicator can significantly help them in making their lifestyles more sustainable.

The chosen graphical method of determination of the correlation coefficient is an efficient tool for studying the relationship between environmental impact and economic welfare of population of Ukrainian regions.

The obtained isocorrelation map shows the differences of spatial distribution and strength of relationship between ecological footprint of typical residents of Ukrainian regions and GRP per capita in 2012. The main result obtained, which is important for the decision-makers, is that the increase of welfare in some regions would cause less increase of environmental impact comparing to other regions.

The research method may be improved in terms of further automation of calculation processes.

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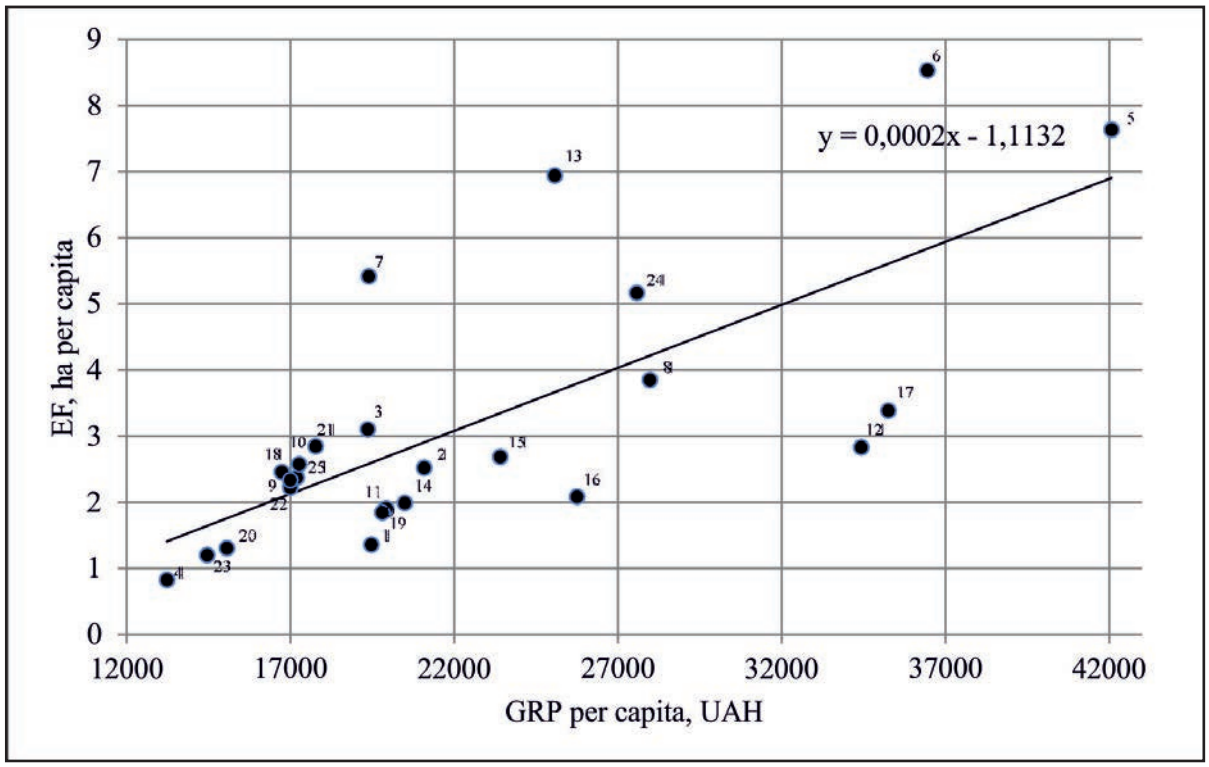

#	Region	#	Region
1	Autonomous Republic of Crimea	14	Lviv Region
2	Cherkasy Region	15	Mykolayiv Region
3	Chernihiv Region	16	Odesa Region
4	Chernivetski Region	17	Poltava Region
5	Dnipropetrovs'k Region	18	Rivne Region
6	Donets'k Region	19	Sumy Region
7	Ivano-Frankivs'k Region	20	Ternopil Region
8	Kharkiv Region	21	Vinnytsya Region
9	Kherson Region	22	Volyn region
10	Khmelnytsky Region	23	Zakarpattya Region
11	Kirovograd Region	24	Zaporizhzhya Region
12	Kyiv Region	25	Zhytomyr Region
13	Luhans'k Region		

Fig. 1. The correlation between the values of the EF and GRP per capita (x) in Ukrainian regions in 2012

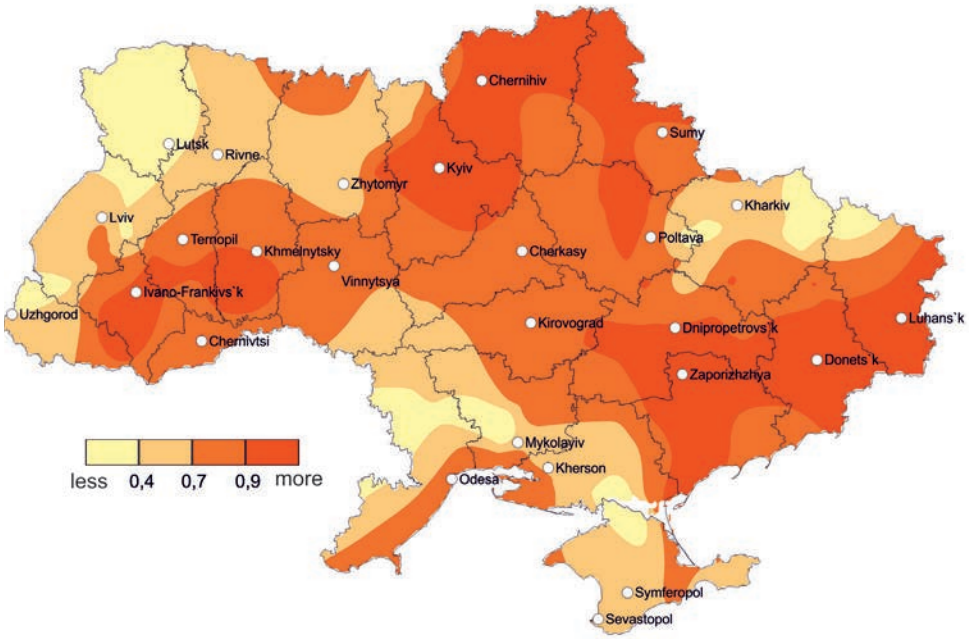

Fig. 2. Isocorrelation map showing relationship between ecological footprint in Ukrainian regions, ha per capita, and GRP, UAH per capita, in 2012

References

1. Promoting Sustainable Consumption : Good Practices in OECD Countries. [Electronic resource]. — Mode of access : http://www.oecd.org/greengrowth/40317373.pdf. — Screen title.

2. Data of State Statistics Service of Ukraine Electronic resource]. — Mode of access : http://ukrstat.org/en.

3. OECD Environmental Outlook to 2030 [Electronic resource]. — Mode of access : http://www.oecd.org/environment/indicators-modelling-outlooks/40202689.pdf. — Screen title.

4. Paavola J. Economics, Ethics and Green Consumption [Electronic resource] / J. Paavola. — Mode of access : http://ru.scribd.com/doc/7673292/chapter-5-economics-ethics-and-green-consumerism. — Screen title.

5. Wackernagel M. Our Ecological Footprint : Reducing Human Impact on Earth / M. Wackernagel, W. E. Rees. — New Society Publ.,1996. — 176 p.

6. Грищенко Н. В. Оценка влияния уровня потребления населения на окружающую среду на региональном уровне / Н. В. Грищенко // Потенціал сучасної географії у розв'язанні проблем розвитку регіонів : матеріали Міжнар. наук.-практ. конф. молодих вчених, присвяченої 95-річчю Національної академії наук України (Київ, Україна, 3 – 5 жовтня 2013 р.). — К. : Логос, 2013. — С. 337-343.

7. Грищенко Н. В. Оценка нагрузки на окружающую среду в Украине на региональном уровне методом экологического футпринта / Н. В. Грищенко // Геополитика и экогеодинамика регионов : науч. журнал. — 2014. — № 2 (10). — С. 489-493.

8. Caeiro S. Procedures and Criteria to Develop and Evaluate Household Sustainable Consumption Indicators / S. Caeiro, T. B. Ramos, D. Huisingh // Journal of Cleaner Production. — 2012. — № 27.— P. 72 – 91.

9. Carrigan M. The Myth of the Ethical Consumer – Do Ethics Matter in Purchase Behaviour? / M. Carrigan, A. Attalla // Journal of Consumer Marketing. – 2001. – № 18 (7). – P. 560 – 577.

10. Ермакова Л. Н. Прогноз урожайности яровой пшеницы на Урале синоптико-статистическим методом / Л. Н. Ермакова, Н. И. Толмачева // Географический вестник. Научный журнал Пермского государственного университета. — №2. — 2006 г. — С.111-117.

11. Девятова Е. В. Долговременные вариации вихревой акивности атмосферы / Е. В. Девятова, П. Г. Ковадло, В. И. Мордвинов // Солнечно-земная физика. — Вып. 13. — 2009 г. — С. 47-54.

12. Poveda G. Feedbacks between Hydrological Processes in Tropical South America and Large-Scale Ocean – Atmospheric Phenomena / G. Poveda, Mesa O. J. // Journal of climate. — Vol. 10. — 1996. — P. 2690-2702.

13. Габдуллина Л. А. Научно-методические аспекты разработки и использования ГИС для геоэкологической оценки территории (на примере Ижевска) (автореферат диссертации на соискание ученой степени кандидата наук). — Пермь, 2007 г. — 36 с.

14. Голиков А. П. Математические методы в географии / А. П. Голиков, И. Г. Черванев, А. М. Трофимов. — Х.: Вища шк. Изд-во при Харьк. ун-те, 1986. — 144 с.

15. Грищенко Н. В. Оценка нагрузки на окружающую среду в Украине на региональном уровне методом экологического футпринта / Н. В. Грищенко // Геополитика и экогеодинамика регионов : науч. журнал. — 2014. — № 2 (10). — С. 489-493.