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# INDICATORS OF THE ENVIRONMENTAL ASPECT OF SPATIAL ORDER AS A TOOL FOR THE ENVIRONMENTAL PROTECTION IN SUBURBAN AREAS

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**Summary**

The spatial range of the present analysis spans the rural and urban communities of Lower Silesia region. The aim of the study was to determine the needs in terms of environmental protection and development, due to environmental resources and equipment in the communal infrastructure. The environmental aspect of spatial order was evaluated. It was assumed that the implementation of the spatial order in the aspect of the environment is done by means of developing that environment, and especially by the presence / absence of the biotic (natural) elements and the presence / absence of technical infrastructure (utilities), as well as the proper use thereof. Analyses were performed using the following indicators: the share of protected areas in the total area of the community, the share of green areas in the total area of the community, forestation rates, share of the population using sewage system in the general population of the community, number of domestic sewage treatment plants and number of septic tanks per 1000 inhabitants, as well as the total municipal waste per capita. Rural and urban communities were compared. The data was obtained from GUS (Central Statistical Office), the local data bank. The results allowed for ranking the communities included in the study according to a hierarchy, and grouping them in the terms of spatial order in the environmental aspect.

**Keywords**

spatial order • environmental protection • shaping the environment • spatial planning

## 1. Introduction

Spatial order – based on article 1 paragraph, 1 of the Spatial Planning and Land Development Act of 27 March 2003 [Ustawa z dnia 27 marca 2003 r. o planowaniu i zagospodarowaniu przestrzennym, Dz. U. z 2003 r. Nr 80, poz. 717] is, along with sustainable development, the basis for the activities associated with the formation of spatial policy by the local government units and government administration bodies, intended use of areas for specific purposes as well as establishing the principles for their management and development. At the local level, the development of spatial order is the responsibility of each community.

According to the Act quoted above, spatial order consists in such formation or development of the given area, which creates a harmonious whole and includes – in the structured relationships – all the conditions and requirements: socio-economic, environmental, functional, cultural, aesthetic and compositional. Spatial order is therefore a multifaceted concept. In this paper it is assumed that the basic, primary element of any given area is the environment. Essentially, the order prevails in nature, thus it is in nature that it is discovered and explored. The undisturbed nature regulates itself and functions well [Parysek 2003]. Human needs can be met only with terrestrial natural resources, and this is why the environment is the source of everything that allows survival [Janikowski 2009]. Markowski [2003] notes that violation of the nature's order is extremely dangerous, and the nature itself can be treated as a synonym for the natural order. This order is the most difficult to restore, and – in some cases – it is impossible to reconstruct. The environment has three basic functions: creating the conditions for life processes, supplying raw materials and energy, as well as absorbing the side effects of human activities, including waste and pollution [Borys 1999].

In this paper, the opinion of Boris and Fiedor [2008] was followed: the indicators which describe the elements of the natural environment (the environmental sphere), socio-economic environment (the socio-economic sphere) and technical environment (technological, or infrastructural sphere) as well as the condition of these elements are the tools of information and diagnosis, which support the management of a particular sphere and the development of its order. The most important feature of these indicators is their comparability, which makes it possible to specify the position of an object (e.g. a community) against other objects. Therefore, in order to describe the state of the environment, in the present work we used the indicators, which are a function of a given characteristic (variable) as well as a synthetic indicator, which aggregates these variables.

## 2. Aims, materials and methods

The aims of the analysis were: 1) to evaluate the spatial order of urban and rural communities in Lower Silesia with respect to environmental sphere by using the indicators of environmental order; 2) to arrange communities according to a hierarchy; 3) to group the communities in terms of their similarities or differences; and 4) to determine the needs for protection and development of the environment in terms of environmental resources and equipment in the municipal infrastructure of the tested units.

The spatial scope of analysis included one hundred and eleven communities in Lower Silesia: thirty-three urban communities (29.7% of the examined communities) and seventy-eight rural ones (70.3% of the examined communities). The state of the communities was studied on the basis of 2013 data. Due to the fact that the subject of evaluation was the environmental aspect of spatial order – a complex phenomenon – a multidimensional comparative analysis was used as a research method. This method allows evaluation of a large number of objects (in this case, – communities, or local units) in terms of numerous variables (indicators) typifying these objects. The choice

of variables for analysis required prior determination of the scope of environmental aspects at the local (community) level, and the determination of data availability.

The study assumes that the data used to describe the communities should meet the following criteria: equal availability of data for all of the examined units, comparability and reliability of data, ease and speed of data collection as well as its free acquisition. For that reason, GUS (Central Statistical Office) was selected as the source of data.

A set of potential variables informing about the state of the environment within the given community was obtained, including:

- the share of protected areas in the total area of the community,
- the share of "soft" protected areas in the total area of the community (this category includes: landscape parks, environmental protection areas, landscape-nature protected complexes),
- the share of "hard" protected areas in the total area of the community (national parks, nature reserves),
- the share of green areas in the total area of the community,
- forestation rate,
- the share of the population using sewage system in the general population number,
- the number of septic tanks per 1000 inhabitants,
- the number of domestic sewage treatment plants per 1000 inhabitants,
- waste from households per 1000 inhabitants,
- total amount of municipal waste per capita.

The division of protected areas into "hard" and "soft" ones was made according to the recommendations of Śleszyński [2013].[1]

Redundant variables were rejected as a result of statistical procedures: variability of characteristics in relation to the objects. We then proceeded to study the degree of correlation of the data, which had been included. To examine the variability of characteristics, the coefficient of variation was used, and a critical value of 10% was assumed. Each variable with a coefficient value higher than the critical one was taken into account in the following stages of the research. The degree of variables' correlation was determined using Spearman's coefficient of rank correlation [Panek 2009]. The value of the critical ratio was determined arbitrarily at 0.7.

Thus selected variables were subject to a process of standardization and conversion of destimulants to stimulants in order to calculate the synthetic indicator, which describes the environmental aspect of spatial order. For each studied community, the synthetic indicator value was calculated on the basis of the previously transformed variables according to the Perkal formula [Runge 2007]. Furthermore, all of the commu-

[1] The indicator related to the share of protected areas in the total area of the community consists of the sum of areas of different categories, which vary greatly in terms of legal status, therefore Śleszyński suggests to distinguish two or three subcategories: "soft", "hard" and "natural" (Natura 2000).

nities were grouped using the Czekanowski method [Heffner, Gibas 2007; Kościółek 2014] and Maczek – the Polish program for grouping data.

## 3. Discussion of the results

Selected variables describing surface elements were chosen for the analysis: forestation rate, the share of protected areas in the total area of the community, and the share of green areas in the total area of the community. They are informative about the value of the environment, its quality, transformation of the environment as well as the possibility of using area for recreational purposes. The selected data also relates to municipal infrastructure (domestic sewage treatment plants, septic tanks, sewage system, municipal waste).

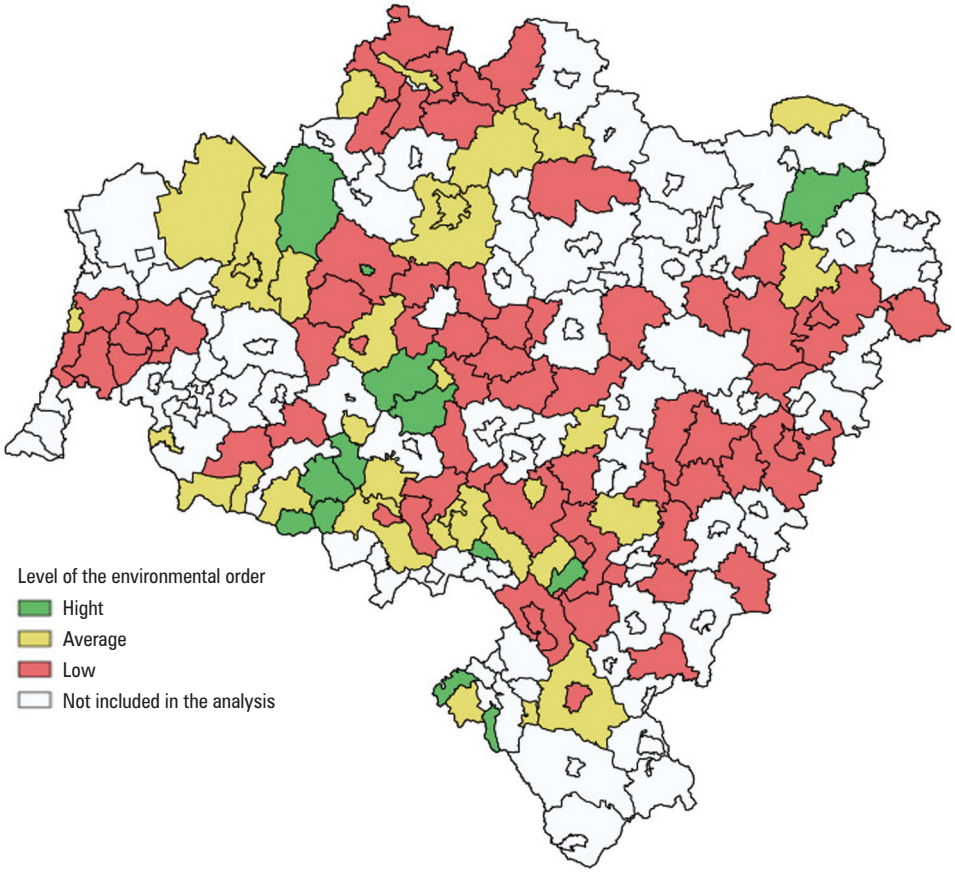
As a result of statistical procedures, a set of eight variables describing the community in terms of the environmental sphere was obtained. This set includes the following variables: 1) the share of protected areas in the total area of the community; 2) the share of "hard" protected areas in the total area of the community; 3) the share of "soft" protected areas in the total area of the community; 4) the share of green areas in the total area of the community; 5) forestation rates; 6) the share of the population using sewage system in the general population of the community; 7) the number of domestic sewage treatment plants per 1000 inhabitants; and 8) total municipal waste per 1 inhabitant. Finally, the variable for domestic sewage treatment plants was excluded from the study – even though the value of the correlation coefficient for this variable does not exceed 0.7, it is negatively correlated with the variable determining the share of the population using sewage system. Its inclusion in the calculation of the synthetic indicator would therefore be unjustified.

Using the synthetic indicator of the environmental sphere of spatial order, each community was evaluated and the ranking of communities was obtained. Values of the indicator for the year 2013 ranged between 0.69 and 2.45, with the average of 1.30. The maximum possible value that a community could obtain was 5.53, and the minimum was 0. The communities with high, medium and low level of spatial order were distinguished by dividing the synthetic indicator values into three equal classes: 2.45 – 1.86; 1.86 – 1.27; and 1.27 – 0.69. The first class consists of only thirteen communities that were rated the highest. The second class includes thirty-three communities, which received an average grade. The third class consists of the highest number of communities – sixty-five units, which received the lowest assessment possible. The classification of the communities is shown on the map (Figure 1).

Urban communities received higher values of synthetic indicator and a higher average rate than the rural ones. The indicator value for the urban communities is between 0.76 and 2.45 with the average of 1.5, while the rural ones received values from 0.69 to 2.37 with the average of only 1.21 (such average classifies communities in the lowest-rated class).

Seven urban communities obtained the highest values: Karpacz, Jedlina-Zdrój, Kudowa-Zdrój, Bielawa, Kowary, Chojnów, Duszniki-Zdrój, and six rural communi-

ties: Krośnice, Paszowice, Mysłakowice, Gmina Męcinka, Gromadka and Janowice Wielkie. The majority of these communities exhibit a high or an average value of the following indicators: the share of protected areas in the total area of the community, the forestation rate, the share of the population using sewage system in the general population number, the amount of municipal waste per capita, as well as a low value of the share of green areas in the total area of community.




Source: author's study (M. Mikołajczyk)

**Fig. 1.** The rural and urban community of Lower Silesia according to the synthetic indicator of the spatial order in the environmental aspect. Source: the calculations of the synthetic indicator based on BDL

The indicator of the share of protected areas in the total area of the community provides us with important information about its environment. Almost 32% of the communities subjected to the study do not have any protected areas within their administrative boundaries. Half of the communities have "soft" protected areas – land-

scape parks, environmental protection areas, or landscape-nature protected complexes. Eight communities with the highest share of "soft" protected areas (out of 43), that is 69%, featured in the highest assessed class of spatial order in the environmental aspect. Almost 28% of all communities have "hard" protected areas: national parks and nature reserves. The community of Karpacz, which obtained the first position in the ranking, has the highest share of the "hard" protected areas (53%) due to the significant share of the Karkonosze National Park, but it does not have any "soft" protected areas. One of the top classified communities – the urban community of Chojnów – does not have any protected areas whatsoever.

The indicator of the share of green areas in the total area of the community informs us about the quality of the environment, the possibility of using areas for recreational purposes as well as about the aesthetic qualities of space. Most of the analyzed communities are characterized by a low share of green areas in the total area of the community. This is particularly visible in the case of rural communities, for which the average share of green areas in the community area is only 0.07%. 38% of the rural communities do not have such areas at all. The highest share of green areas was found in the urban community of Chojnów – i.e. 10.3%.

Forestation rate has an impact on climate formation, water balance, maintaining biological potential of various species, and soil protection. Among the analyzed communities, a high proportion of forests in the community area – more than 60% – is found in two rural communities of Bolesławiec District: Osiecznica (83.8%) and Gromadka (71.6%), and in four urban communities belonging to the Jelenia Góra District: Szklarska Poręba (79.8%), Karpacz (64.1%), Kowary (63.9%) and Piechowice (62.6%). The average forestation rate in all studied communities is 23.8%; the average in all urban communities – 26%; and the average in rural ones – 22.9%. Only one community has no forest areas: the urban community of Jawor.

The share of the population using sewage system in the general population of the community is very important for the protection of environment. The higher it is, the better the environmental protection, as the amount of recycled sewage increases. None of the communities examined in 2013 had 100% of the population using the sewage system. The studied urban communities, in most cases, are better equipped in terms of sewage system than the rural ones. However, rural community of Warta Bolesławiecka is an exception, with the highest share of the population using sewage system – in this case, this figure stands at 99.5%. Only in four urban communities the share of population using sewage system is lower than 50%. These four communities constitute 12% of all studied communities. Among rural communities, this situation concerns over 67% of all studied communities. Furthermore, in 6% of the studied rural communities, the share of population using sewage system equals zero. The variable defining the share of the population using sewage system is negatively correlated with the variable of the number of domestic sewage treatment plants per 1000 inhabitants. It has been observed that the higher the share of the population using the sewage system, the lower the amount of domestic sewage treatment plants. This variable was not included in the calculation of the synthetic indicator. Both variables would negate each other's value:

some communities with a high percentage of the population using sewage system would have reduced the scores, because of the possession of a small number of domestic sewage treatment plants, and vice versa.

Rural communities demonstrate better results associated with the amount of municipal waste per capita. The average for rural communities in 2013 was 171 kg per capita, and for urban ones – 304 kg per capita. Among urban communities in 2013, the largest amount of municipal waste per capita was recorded in the urban community of Karpacz, at 602 kg, and among rural communities – in Kobierzyce – at 335 kg. The community of Karpacz received the highest rank in the assessment of environmental aspects of spatial order. The lowest amount of waste per capita among urban communities was recorded in Świeradów-Zdrój – at 161.2 kg, and among rural communities – in Dobroszyce – at 32.2 kg.

Normalized values for top-rated communities are presented in Table 1. Green color was used to highlight high values, yellow – for average values, and red – for low values. The latter can be observed especially in the case of the participation of green areas in the total area of the community, and the share of the "hard" protected areas. The majority of remaining variables received an average rank or a high rank.

**Table 1.** The normalized variables (I-VII) and the values of the synthetic index (WS) for the thirteen best assessed communities

| Community (urban/rural) | I | II | III | IV | V | VI | VII | WS |
|---|---|---|---|---|---|---|---|---|
| Karpacz (u) | 2.61 | 8.58 | 0 | 0.14 | 3.38 | 2.43 | 0 | 2,45 |
| Krośnice (r) | 3.39 | 0 | 4.35 | 0 | 2.03 | 1.40 | 5.41 | 2.37 |
| Jedlina-Zdrój (u) | 3.40 | 0 | 4.35 | 0.20 | 2.66 | 1.98 | 3.78 | 2.34 |
| Kudowa-Zdrój (u) | 1.57 | 5.16 | 0 | 0.41 | 2.50 | 2.75 | 3.20 | 2.22 |
| Paszowice (r) | 2.83 | 0.43 | 3.62 | 0.07 | 1.54 | 2.13 | 4.77 | 2.20 |
| Mysłakowice (r) | 3.09 | 0 | 3.96 | 0 | 2.08 | 1.74 | 4.23 | 2.16 |
| Męcinka (r) | 3.01 | 0 | 3.86 | 0 | 1.68 | 1.71 | 4.77 | 2.15 |
| Gromadka (r) | 2.06 | 0.13 | 2.75 | 0 | 3.78 | 1.15 | 4.57 | 2.06 |
| Bielawa (u) | 1.88 | 0.13 | 2.41 | 1.28 | 1.80 | 3.02 | 3.67 | 2.03 |
| Kowary (u) | 1.62 | 0.58 | 1.85 | 0.47 | 3.37 | 2.69 | 2.99 | 1.94 |
| Chojnów (u) | 0 | 0 | 0 | 6.96 | 0.02 | 2.92 | 3.48 | 1.91 |
| Duszniki-Zdrój (u) | 3.67 | 0 | 0 | 0.74 | 3.06 | 2.83 | 3.01 | 1.90 |
| Janowice Wielkie (r) | 2.16 | 0 | 2.77 | 0 | 2.08 | 1.49 | 4.79 | 1.90 |

Data Source: BDL. Author: M. Mikołajczyk

I – the share of the protected areas in the total area of the community; II – the share of the "hard" protected areas in the total area of the community; III – the share of the "soft" protected areas in the total area of the community; IV – the share of the green areas in the total area of the community; V – forestation rates; VI – share of the population using the sewage system in the general population number; VII – total municipal waste per capita; WS – the synthetic indicator

The division of communities into groups using the Czekanowski method facilitated the demonstration of a relationship (or lack thereof), between the studied communities. Among the tested objects, six groups of similar communities were formed. Some communities exhibit similarities with two groups only. Others do not show many similarities to any other objects. The total lack of the relationship is characteristic of the urban community of Karpacz, and an almost total lack – of the urban community of Kudowa-Zdrój, which is very poorly connected with the following communities: Szklarska Poręba, Piechowice, Podgórzyn and Lewin Kłodzki. Likewise the urban communities of Bielawa and Duszniki-Zdrój have poor relationships with other communities, and they do not belong to any of the created groups.

The first and largest group includes sixty-two urban and rural communities, which were assessed in the ranking as average or poor. The second group includes seventeen communities. Some communities have links with these two groups. Eight out of thirteen highest ranked: Marciszów, Janowice Wielkie, Męcinka, Paszowice, Mysłakowice, Jedlina-Zdrój, Krośnice and Gromadka are similar to each other and form another group. The urban community of Chojnów has very weak links with the urban communities of Świdnica, Głogów, Zgorzelec, Dzierżoniów and Jawor, and together with those communities, it forms a group – the relationship is due to a significant share of green areas in the total area of the community. The fifth group includes three communities: Wałbrzych, Polanica-Zdrój and Szczawno-Zdrój. They are distinguished by a high proportion of the population using sewage system, an average percentage of forestation, and a low value of other variables. The last group consists of rural communities: Legnickie Pole, Kobierzyce, Kamieniec Ząbkowicki and Zgorzelec, which received the lowest score of the environmental aspect of spatial order.

## 4. Conclusion

The study made it possible to assess the condition of spatial order in the environmental aspect in terms of selected variables for one hundred and eleven rural and urban communities in Lower Silesia. It also allowed us to determine similarities between the studied communities as well as to demonstrate the possibility of development of these communities.

The top rated community in the study is the urban community of Karpacz. It has a high forestation rate, the highest share of the "hard" protected areas in the total community area (Karkonosze National Park) of all the analyzed communities, and a high percentage of the population using sewage system. However, it has an average share of protected areas in the community area, a low share of green areas in the community area, zero "soft" protected areas as well as the highest amount of municipal waste per capita. This community stands out from other analyzed objects and it shows no similarities to them.

Nearly all of the top rated communities have protected areas. The only exception is the urban community of Chojnów – which is located on the 11th position in the ranking, and does not have any protected areas whatsoever. This community exhibits the highest share of green areas.

None of the studied communities obtained the highest possible value for all the variables, which were taken into account in the analyses. Only thirteen out of one hundred and eleven communities received high scores for the synthetic indicator of the environmental aspect of spatial order, and as many as sixty-five received the lowest score. This means that the studied communities have an opportunity for development, and for improvement in the environmental aspect. There is a probability that the development of communities is possible for the majority of the studied variables, for instance through expansion of the sewage system, designation of green areas and environmental protection areas. Improvement of the values for these variables will result in a higher evaluation of the environmental aspect.

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