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The sozological profiles of Polish communes (2000 – 2009) – methods and applications

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Abstract: The great amount of sozological information, which means the one in regard to the pressure on environment, its quality and actions undertaken in the scope of environmental protection, which was gathered within the last two decades, was not fully used at that time in order to work out detailed synthesis, which are so far outdated for the whole of Poland or are prepared in regard to the voivodeships. This has resulted in the lack of complex introductory sozological data for policies and strategic documents at the national and regional levels, in which the socio-economic data is far more detailed than the sozological ones. Thus, this article presents studies undertaken by the author, which is aimed at working out methods of complex sozological diagnosis as well as selected initial results of their application. The search query of the resource data, carried out in 20 institutions allowed to choose data from the first ten, which was used to calculate ca. 80 measures of pressure on environment, its quality and reaction to environmental issues. 2478 Polish communes constituted the basic field of analysis, and the study period covered the years 2000-2009. The sozological regionalization of Poland shall be the ultimate aim of the research. It will allow for the formulation of the recommendations in regards to required actions in the scope of environmental protection in different types of communes. Results shall facilitate an increase in the range of environmental information which shall be used in strategic documents and strategic environmental impact assessments. They can also improve the process of law implementation, including the EU directives.

***Key words*:** sozological diagnosis, environmental quality, environmental indicators, sozological regionalization, Poland

Introduction

Recognition of the issues connected with anthropogenic pressure on the environment, its quality as well as actions within the scope of environmental protection, traditionally determines one of the main directions of research within the natural sciences. Apart from the scientific value, this research also constitutes a very important role of application. It constitutes the basis for formulating various policies and strategies which are to mitigate the influences of anthropogenic system on the natural system as well as to implement the actions. In Poland, especially after the year 1989, when the transformation of the political regime took place, the amount of information and synthesis considering the issues of environmental protection has risen gradually. Although – due to information explosion – the amount of data is enormous, these synthesis are of local or general character, which refers to the vast units of administrative division of the country.

The XXth century ground-breaking Polish research, within this field, led in the 80s towards delimitation of the endangered areas and the ecological disaster (Kasenberg, Rolewicz 1985, Rolewicz 1993). However, from that moment on, a few detailed synthesis of the sozological data of Poland were carried out, among which the research conducted by Siuta and Kucharska (1996) ought be considered as the most important. Majority of this kind of studies were carried out by Environmental Protection Inspection Agency (IOŚ 2003, 2004, 2010a, 2010b). However, as a rule, they presented information for 16 voivodeships or the entire country and spread over relatively short periods of several years. The use of this abundant information about the natural environment and its protection could not keep up with the increase of its amount.

Even the amount and the accuracy of data used in the process of preparing the strategic documentation at the national level could be the evidence for the above-mentioned thesis. Among the most recent policies, prepared by the Ministry of Regional Development, which refers to e.g. National Strategy of Regional Development 2010-2020 and the project Concept of Spatial Management of the Country 2030. While the majority of socio-economic diagnostic data was presented thereby at the level of accuracy complying with particular communes, the data describing the environment was referred to as districts or schematically drawn area of the real occurrence of particular phenomenon. The “averageness” of some phenomena, e.g. terrain of the protected areas, within the vast administrative units, leads very often to a false diagnosis. It is similar in case of the application of the above-mentioned rate of the share of protected areas in the total district area in order to determine the natural value of the area, which cannot be characterized by the high consistency.

The above-mentioned factors incline to conclude that the level of use of data referring to natural environment in Poland is insufficient and inadequate compared to the number of collected information and the prepared synthesis does not allow for the effective application of such for the need of preparing various politics and strategic documents at the national and voivodeship levels. Thus, the main motive of carrying out the research was the need for a corresponding consideration of natural, social and economic information in the policies of spatial dimension character as well as in the politics and strategic documents which present these assumptions. That is why the author of the article, using the financial resources granted by Ministry of Science and Higher Education, started his research in order to fill up this gap. This study aims at working out the sozological diagnosis for Poland at the commune level which shall end with the sozological classification of the country. Both previous foreign experiences (among others, the works of Braun 2008, Danz 2007, Dearing 2006, Metzger, Schröter 2006 and Wilson et al. 2007) as well as the research carried out by the author at the voivodeship level (Kistowski 2003, Gończ, Kistowski 2004) and other national studies (among others Bartkowski 1975, Borys 2005).

The term “sozology” used in our title was introduced in the mid 60s of the XXth century (Goetel 1966) and refers to the field of study dealing with the issues of environmental protection, causes and the effects of anthropogenic changes on the structure and functioning of natural systems as well as the ways of preventing and reducing their effects. Even though, its application has not been generally accepted in world-literature, it is still often used in Poland (e.g. in the case of maps presenting environmental protection issues) & renders, in a great way, the object of the research whose methodological assumptions and initial results are presented in this article.

Fundamental sources of sozological information, study assumption and methods

The main aim of the research was to devise and introduce the method of complex sozological diagnosis, which would enable a better consideration of synthetic environmental information in the state’s policy. The research was carried out in the years 2009-2012 and divided into four basic stages presented in figure 1.

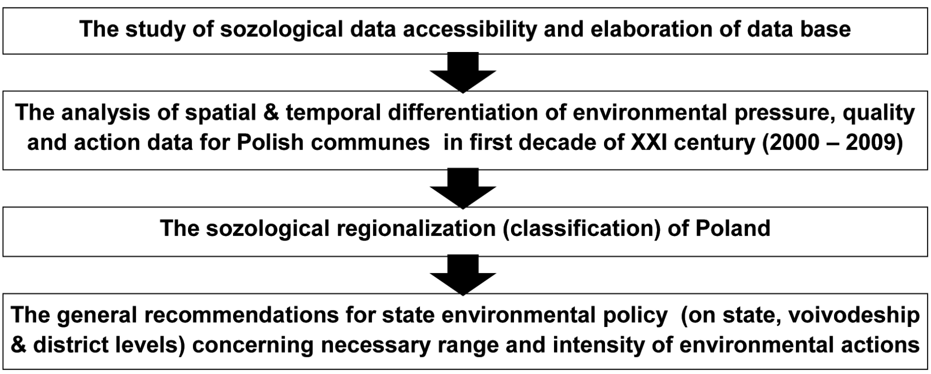

Fig.1. The main stages of study

The main operational goal encapsulated preparation of a set of measuring instruments and environmental indices concerning three "classical" groups of environmental protection issues:
- anthropogenic pressure (impact) on the environment,
- quality (condition) of the environment,
- people's actions within the scope of environmental protection (reaction to its unsatisfactory quality).

2478 Polish communes were accepted as basic field for diagnosis, while the municipal-village boroughs were treated as a single unit. Due to the accessibility and – for majority of features – comparability of data, the 2000-2009 decade was accepted as the first period of diagnosis.

A fundamental problem which occurred in the first stage of this research was the efficient selection of data, which would meet particular conditions. In spite of a great amount of information, have been met various difficulties in the process of recognition of its sources, which considered in particular:
- vast range of data sources, which made it difficult to put their structure in order,
- diversity of the spatial character of data (point, line, spatial data) in the area under consideration (e.g. communes, water catchment areas, geometric fields in the case of modeling), which would result in the need to unify all data for the sake of estimation,
- diversity of the cycle of data gathering,
- changeability in the methodology of monitoring and evaluation of the quality of the environment,
- spatial and time gaps in sozological data.

Having verified the accessible data, there was assumed that exists a condition on which one can apply them in the study. They need to have the below-stated features:
- quantification of data in a form of absolute value or the evaluation presented at the point of classification application,
- unambiguous localization of the place/area to which the data refers,
- relatively uniform coverage of the area of the country which would enable the evaluation of spatial diversity,
- accessibility of data, at least, to the half (5 years) of the study period (in a few specific cases the data from the shorter period was allowed),
- representation of relatively vast range of environmental characteristic and the issues of its protection.

The data gathered in the Local Data Bank of Central Statistical Office (LDB) (http://www.stat.gov.pl/bdl/) met the above-mentioned conditions best, considering the measures of pressure on the environment and the response, while considering the measures of environment quality such data were found in State and Regional Inspectorates of Environmental Protection. However, they were more faulty than those from the LDB. Moreover, having verified the data coming from ca. 20 different institutions, only were used information gathered and processed by:
- State Sanitary Inspectorates,
- Polish Geological Institute,
- Administration of State Forests (Forestry Research Institute),
- Institute of Soil Science & Plant Cultivation,
- Polish Academy of Science (Institute of Nature Conservation and Institute of Zoology),
- Polish Society for Bird Conservation and other Polish ecological NGOs,
- Office for Pro-ecological Consulting and Measurements "Ekometria" from Gdańsk.

For the data considering the quality of environment, additional rate of completeness of information (K) was defined and calculated on the basis of the following formula:

$$K = n L \ / \ 10 P$$

where: n – total number of points, in which the monitoring of environmental quality was carried out in the years 2000-09,

L – number of years, in which the monitoring of environmental quality was carried out in the years 2000-09,

P – area of the unit (commune), where the completeness of information was evaluated (km^2).

Finally, it was decided to apply ca. 80 measuring instruments (table 1): 30 within the scope of the pressure on environment, 30 considering the quality and 20 referring to the protective actions.
The values were determined for each year of the research period, for which data were accessible in case of measures of pressure on environment and reaction:
• measures complying with the absolute values of substances introduced to the environment or resources drawn from it or measures reducing the amount of harmful substances or amount/area of the undertaken protective actions;
• indices calculated by referring one absolute values to the others (the percentage) or referring to the number of population or the commune area.
In case of measures of environmental quality, they were most often defined as concentration of the substance in the particular volume of air or soil; or the class of quality of environment owing to the classification determined by the precepts of the law, drawn up on the basis of the analysis of concentration of various pollutions or on the number of organisms (surface and underground waters, water sediments, defoliation of forests, condition of habitats and species). Determined in such way measures and indices enabled carrying out the analysis, which referred to their:
• values for particular years (especially last year) within the study period,
• average value for the whole study period;
• tendency for the changes in values within the whole period of diagnosis (the final year minus the initial year).

Table1. The share & characteristics of measures for sozological diagnosis of Poland

No	**Data subject**	**Period**	**Type of measure**		**Index reference**	**Data source**
			Absolut measure	**Index**		
Pressure on environment measures						
1	Total industry emission of air gas pollutants	2000-05	t	$t*km^{-2}$	comm. area	BDL GUS
2	Total industry emission of air dust pollutants	2000-05	t	$t*km^{-2}$	comm. area	BDL GUS
3	Total water consumption by state economy & municipal consumers	2000-09	dam^3			BDL GUS
4	Water delivered to households	2000-09	dam^3			BDL GUS
5	Households water consumption per 1 consumer	2002-09		m^3*pers^{-2}	comm. popul.	BDL GUS
6	Water consumption by industry	2000-09	dam^3	$dam^3*enterprises^{-2}$	enterprises (RegonC,D,E)	BDL GUS
7	Water consumption by agriculture & forest economy	2000-09	dam^3			BDL GUS
8	Households energy consumption per 1 consumer	2002-09		$kWh*pers^{-2}$	comm. popul.	BDL GUS
9	Total waste water requiring treatment	2000-09	dam^3			BDL GUS
10	Total untreated waste water discharged to water and soil	2000-09	dam^3	%	waste water requiring treatment	BDL GUS
11	BOD_5 loads in municipal waste water after treatment	2000-09	kg	$kg*pers^{-2}$	comm. popul.	BDL GUS
12	COD loads in municipal waste water after treatment	2000-09	kg	$kg*pers^{-2}$	comm. popul.	BDL GUS
13	Suspension loads in municipal waste water after treatment	2000-09	kg	$kg*pers^{-2}$	comm. popul.	BDL GUS
14	Total N loads in municipal waste water after treatment	2000-09	kg	$kg*pers^{-2}$	comm. popul.	BDL GUS
15	Total P loads in municipal waste water after treatment	2000-09	kg	$kg*pers^{-2}$	comm. popul.	BDL GUS

16	BOD_5 loads in industrial waste water after treatment	2000-09	kg	kg*enterprises^{-2}	enterprises (RegonC,D,E)	BDL GUS
17	COD loads in industrial waste water after treatment	2000-09	kg	ditto	ditto	BDL GUS
18	Suspension loads in industrial waste water after treatment	2000-09	kg	ditto	ditto	BDL GUS
19	Total N loads in industrial waste water after treatment	2005-09	kg	ditto	ditto	BDL GUS
20	Total P loads in industrial waste water after treatment	2005-09	kg	ditto	ditto	BDL GUS
21	Chlorides & sulfides loads in industrial waste water after treatment	2003-09	kg	ditto	ditto	BDL GUS
22	Volatile phenols loads in industrial waste water after treatment	2003-09	kg	ditto	ditto	BDL GUS
23	Total sludge generated from municipal waste water treatments	2003-09	t	kg*pers^{-2}	comm. popul.	BDL GUS
24	Deposited sludge generated from municipal waste water treatments	2003-09	t	kg*pers^{-2}	comm. popul.	BDL GUS
25	Sludge from municipal waste water treatments accumulated to 2009	2003-09	t	kg*pers^{-2}	comm. popul.	BDL GUS
26	Total sludge generated from industrial waste water treatments	2003-09	t	kg*enterprises^{-2}	enterprises (RegonC,D,E)	BDL GUS
27	Deposited sludge generated from industrial waste water treatments	2004-09	t	ditto	ditto	BDL GUS
28	Sludge from industrial waste water treatments accumulated to 2009	2004-09	t	ditto	ditto	BDL GUS
29	Mixed municipal waste collected during the year	2005-09	t	kg*pers^{-2}	comm. popul.	BDL GUS
30	Total industrial waste generated	2000-09	1000 t	t*enterprises^{-2}	enterprises (RegonC,D,E)	BDL GUS
31	The area of land filled industrial waste	2000-09	ha	‰	comm. area	BDL GUS
32	Timber removals from non-state forests (private and municipal)	2000-09	m^3	m^3*ha^{-1}	area of private and municipal forests	BDL GUS
Environmental quality (state) measures						
33	Average SO_2 air concentration in monitoring points	2000-09		μg*m^{-3}		PMŚ GIOŚ
34	Average NO_2 air concentration in monitoring points	2000-09		μg*m^{-3}		PMŚ GIOŚ
35	Average PM10 air concentration in monitoring points	2000-09		μg*m^{-3}		PMŚ GIOŚ
36	Average benzene air concentration in monitoring points	2004-09		μg*m^{-3}		PMŚ GIOŚ
37	Average benzo-α-pyrene air concentration in monitoring points	2004-09		ng*m^{-3}		PMŚ GIOŚ
38	Average arsenic air concentration in monitoring points	2000-09		μg*m^{-3}		PMŚ GIOŚ
39	Average cadmium air concentration in monitoring points	2000-09		μg*m^{-3}		PMŚ GIOŚ
40	Average nickel air concentration in monitoring points	2000-09		μg*m-^{3}		PMŚ GIOŚ
41	Average lead air concentration in monitoring points	2000-09		μg*m^{-3}		PMŚ GIOŚ
42	Number of permissible concentrations exceedances for chosen air pollutants in monitoring points	2005-09	number of days	% of days in year	number of days in year	PMŚ GIOŚ
43	Modelling average year SO_2 air concentration in communes	2005,2008		μg*m^{-3}		Ekometria

44	Modelling average year NO_2 air concentration in communes	2005,2008		µg*m^{-3}		Ekometria
45	Modelling average year NO_x air concentration in communes	2005,2008		µg*m^{-3}		Ekometria
46	Modelling average year PM10 air concentration in communes	2005,2008		µg*m^{-3}		Ekometria
47	Modelling average year PM2,5 air concentration in communes	2005,2008		µg*m^{-3}		Ekometria
48	Average quality class of rivers water in monitoring points	2000-03		class I-non		PMŚ GIOŚ
49	Average quality class of rivers water in monitoring points	2004-07		class I-V		PMŚ GIOŚ
50	Ecological state/potential of rivers' water in monitoring points	2008-09		class 1-5		PMŚ GIOŚ
51	Average quality class of lakes' and reservoirs' water in monitoring points	2000-06		class I-non		PMŚ GIOŚ
52	Average quality class of lakes' and reservoirs' water in monitoring points	2007-09		class I-V		PMŚ GIOŚ
53	Average quality class of underground water in monitoring points	2000-09		class I-V		PMŚ GIOŚ
54	Average quality class of water's bottom sediments in monitoring points	2000-09		class 0-III		PMŚ PIG
55	Average noise level of day-time in monitoring points	2000-09	dB			PMŚ GIOŚ
56	Average cadmium arable soil concentration in monitoring points	2000,2005		mg*kg^{-1}		PMŚ IUNiG
57	Average copper arable soil concentration in monitoring points	2000,2005		mg*kg^{-1}		PMŚ IUNiG
58	Average nickel arable soil concentration in monitoring points	2000,2005		mg*kg^{-1}		PMŚ IUNiG
59	Average lead arable soil concentration in monitoring points	2000,2005		mg*kg^{-1}		PMŚ IUNiG
60	Average zinc arable soil concentration in monitoring points	2000,2005		mg*kg^{-1}		PMŚ IUNiG
61	Average S-SO_4 arable soil concentration in monitoring points	2000,2005		mg*100g^{-1}		PMŚ IUNiG
62	Average aromatic hydrocarbons arable soil concentration in monitoring points	2000,2005		µg*kg^{-1}		PMŚ IUNiG
63	Area of anthropogenic land cover (Corine Land Cover 1.1-1.4 classes)	2000,2006	km^2	%	comm. area	Corine L.C.
64	Average defoliation class of forests stands	2000-09		formula		PMŚ IBL
65	Average class of Nature 2000 biotopes conservation state	2006/09		class 0-2		PMŚ GIOŚ
66	Average class of Nature 2000 plant species conservation state	2006/09		class 0-2		PMŚ GIOŚ
67	Average class of Nature 2000 animals species conservation state	2006/09		class 0-2		PMŚ GIOŚ
Response for environmental problems measures						
68	Reduction of industry emission of air gas pollutants	2000-05	t	%	gas pollutants emission	BDL GUS
69	Reduction of industry emission of air dust pollutants	2000-05	t	%	dust pollutants emission	BDL GUS
70	Municipal waste water biologically treated & treated with increased biogene removal	2003-09		%	total municipal waste water	BDL GUS
71	Industrial waste water biologically treated & treated with increased biogene removal	2000-09	dam^3	%	total industrial waste water req.treatment	BDL GUS
72	Recycled municipal sewage sludge	2003-09	t	%	total municipal sewage sludge	BDL GUS

73	Recycled industrial sewage sludge	2004-09	t	%	total industrial sewage sludge	BDL GUS
74	Municipal waste collected & land filled	2005-09	t	%	total collected municipal solid wastes	BDL GUS
75	Recycled industrial waste	2002-09	1000 t	%	total industrial solid wastes	BDL GUS
76	Balance of municipal trees planting & cuttings	2004-09	quantity	pcs*km^{-2}	comm. area	BDL GUS
77	Balance of municipal shrubs planting & cuttings	2004-09	quantity	pcs*km^{-2}	comm. area	BDL GUS
78	Parks & other municipal green areas	2000-09	ha	%	comm. area	BDL GUS
79	Forests areas	2000-09	ha	%	comm. area	BDL GUS
80	Total afforestation areas	2000-09	ha	‰	comm. area	BDL GUS
81	National parks areas	2000-09	ha	%	comm. area	BDL GUS
82	Nature reserves areas	2000-09	ha	%	comm. area	BDL GUS
83	Landscape parks areas	2000-09	ha	%	comm. area	BDL GUS
84	Number of nature monuments	2000-09	quantity	pcs*km^{-2}	comm. area	BDL GUS
85	Number of nature monuments established by local self-governments	2003-08	quantity	pcs*km^{-2}	comm. area	BDL GUS
86	Nature 2000 (SPAs & SACs) areas	2009	ha	%	comm. area	GDOŚ

Explanations: BDL GUS – Local Data Bank, PMŚ – state environmental monitoring, GIOŚ – Chief Inspecto-rate of Environmental Protection, PIG – Polish Geological Institute, IUNiG – Institute of Soil Science & Plant Cultivation, IBL – Forestry Research Institute, GDOŚ - General Directorate for Environmental Protection

In order to carry out the sozological classification of communes the integrated measures were calculated (according to the scheme presented in fig. 2), having calculated the measures and indices within the frame of each of the three basic groups (pressure, quality and reaction). The next step was their standardization considering to particular components and elements of environment, which refer to sozological issues (particularly air and acoustic climate, waters, land surface with soils and the biotic features). It served the purpose of limiting the number of variables, in order to simplify the process and enable an attempt to evaluate the relation between the values of some groups of measures (e.g. the ones referring to waters and air) within two or three groups. Sozological classification is will be the last stage of the study, planned to carried out in the year 2012.

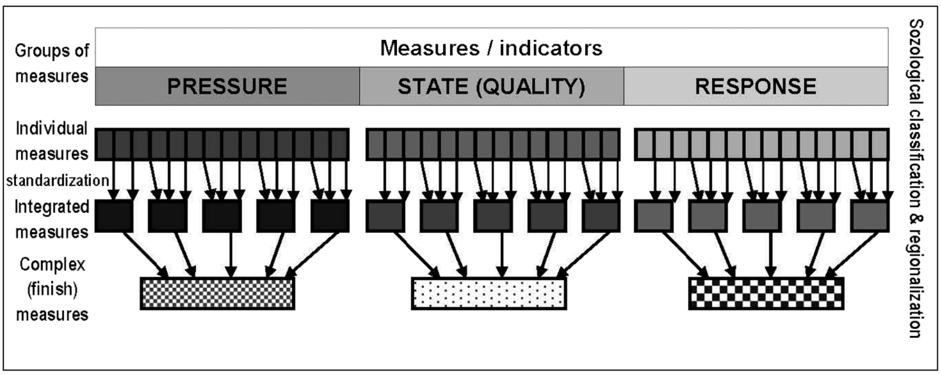

Fig.2. The process of sozological data aggregation as an element of study method

Selected initial results of the study

A very vast scope of research realized in the frame of the presented project, due to its duration, now only allow to indicate some examples referring to the basic groups of results, which ought to be fully published by the end of year 2012. Some selected results were presented below and they refer to:

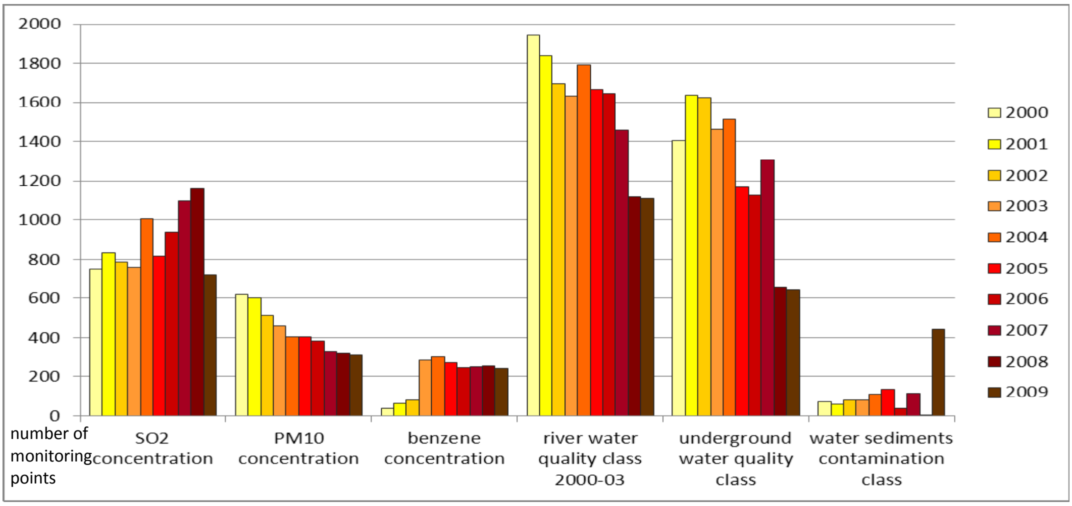

Fig.3. The number of example environmental monitoring points in Poland during study period

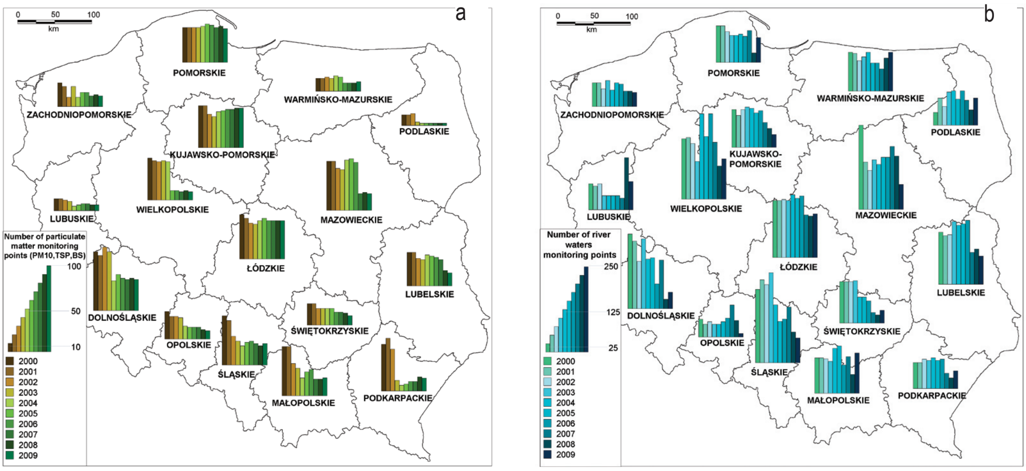

Fig. 4. The number of environmental monitoring points in every voivodeship during study period: a - particulate matter concentration monitoring, b - quality of river waters monitoring

• evaluation of completeness of data referring to some features of the quality of environment,
• evaluation of quality of the environmental features in the selected voivodeship,
• measures and indices of pressure on the environment considering communes throughout Poland.

With respect to the amount of data, figure 3 presents a general number of measuring points of environmental monitoring during each year of the study period. They define the air concentration of: sulphur dioxide, particulate matter (PM10, BS – black smoke, TSP – total suspended particulate) and benzene as well as the class of cleanliness of flowing, stagnant water bodies (lakes) and underground waters. Collected data shows that the majority of measuring points refers to the flowing (rivers) and underground waters while the least points refer to stagnant waters and benzene. In the case of flowing and underground waters as well as the dust in the air, we observe a decrease in the number of points in the second half of the study period. It is mainly due to adjustment in the Polish system of environmental monitoring to the standards of European Union and leaving the "preventive" monitoring (which is already carried out on the areas with the diverse quality of environment) in favor of "warning" monitoring realized mainly on the terrains which are endangered by anthropogenic changes of the environment.

The same information, although presented in a more detailed way referring to the voivodeships, is shown in

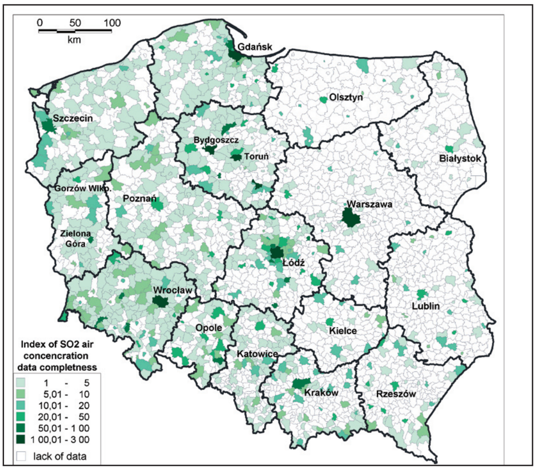

Fig. 5. Index of data completeness for SO2 air concentration in communes during 2000-09

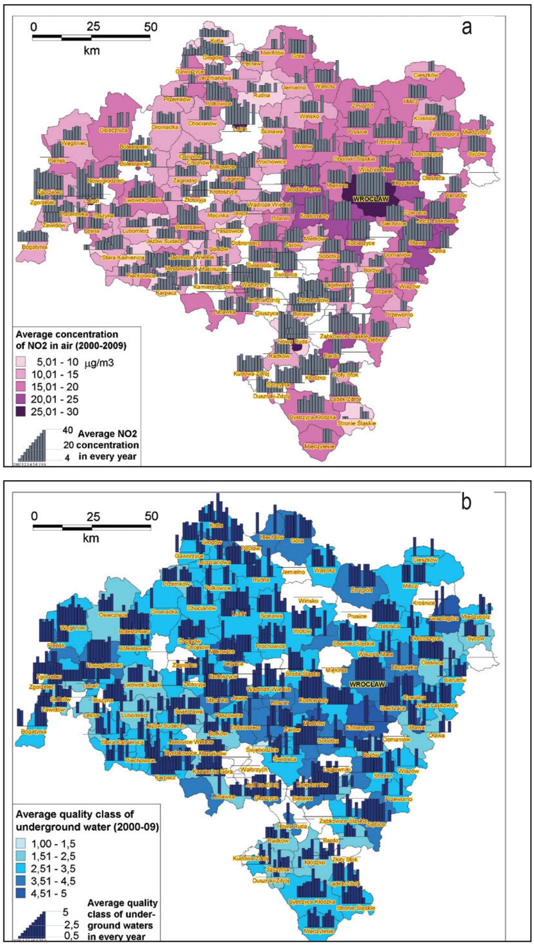

Fig.6. The every year and average value during 2000-09 of environmental indicators in communes of Lower Silesia voivodeship: a - NO2 concentration in air, b - underground waters quality classes

figure 4 – and representing the example of the number of measuring points of condensation of particulate matter and the quality of flowing waters. In the first case we observe huge, multiple differences between the number of points in the particular regions. Majority of points (from several dozens to over 100 annually) were shown in the following voivodeships: Lower Silesian, Łódź, Masovian, Kuyavian-Pomeranian and Pomeranian. While the least points (from a few to a dozen or so) in: Podlaskie, Warmian-Masurian, Lubusz and West Pomeranian. In some regions the number of points was stable within the entire period of study (Kuyavian-Pomeranian, Pomeranian, Łódź) while in the others (Lower Silesian, Silesian, Lesser Poland, Podkarpackie) the number was greatly reduced, up to a few times (like in The Greater Poland).

Considering the quality of the river waters, the differences between the number of monitoring points in particular regions are not such significant (maximum 3-times). However, there are also voivodeships with dense network of points (170-250 annually): Silesian, Great Poland, Lower Silesian, Łódź, Masovian; and the scarce network (50-100 annually): Opolskie, Lubusz. West Pomeranian and Podkarpackie. In that case, also in the late years of the study period, in some regions we could observe the drop in a number of points (e.g. Lower Silesian, Great Poland, Świętokrzyskie) whereas an increase in the other ones (Lubusz) while there was also the ones which are characterized by a stable number (e.g. Łódź, Little Poland, Warmian-Masurian).

The last, most detailed example of the research on the data range, refers to distribution of the meter of information completeness (K) with respect to the measuring points of condensation of SO2 in the air within the communes network (fig. 5). What results from that is that the highest completeness of data occurs in the most populated cities (Warsaw, Łódź, Wrocław, Gdańsk, Bydgoszcz, Toruń, Włocławek, Kraków, Szczecin and a few other ones) as well as within and in the surroundings of the urban agglomerations. The communes of Western Poland are characterized by much higher completeness than the ones in the Eastern part. It is particularly high in the Lower Silesian and Pomeranian regions.

The following results of this study consider the spatial and temporal distribution of the selected indices of pressure on the environment as well as its quality in the chosen voivodeship (Lower Silesian) and the whole country. The

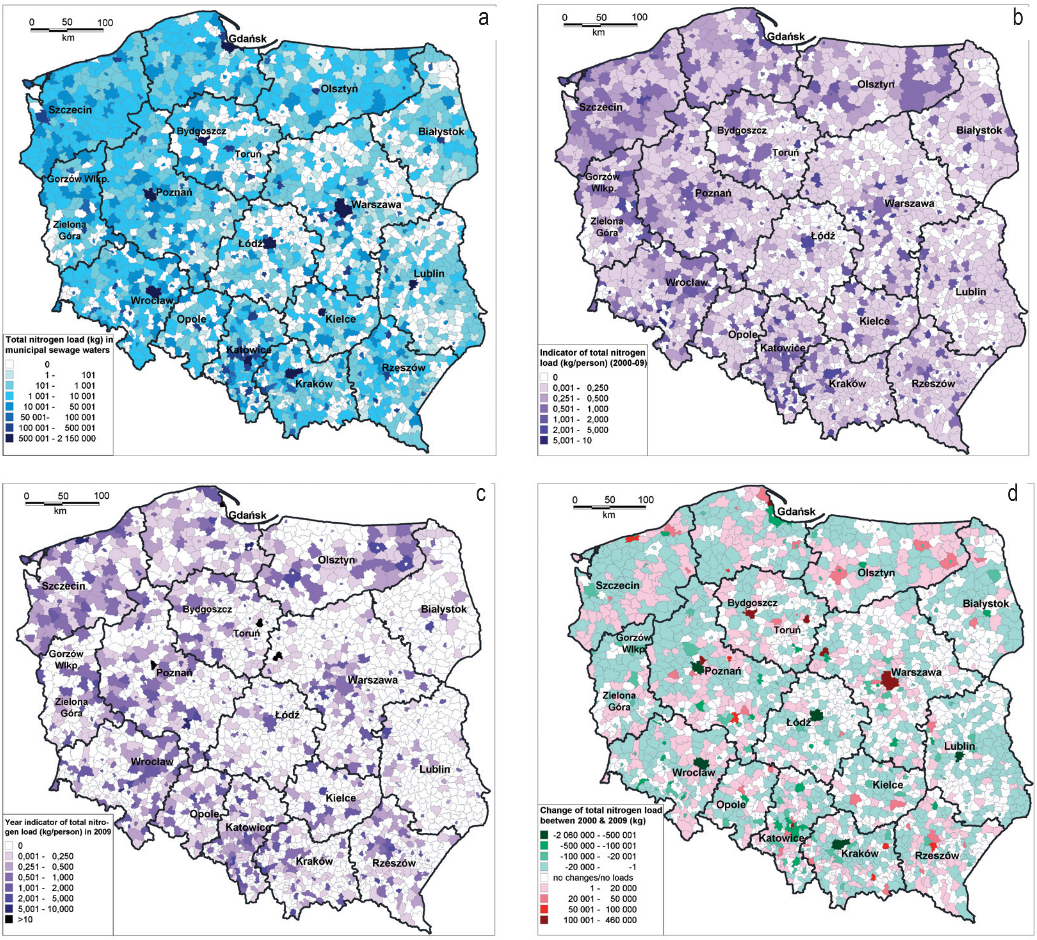

Fig.7. The different types of measures of nitrogen load in municipal sewage waters for Polish communes: a - average year total nitrogen load during 2000-09 (kg), b - average index of total nitrogen load during 2000-09 (kg/person), c - average index of total nitrogen load in 2009 (kg/person), d - change of total nitrogen load between 2000 and 2009 (kg)

voivodeship example refers to condensation of NO2 in the air and the class of the quality of underground waters in the communes of Lower Silesian voivodeship in the years 2000-2009 (fig. 6). The average condensation or the class in a decade was presented by the cartogram, while the cartogram presents the averages for the communes separately for each year. In both cases the data are characterized by a high completeness. They depict worse condition of the environment in the Wrocław agglomeration and its surroundings, as well in some other towns and the northern part of this region while the better condition was found in Sudety Foreland and Kłodzko Land. Generally, it reflects the spatial distribution of the main factors of pressure on the environment: intensity of traffic in case of air pollution condensation and the anthropogenic sources of pressure on underground water (the intense settlement, industrial activity, agriculture and tourism).

The last example refers to the selected measures of pressure on the environment – the load of nitrogen disposal into the water environment from municipal sewages. It was presented in figure 7 in four depictions: average-yearly absolute amount of load in the years 2000-2009 (kg) (a), index of average-yearly absolute amount within the study period in regard to the population in the communes (b), the same index for the year 2009 (the final year of the study period) (c), and the change in the size of the absolute nitrogen load between the year 2000 and 2009 (d). The general pictures of the distribution of the absolute values of this meter and the index referring to the number of inhabitants are quite similar (the greater intensity of the pressure on environment in the Western, Southern and Northern Poland, lower in the Eastern and Central Poland outside the urban agglomerations). However, the more detailed analysis shows, that the highest absolute values of the load of nitrogen in the communal sewage (>500 000 kg annually) are characteristic for the main cities (Warsaw, Łódź, Kraków, Wrocław, Poznań, Gdańsk, Lublin, Katowice, Bydgoszcz), while the index referring to the population is the highest (5-10 kg/capita annually) in the urban and rural communes, where the sewage treatment plants were located, which were operating for the service of the majority of communes, especially in the metropolis (Walim and Świebodzice in Lower Silesian and Pruszków in Masovian). The absolute change in the size of the load between the initial and the final year of the study period remains significantly different. The greater increase of the load (100 000 – 460 000 tons), which implies a greater pressure on the environment, occurred in the communes of various character, which are commonly characterized by the introduction or increase of throughput in the existing sewage treatment plant. These are, for example, Warsaw and Stara Biała in Masovian, Bydgoszcz and Brzuze i Kuyavian-Pomeranian, Czerwonak In Great Poland or Kosakowo in Pomeranian. On the other hand, the greater drop in the load of nitrogen in the sewage (500 000 – 2 000 000 tons), which is an evidence of a decrease in anthropogenic pressure on water environment, occurred in the largest cities (Łódź, Kraków, Wrocław, Poznań, Lublin), where the municipal treatment plants were modernized, thus, increased efficiency in reduction of pollution in the sewage.

Directions of Application of the study results

The random examples of the accomplished research presented in this article are the evidence of the vastness of the range of issues conveyed by this study, which depicts varying applications. One should expect that its basic ultimate effects would be:

• recognition of the spatial distribution of the pressure on environment, its quality and the selected actions within the frame of environmental protection of the communes system in Poland,

• defining the temporal dynamics of the above-mentioned phenomena in the first decade of the XXI century in the communes,

• carrying out the sozological regionalization of Poland,

• an attempt to formulate recommendations for policy-making at the national, voivodeship and district levels in regards to the scope and intensity of the actions in favor of environmental protection.

One ought to hope that these results, after proper dissemination in both traditional and Internet forms of publication should be applicable, among other things, in:

• the process of working out the documents in the field of ecological policy of the state, including the programs of environmental protection at the voivodeship and district levels as well as other strategic documents of the spatial nature (e.g. the Concept of Spatial Management of the Country, plans of spatial management of voivodeships and the metropolitan areas, national and voivodeship developmental strategies, and sectorial policies) in order to improve the implementation of the environmental data into the above-mentioned documents,

• work out the strategic environmental assessments for influencing the environment in different documents at the national and regional levels, thanks to which their quality, presently considered to be ineffective, may increase,

• indicate the information gaps considering sozological data and the other problems with regards to collection, processing and disseminating these data, which allow for upgrade and optimize the process of data collection and gathering,

• implement the requirements resulting from the national and commonwealth regulations, especially the directives relating to the quality of air and its protection, Water Framework Directive or the INSPIRE Directive, which implementation into the Polish practice of environmental protection is far too slow.

The great range of cartographic products, worked out with the use of the GIS technologies, may also allow for working out the preparation of a sozological atlas in the future. The proposed methodology, in case of its positive verification, can be useful in the future to update the sozological diagnosis of the country on the basis of data for the following periods.

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