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Original Research Article

PROTECTION OF AIR AND GROUNDWATER IN POLISH MUNICIPALITIES OF VARYING WEALTH AS ADAPTATION TO CLIMATE CHANGE

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A b s t r a c t

Protection of air and groundwater as an adaptation to climate change is currently one of the main economic and social challenges at both the global, national, regional and local levels. This is confirmed by the author's review of the literature in this area. Higher wealth of Polish municipalities is not always consistent with greater municipal involvement in environmental protection and its results, which requires deeper analysis. Factors such as the nature of municipalities and the natural conditions of municipalities due to their spatial location are also important. The subject of this article's research is a comparative analysis (based on detailed indicators of environmental governance of the Central Statistical Office (CSO)) of the degree of involvement of 30 Polish municipalities of varying wealth in air and groundwater protection, as well as a comparison of their natural conditions in terms of forest cover and biodiversity, which should promote better adaptation to climate change at the local level.

Keywords: climate change, air protection, adaptation to climate change)

1. INTRODUCTION

Protection of air and groundwater as an adaptation to climate change is currently one of the main economic and social challenges at both the global, national, regional and local levels. This is confirmed by the author's review of the literature

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in this area. Higher wealth of Polish municipalities is not always consistent with greater municipal involvement in environmental protection and its results, which requires deeper analysis. Factors such as the nature of municipalities and the natural conditions of municipalities due to their spatial location are also important. The subject of this article's research is a comparative analysis (based on detailed indicators of environmental governance of the Central Statistical Office (CSO)) of the degree of involvement of 30 Polish municipalities of varying wealth in air and groundwater protection, as well as a comparison of their natural conditions in terms of forest cover and biodiversity, which should promote better adaptation to climate change at the local level.

2. LITERATURE REVIEW

The activities of municipalities in the field of air and groundwater protection, and in particular adaptation, related to climate change have already lived to see a very extensive literature on the subject. Due to the always limited volume of the article, the author reviewed the literature only in selected, some exemplary aspects of the activities of municipalities and the activities of researchers in this area in Poland, Europe and the world. Lackowska and Swianiewicz [13] analysed the types of climate change actions taken by Polish municipalities, as well as the determinants of the policies undertaken. In doing so, they used a distinction between climate change mitigation and adaptation measures. The empirical material came from a survey of all Polish municipalities in 2014. According to them, the survey showed a significant convergence of the situation in Polish municipalities with that reported in the foreign literature. Polish municipalities most often declared climate change mitigation measures, which the authors attributed to nationwide and EU support. Guidelines for implementing a low-carbon economy at the local level, combined with sources of funding for investments in this area, resulted in a clear focus of local governments on air protection (reducing carbon emissions). Among the variables explaining the reasons for the differentiation of actions in the face of climate change, the size of the local government, related to its resources, proved to be the most important. The perceived threat of extreme weather events related to the water environment (e.g., floods) was also important for adaptation efforts. Other variables (including local government wealth) were secondary to size. In contrast, declaring a willingness to spend more money on mitigation than on adaptation was clearly associated with a belief in the human impact on slowing climate change and a belief that local government should pursue climate policy.

Global carbon dioxide emissions from the use of fossil fuels, according to analysis by J. March, already amounted to 28 billion tons in 2005 and continued to rise in the following years. Securing the climate against dangerous warming will be to reduce emissions to about 10 billion t/year by 2030 and at the latest

2050. Implementation of the Kyoto Protocol, as well as subsequent G8- summits, does not ensure adequate emission reductions, as countries that emit large amounts of greenhouse gases have not committed to their compliance. Therefore, urgent changes are needed in the transport sector due to its high and growing share of greenhouse gas emissions. In the EU-27, as much as 72% of freight transport was by car and only 17% was by rail. Passenger trips by private cars accounted for as much as 83% of passenger transportation and the share of railroads was only 8% [16]. The cost of protecting the environment to ensure a satisfactory quality of life is high, at 2 percent of GDP, which in rich countries translates into expenditures measured in billions of dollars a year. A significant portion of this expenditure in the world is consumed by ambient air protection [12].

Air and climate protection is an area of investment activity of local governments. The subject of interest in the research of Ostachowski and Saneta-Półgrabi [19] was the north-western part of the Lesser Poland Voivodeship, especially local governments located in the counties of Krakow, Chrzanow and Olkusz. This area is particularly exposed to the transport of gaseous and particulate pollutants from the Silesian province, as well as produces a lot of substances due to the industry located here. The main thesis of the study is that the measures taken by local governments of north-western Malopolska province in the field of air and climate protection have in many cases proved to be late and insufficient. The method used in the study was an analysis of reporting documents and financial data available for these local units in the Local Data Bank. The Warsaw metropolitan area is also at high risk from air pollution. Warsaw has pledged to reduce greenhouse gases by 40 percent by 2030 and to achieve climate neutrality by 2050 at the latest. The city is already implementing numerous initiatives to help achieve this goal, with the ultimate goal of combating negative impacts and facilitating adaptation to modern climate change [3].

Another article related to the topic at hand addresses the issue of local spending on air and climate protection, as an expression of local government concern about these currently most important environmental issues. The international documents adopted in December 2015 on this issue were also echoed in the local space. They intensified the activities of Polish local governments in this matter. The study analyses the investment activity of local governments in the field of air and climate protection in the municipalities of Busko district, located in the Świętokrzyskie Voivodship, in 2015-2018. It draws attention to the problem of still limited financial resources of many smaller municipalities, but also to the usual facade of political declarations of local leaders in relation to subsequent actions. He also sees the problem of residents' access to the gas grid as one of the barriers to energy transition and helping to halt climate change. The main hypothesis of the article is that the level of spending by the municipalities of Busko County on air and climate protection has improved, although it still proves

insufficient in relation to existing needs in this area. Its verification became possible through the use of financial reports included in the analysis of local governments and CSO data [22].

On the other hand, in the legal aspect, another article is an attempt to find an answer to the question of whether the legal regulations in force in Poland on the elimination of low emissions from the household and municipal sector are effective enough to ensure a significant improvement in the state of air cleanliness. Thus, the subject of the publication is the analysis of the legal regulations in force in our country in the above area. It indicates the means of action available to the various public administration bodies carrying out the public task of reducing low emissions of pollutants into the air. Interactions (links) between local government units and between them and the government administration in the analysed area are described. The article identifies directions for achieving the goals of reducing low emissions. Basically, the publication is a voice in the discussion of legal instruments that will ensure the improvement of the state of clean air in Poland [2]. In the long term, decarbonisation and development sustainability are almost equivalent, as it is difficult to imagine a trouble-free economy under conditions of climate catastrophe. However, because of the collective responsibility inherent in climate protection, efficiency requires that decarbonisation be done on a global scale, not just on the scale of some region. And in the short term, improperly conceived decarbonisation can even threaten this sustainability [31].

Żurawik [2020] recognizes the environmental qualities of his place of residence in his analyses. He writes: ’I am lucky to live in a very picturesque area. As residents, we try to prevent harmful human activities, we take care of forests, waters, animals - everything tangible, and visible to the eyes. But what about the air? This is where the topic I have been pursuing comes in: protecting the air from harmful emissions, mainly from outdated household heat sources’. The author took up this issue, as human health is a priority for her. The state of the entire planet is also important.

National authorities in many European countries are striving to mainstream climate change adaptation into existing policies in order to achieve coherence and synergies and avoid inappropriate adaptation. Given the local variation in climate change impacts, the lion's share of climate change adaptation work will have to take place at the local level. The integration of climate change adaptation into existing sectors in Norwegian municipalities, at the forefront of environmental solutions in Europe, has been studied, among other things. Using the theories of mainstreaming and policy integration, it was found that policy development was slower but more robust in municipalities that chose a horizontal, cross-sectoral approach to mainstreaming than in municipalities that chose a vertical sectoral approach to mainstreaming [22].

Climate change adaptation has been put on the political agenda to varying degrees in all industrialized countries. In most of these countries, adaptation measures have not yet been enacted into legislation and are therefore voluntary undertakings in practice. The study therefore examined, among other things, how the implementation of climate change adaptation measures in Norwegian municipalities was carried out. It was found that the municipalities surveyed have implemented or have concrete plans to implement adaptation measures [5]. The findings show that municipalities are capable of implementing adaptation policies. It depends on many factors: the efforts of individuals within the municipal organization, the size of the municipality and the use of external expertise.

Norwegian researchers have studied the processes of adaptation to a changing climate in the water supply and wastewater sector in five Norwegian municipalities. The case illustrates that the combination of features of climate change adaptation as a policy issue, institutional features associated with the vertical organization of the water sector in Norway, and features of professional networks between local and national levels of governance appear to foster awareness of the problem and a proactive approach to solving it. Important mechanisms related to the production of policy solutions in governance networks mediating knowledge transfer between different institutional levels have been identified. With these observations, the research contributes to the debate on the functioning of governance networks and, in particular, to knowledge about the factors that foster effective network governance [10]. Norway already has the institutional structure and public service delivery apparatus in place to cope with the future impacts of climate change. However, there are enormous challenges in coordinating these institutions at different levels of government for climate change adaptation. Based on a wide-ranging case study, they explored how local actors believe multi-level coordination of different levels of government and policy sectors is currently functioning, what mechanisms are being used, and what coordination challenges have been identified. The authors found that the selected regional level in Norway - the counties (counties) - has great potential to act as a multi-level coordination actor [9].

Other studies have looked at how Danish municipalities are adapting to climate change and what added value can be achieved by changing management modes. The study found that adaptation is rather narrowly defined as mainly concerned with water management, and that planning and implementation of adaptation takes place in technical departments in municipalities. Cross-sectoral cooperation is limited, as is the involvement of citizens and external resources [14]. According to a government decision, all construction and renovation of buildings in Dutch cities starting in 2020 must be climate resilient. Part of this climate resilience includes adaptation to (extreme) heat. The Heat Resilient Cities project is a collaboration between two research institutes, 13 municipalities and

the water authority in the Netherlands. The goal of this project is to transfer current knowledge about heat adaptation in cities to practice and fill gaps in research. The research focused on clear visualizations of problem areas, heat-resilient measures applied in the Dutch context, and design guidelines leading to more heat-resilient cities [25].

Nature-based adaptation planning is an ambitious undertaking, not least because it requires a transdisciplinary approach to combine the efforts and capacities of different actors. However, empirical knowledge of related management processes is scarce and fragmented. Against this backdrop, the following analysis examines the integration of nature-based approaches to climate change adaptation with municipalities' day-to-day planning practices and related governance. The results show the many constraints municipal staff face and how they use targeted strategies to overcome them and take advantage of existing incentives [27]. Five complementary strategies were identified: 1. targeted collaboration with stakeholders; 2. strategic citizen engagement; 3. outsourcing; 4. changing internal work structures; and 5. implicit scientific-political integration.

The transformation of single-family home neighbourhoods is a central issue in the search for a more sustainable city. This residential model remains very popular among middle-class households, despite the significant costs and impacts associated with its operation. Local governments are increasingly interested in the associated impacts, even if they lack clear planning strategies. The case study presented next concerns a municipality that is part of the metropolitan area of Catania, Italy. Built-up areas cover more than 50% of the total area of the municipality, and the dominant development type is detached single-family homes. The existing settlement pattern is essentially a "car town" for about 20,000 residents with a very limited presence of services. The analyses conducted show that this settlement is unsustainable, not because of insufficient green space or permeable soils, but because it lacks any urban quality. The resulting environmental impact is significant both in terms of greenhouse gas emissions and contribution to urban runoff [8].

Tirana (Albania), like many European capitals, has recently experienced changing weather patterns, such as rising temperatures and the occurrence of extreme weather events. Such events - combined with rapid urban growth and impervious cement covering the city's natural soil - have resulted in increased flooding, riverbank erosion, traffic delays, increased summer cooling expenses, increased demand for health services, and an urgent need for smart city planning. Tirana is preparing a set of climate change adaptation measures to manage the resulting risks and adapt to climate change [15]. The city administration should integrate climate change adaptation into its management and planning processes. This task was prepared using the Climate Compassi tool included assessing the

vulnerability of various sectors in the city, evaluating the risks posed to vulnerable target groups and proposing possible adaptation options.

Recent studies of groundwater protection also include, among other things, the Rural Water and Sanitation Support Program in Kosovo (RWSSP) funded by the Swiss Agency for Development and Cooperation (SDC), which has significantly increased access to public water supply for Kosovo's rural population. The program began supporting the first implementation of a groundwater protection zone (locally known as a sanitary protection zone) in Kosovo in accordance with the law and through a systematic process. This article describes the full process of establishing sanitary protection zones for public groundwater wells in Kosovo and reveals the technical and administrative challenges, as well as lessons learned during the process [18]. Water supply deficits during periods of drought, groundwater contamination and climate change are major challenges to the sustainability of groundwater resources from hard rock aquifers in rural Galicia (Spain). Groundwater quality data show bacteriological and nitrate contamination due to poor manure management in fields and sporadic manure discharges from pig and mink farms. Groundwater management and protection measures are proposed to prevent groundwater pollution and achieve a sustainable groundwater supply [23].

In terms of future European regulatory issues, meanwhile, it seems important to assess the impact of the German Constitutional Court's March 24, 2021 ruling on German and European climate protection regulation. The main thesis boils down to the need to change both legal regimes in the direction of drastically reducing carbon emissions into the environment [11].

Globally, Canada ranks among the highest in quality of life and especially in its environmental aspect. In Europe, the Scandinavian countries lead the way. Significant world economies also include the territories of municipalities and regions (states) in the Canada, US, Australia, China and South Africa.

In the state of Ontario (Canada), institutional barriers and bridges to local adaptation to the effects of climate change affecting small rural municipalities and conservation authorities in the state were examined, and elements of a community-based adaptation strategy related to water infrastructure were proposed as a case study of community adaptation to climate change. Local water quantity and quality problems can occur especially in groundwater recharge areas. Municipalities can rely on some existing institutions to create an effective adaptation strategy based on the watershed/regional perspective, their credibility and expertise. Voluntary and federal-level climate change mitigation programs are about to be established [4].

Climate protection in the United States remains a controversial issue. For many years, experts have been arguing over whether carbon dioxide - considered the most important factor in spoiling the world's climate - can be considered a

pollutant under national regulations. Moreover, the legitimacy of adopting regulations on the matter depends crucially on economic parameters whose values are not generally agreed upon. However, the recent evolution of views prevalent in the U.S. on the subject seems to herald far-reaching changes in tightening carbon reduction requirements [30].Cities are key sites for climate change adaptation efforts. However, there are many different responses to risks at the urban level. Why are communities taking adaptation actions in the face of weather and climate risks? What cities do in response to existing natural hazards, such as floods, droughts and blizzards, was investigated as an analogy for understanding the factors that influence adaptation behaviour in the face of climate change risks. A survey of 60 US municipalities was conducted, followed by six in-depth case studies in the intermountain states of the West: Colorado, Wyoming and Utah (USA), which regularly experience extreme weather and climate events. The analysis showed that risk perceptions and external factors, such as planning requirements and funding availability, are important drivers. The results suggest that many factors interact or act in combination to create an environment conducive to action in the face of weather and climate risks [6].

Increasing attention is being paid to understanding how climate change policy is shaped by the actions and interests of local governments. This study explores the links between local government efforts to maintain and sustain public trust and their considerations of climate change adaptation related to water management. Document analysis and 24 interviews with local public officials are used to shed light on these considerations in three small municipalities in central Pennsylvania (USA): Chambersburg, Carlisle and Gettysburg [26]. The analysis indicated that the paradox of public trust leads to public officials taking actions and considerations that are consistent with climate change adaptation, but paradoxically not realizing it. The implications of this mindset of those in power for climate change actions and policies were also explored. Suggestions for preventing the logic of inaction expressed by public officials were identified, and the potential of state and federal interventions to stimulate climate change adaptation in contexts such as these local governments was explored.

Local governments are responding to top-down policy initiatives by both federal and state governments to reduce emissions and adapt to any potential impacts of climate change. While climate change is undoubtedly a global issue, many solutions will be implemented at the local level. This issue was explored by identifying regional differences in response to climate change in New South Wales (NWS), Australia. To this end, publicly available council and regional documents for all NSW councils were reviewed between September 2010 and September 2011. The response indicators examined were based on the NSW Green Building Plan (2005). These were: awareness raising, emissions reduction and adaptation planning [7]. It was found that the councils were undertaking many

practical projects to meet the goals of this plan. As a result, they are reducing significant amounts of emissions. Adaptation is progressing through the development of risk-based climate change adaptation plans. The councils are addressing specific management areas, such as water management. They use guidelines that incorporate climate change as part of best practices.

The low effectiveness of environmental policy implementation is a major problem in China's environmental management today. The environmental intelligence (EPI) policy is an administrative measure used by the central environmental protection department to persuade local governments to zealously fulfil their environmental responsibilities. This study adopts China's EPI policy as a quasi-natural experiment. We use panel data of 261 prefecture-level cities in China from 2009 to 2018 as the research sample, and use a spatial difference-in-differences (SDID) model to investigate the effect and mechanism of EPI policy on air pollution. The results show that EPI policies can effectively improve air quality, EPI policies have obvious spatial spillover effects. Namely, EPI policies can not only reduce local air pollution, but also reduce air pollution in neighbouring cities. The EPI policy reduces air pollution in neighbouring cities within a spatial attenuation limit of 400 kilometres. The results of the mechanism study show that EPI policies can improve air quality by promoting the modernization of industrial structure and technical progress. In addition, the pollution reduction effect of EPI is more significant in resource-based cities. The research results in this article are an important reference for China and other developing countries to improve air quality [21].

A recent study in China also looked at the impact of air pollution on urban innovation capacity. The innovation capacity index is reconstructed based on innovation performance. Air pollution significantly inhibits urban innovation capacity. The "loss of human resources" effect and "resource displacement effect" are justified. The inhibition of air pollution on innovation capacity has urban heterogeneity. Technological innovation can help reduce air pollution, but existing relevant studies have not clarified whether and how air pollution affects urban innovation capacity. Accordingly, based on a fixed-effect model, a panel of 281 prefecture-level cities in China from 2003 to 2015 was studied and found that air pollution significantly inhibits the improvement of urban innovation capacity overall in China. Meanwhile, under the "human resource loss effect," air pollution in large-scale cities or eastern China has a much greater inhibiting effect on innovation capacity [1].

The literature review concludes with a study of one of Africa's most developed countries, South Africa. The analyses presented how the impact of climate change relates to the more immediate socioeconomic problems of rural residents in the Sekhukhune district of South Africa. Residents cited water shortages, unemployment, sanitation problems and flooding, as well as HIV/AIDS

and other diseases as major stressors. They also cited a lack of communication from local government authorities as a factor compounding stress and problems. The authors recommend that funding support national and local priorities while addressing climate change issues [28].

3. THE TEST SAMPLE

The subject of the author's own research are urban-rural municipalities, which are, so to speak, "microstolises" of land districts in Poland, which have been aggregated into three groups of 10 municipalities each in terms of their budget income. In order by income per capita in ascending order: wealthiest (Słubice, Grodzisk Mazowiecki, Goleniów, Gryfino, Świecie, Drawsko Pomorskie, Police, Kozienice, Piaseczno, Polkowice), moderately wealthy (Wolomin, Łobez, Bytów, Grójec, Ząbkowice Śląskie, Myślenice, Strzelce Opolskie, Wieliczka, Pszczyna, Kartuzy), and the least affluent (Kazimierza Wielka, Opatów, Mońki, Miechów, Wschowa, Nisko, Łęczna, Jędrzejów, Dąbrowa Tarnowska, Szydłowiec). The 30 municipalities make up a total of about 10% of all 314 municipalities, "micro-capital" counties in Poland.

The selection of municipalities is not accidental. It was done deliberately, because past research shows that the modernization of municipal administration, including local development management, is much faster in large and medium-sized cities with county rights [17]. At the same time, it is there and in the suburban areas of large cities that quality of life indicators are generally higher than quality of life indicators in urban-rural municipalities of cities with land districts, according to recent, recent research [24]. Therefore, there is a need for an in-depth study of precisely these municipalities, which should also serve as local centers of development and its balancing for all 314 land districts, occupying an incomparably larger territory than the cities with county rights themselves and their immediate surroundings. The choice of only urban-rural municipalities was deliberate, due to the additional tasks incumbent on them, including balancing development between the rural and urban parts of the municipality and using management instruments adequate for both urban and rural territories. Thus, the selection of municipalities - county cities was determined by the alignment of the quality of life in the municipalities, especially in the environmental segment, as well as the dependence of their commitment to air and groundwater protection on their wealth.

4. RESEARCH METHOD

The research used both quantitative and qualitative techniques. The CSO's indicators of sustainable development in municipalities were analysed quantitatively, in particular 13 indicators of environmental governance (tables). In order to enable comparative analysis of all 30 surveyed municipalities and all detailed indicators with different measures, each detailed indicator was converted into a point value from 1 to 30 points. The lowest point value (1 point) represents the least favourable environmental indicator value for the nationwide sample of 30 municipalities, and the highest point value (30 points) represents the most favourable environmental indicator value for the sample of 30 municipalities. Scoring was positively correlated with the stimulants of environmental governance in municipalities. The higher the specific indicator, the higher the score. This was true for specific indicators from number 1 to 11 (tables). Scoring was negatively correlated with the destimulants of environmental governance in municipalities. The higher the detailed indicator, the lower the score. This was true for detailed indicators number 12 and 13 (tables). In addition, 10 specific indicators were divided into those significantly dependent on the environmental policy of municipalities (numbers 1, 4, 5, 7, 8, 9, 10, 11, 12, 13) and 3 specific indicators independent significantly of the environmental policy of the municipality (numbers 2 and 3 - commercial sector: industry, services) and number 6 - forest cover dependent on the natural location of the municipality. The municipalities analysed were ranked in order of increasing wealth in three subgroups: least wealthy, medium wealthy and most wealthy.

A preliminary qualitative analysis looked at the specific nature of the municipalities achieving the most favourable or least favourable values of environmental indicators, and sought reasons for these facts having their origin in the specifics of the municipality: agricultural, industrial, service, etc.

5. RESULTS OF RESEARCH

The results of the survey are included in Table 1, divided into 3 parts (a, b and c). The first part (a) presents the urban municipalities with the lowest per capita wealth. The second (b) municipalities with average per capita wealth and the third (c) municipalities with the highest per capita wealth. All municipalities are ranked according to increasing per capita wealth, from the smallest - Kazimierza Wielka - to the largest - Polkowice.

Table 1a. The results of experimental research and computer calculations

Domains		Indicators	Kazimierza Wielka	Opatów	Mońki	Miechów	Wschowa	Nisko	Łęczna	Dąbrowa Tarnowska	Jędrzejów	Szydłowiec
Climate change	1	Municipal expenditures on air and climate protection per capita*	23	20	26	28	6	16	17	15	22	29
		Total	23	20	26	28	6	16	17	15	22	29
Protection of air and groundwater	2	Share of pollutants retained or neutralized in pollution abatement facilities at sensitive facilities in total pollutants generated - gaseous (excluding CO_2)*	1	1	1	7	1	1	1	1	1	1
	3	Share of pollutants retained or neutralized in pollution abatement facilities at sensitive facilities in total pollutants generated - particulate*	1	16	9	2	1	1	17	1	21	13
	4	Users of gas facilities as a % of total population	1	7	2	4	14	20	30	22	3	6
	5	Using sewerage system as % of total population	3	1	7	2	15	14	21	10	5	6
		Total	*6(1)*	25	*19(3)*	*15(2)*	31	36	69(2)	34	30	26
Land use	6	Forest cover	2	1	8	5	15	28	4	10	13	21
		Total	*3(3)*	1	8	5	15	28(2)	4	10	13	21
Biodiversity	7	Share of legally protected areas in total area*	12	10	20	29	14	1	19	7	28	21
	8	Share of parks, greens and green spaces in total area	1	1	1	2	2	2	8	1	2	3
		Total	13	11	21	31	16	*3(1)*	27	*8(3)*	30	24
Waste management	9	Amount of mixed municipal waste from households collected during the year, per capita (in kg)	1	5	10	4	16	6	17	8	3	9
	10	Wastewater treated biologically and with enhanced nutrient removal in total wastewater (in %)	30	30	30	30	30	30	30	30	30	30
	11	Number of household treatment plants	12	18	25	28	13	9	22	11	2	5
	12	Wild landfills - number per 100 km^2*.	6	13	11	9	6	13	9	11	10	2
	13	Wild landfills - area per 100 km^2* (in m^2)	13	27	23	21	3	26	8	24	5	20
		Total	*62(2)*	93	99	92	68	84	86	84	*50(1)*	66
		Total Domains	*106 (1)*	150	173	171	*136 (2)*	167	203	151	*145 (3)*	166

Source: own compilation based on CSO in points (1-30)

Table 1 in parts a, b and c contains uniform scoring for municipalities (from 1 to 30) according to the scoring adopted according to the methodology. Environmental indicators from the smallest relative value for 30 municipalities 0d 1 point to 30 points. In bold italics are 3 values in order (in parentheses) from the smallest in each value together for the five areas analyzed. In bold and underlined font are marked the 3 largest values in each area and in the areas together.

Table 1b. Comparison of 30 Polish municipalities with varying wealth ascending - 10 moderately wealthy municipalities in points (1-30) (*-data for county)

Domains		Indicators	Wołomin	Łobez	Bytów	Grójec	Ząbkowice Śląskie	Myślenice	Strzelce Opolskie	Wieliczka	Pszczyna	Kartuzy
Climate change	1	Municipal expenditures on air and climate protection per capita*	13	3	5	9	25	21	10	27	24	11
		Total	13	*3(3)*	5	9	25	21	10	27	24	11
Protection of air and groundwater	2	Share of pollutants retained or neutralized in pollution abatement facilities at sensitive facilities in total pollutants generated - gaseous (excluding CO_2)*	5	1	1	1	1	1	1	4	1	1
	3	Share of pollutants retained or neutralized in pollution abatement facilities at sensitive facilities in total pollutants generated - particulate*	7	9	12	5	1	4	10	1	18	3
	4	Users of gas facilities as a % of total population	18	9	12	28	17	21	8	29	19	5
	5	Using sewerage system as % of total population	11	16	24	8	12	25	18	3	4	9
		Total	41	35	49	42	31	51	37	37	42	18
Land use	6	Forest cover	9	20	22	7	6	18	17	6	16	24
		Total	9	20	22	7	6	18	17	6	16	24
Biodiversity	7	Share of legally protected areas in total area*	13	4	13	15	11	8	23	2	3	25
	8	Share of parks, greens and green spaces in total area	4	3	1	2	3	1	5	7	8	2
		Total	17	*7(2)*	14	17	14	9	28	9	11	27
Waste management	9	Amount of mixed municipal waste from households collected during the year, per capita (in kg)	13	12	11	27	28	2	7	26	14	21

	10	Wastewater treated biologically and with enhanced nutrient removal in total wastewater (in %)	30	30	30	30	30	30	30	30	30	30
	11	Number of household treatment plants	10	21	17	27	24	20	4	30	15	23
	12	Wild landfills - number per 100 km^2*.	3	9	13	9	10	11	5	1	11	12
	13	Wild landfills - area per 100 km^2* (in m^2)	15	12	27	7	9	25	16	10	24	6
		Total	71	84	98	100	101	88	62	97	94	92
		Total Domains	151	149	188	175	177	187	154	176	187	172

Source: own compilation based on CSO in points (1-30)

The analyses resulted in the results in Table 1, divided into three parts (a, b, and c).

Table 1c. Comparison of 30 Polish municipalities with varying wealth in ascending order - 10 most wealthy municipalities in points (1-30) (*-data for county)

Domains		Indicators	Drawsko Pomorskie	Gryfino	Słubice	Świecie	Police	Goleniów	Grodzisk Mazowiecki	Kozienice	Piaseczno	Polkowice
Climate change	1	Municipal expenditures on air and climate protection per capita*	1	2	8	1	7	4	18	19	12	14
		Total	*1(1)*	*2(2)*	8	*1(1)*	7	4	18	19	12	14
Protection of air and groundwater	2	Share of pollutants retained or neutralized in pollution abatement facilities at sensitive facilities in total pollutants generated - gaseous (excluding CO_2)*	1	9	1	2	8	6	11	10	12	3
	3	Share of pollutants retained or neutralized in pollution abatement facilities at sensitive facilities in total pollutants generated - particulate*	6	21	11	19	15	14	1	20	1	8
	4	Users of gas facilities as a % of total population	16	15	23	10	27	11	24	13	25	26
	5	Using sewerage system as % of total population	17	20	19	27	28	23	13	26	22	29
		Total	40	65	54	58	78(1)	54	49	69(2)	60	66(3)
Land use	6	Forest cover	19	11	21	26	12	27	3	23	14	25
		Total	19	11	21	26	12	27	3	23	14	25

Biodiversity	7	Share of legally protected areas in total area*	24	17	22	26	5	6	16	9	27	18
	8	Share of parks, greens and green spaces in total area	1	2	1	3	9	2	4	2	6	7
	Total		25	19	23	29	14	8	20	11	33	25
Waste management	9	Amount of mixed municipal waste from households collected during the year, per capita (in kg)	15	18	30	23	24	29	25	22	20	19
	10	Wastewater treated biologically and with enhanced nutrient removal in total wastewater (in %)	30	30	30	30	30	30	30	30	30	30
	11	Number of household treatment plants	19	26	14	1	8	29	16	7	3	6
	12	Wild landfills - number per 100 km^2*.	12	11	6	4	12	10	13	8	7	3
	13	Wild landfills - area per 100 km^2* (in m^2)	17	4	22	14	1	18	27	11	19	2
	Total		93	89	102 (3)	72	75	116 (1)	111 (2)	78	79	60
	Total Domains		178	186	208 (2)	186	186	209 (1)	201 (3)	200	198	190

Source: own compilation based on CSO in points (1-30)

6. CONCLUSIONS AND RECOMMENDATIONS

- A review of the literature on the subject, especially the most recent, shows that the problem of climate protection, including air and groundwater protection, is very important for municipalities (counties*) both in Poland, Europe and the world.
- The total indicators of involvement in the territory of municipalities (counties*) of varying wealth in air and groundwater protection are generally consistent with the wealth of municipalities (most favourable in the wealthiest and least favourable in the least wealthy).
- However, one detailed indicator most related to the municipality (county*) of municipalities' expenditures on air and climate protection per capita is smallest in the rather wealthiest municipalities and rather largest in the least wealthy municipalities, which may favour equalization of expenditures relative to the wealthiest municipalities.
- One specific indicator least related to wealth (forest cover) has a distribution that depends on the natural conditions of the municipality, but which may prompt further analysis, the two smallest values are reached in the least wealthy municipalities.

- Expenditures by municipalities on air and groundwater protection, particularly on the sewage network and waste management, are clearly positively related to the degree of wealth of municipalities.
- Despite the large expenditures of municipalities on environmental protection additionally supported by EU and government funds, the least wealthy municipalities have so far failed to make up for significant differences in all areas shaping the quality of life of residents through environmental governance.
- In order for the quality of life of residents to be shaped in a sustainable manner, it is postulated to continue to prioritize the expenditures of the least wealthy and moderately wealthy municipalities on air and groundwater protection as adaptation to climate change, and continue to support them specifically through the environmental policies of the EU and the national government.
- The results of the study can be generalized with little probability of error to all 314 municipalities - district cities in Poland, because the research sample, as previously justified, includes municipalities of varying wealth and varying natural environmental conditions.
- This article, against the background of the existing review of the literature on the subject, brings a new, comprehensive and comparative analytical treatment of municipalities with different resources, wealth and natural environmental conditions in terms of their activity for climate protection, especially air and groundwater.

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