

WATER CITY INDEX 2021

EFFICIENCY RANKING
OF USING
WATER RESOURCES
IN POLISH CITIES.

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SCIENTIFIC EDITORIAL

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INTRODUCTION

PROFESSOR JERZY HAUSNER



“Urban water policy is not only about preventing water crises, but should rely on measures which will allow for productive use of this resource.”

Each public policy has its tool part and its system part (related to certain standards and regulations). These parts must fit together if we want the public policy to be effective. Both the tool and system parts are based on reliable knowledge (evidence-based policy). Information itself does not necessarily generate knowledge since it needs to be structured. Therefore, studies such as indices are characterized by the fact that they provide objective and structured information. And if these indices are developed by a team of experts who can interpret conclusions and define the desired course of action through these conclusions, a shift from information to knowledge is possible. Knowledge becomes the basis for carrying out tool (operational) activities, as well as designing system changes. In this sense, indices which would enable comparison of the situation of various entities (in this case, cities) are particularly important as they show a comparative background.

Water management is becoming an increasingly serious development challenge for Poland. This is not a challenge that appears only periodically. With different intensity and in different areas in Poland, there will be occurring various phenomena, which are indicative of water crises (too much water, too little water, or too dirty water). There are areas of constant water deficit, areas subject to stepping, there are places where the flood threat is higher than average, and the water quality, even if it improves in one location, deteriorates in another and still requires improvement. Using water reserves (underground resources) means exhausting strategic reserves and, at the same time, is a capital-intensive activity. In fact, this should not be done unless there is a very good reason. We should use inflowing waters, of which Poland has a fair amount, as long as we are able to such water in the correct manner. The proper management of water resources applies not only to agriculture, but also to cities. Contemporary activities in the area of urban water crises no longer rely solely on building flood defenses, but on creating multi-level retention systems (from small solutions to large infrastructure). We should strive to capture water resources in order to, on the one hand, maintain environmental values and adhere to ecological standards, and, on the other hand, to meet the needs of city users.

Water may be said to be a resource, the use of which should also be combined with the management of other resources. Water supply and sewage systems do not only have to collect energy, they can also be used to generate it, and this is already the case in several places around the world. Cogeneration does not have to be about the water-energy relationship; it can be about environmental protection, health protection, or improving the quality of life. Thus, urban water policy is not only about preventing water crises, but should rely on measures which will allow for productive use of this resource.

The Water City Index 2021 ranking is the starting point for an intellectual discussion and should be considered the first step for city governments in terms of self-reflection and implementation of activities aimed at stimulating urban water policy.

Professor Jerzy Hausner



PREFACE

JAROSŁAW MIZIOŁEK, PRESIDENT OF MANAGEMENT BOARD AT ARCADIS



“We are striving to achieve the goals of sustainable development and to increase climate resilience. Unfortunately, without taking proper care of water, these goals will never be achieved, and climate change will hit us hard.”

The Water City INDEX ranking has been created for city authorities, representatives of the local community, entrepreneurs, non-governmental organizations, public institutions, and all other entities involved in the protection of water resources, but also for residents. The numbers making up the ranking perfectly illustrate how cities and water coexist on a daily basis. From year to year, we have drawn more and more interesting conclusions and have observed the change of our water-city relations. Moreover, the results of the ranking are a valuable source of information for local authorities at various stages of shaping and implementing the local water policy. Therefore, it gives me even greater joy and pride to present to you the third edition of the Water City INDEX ranking.

We hear about crises in the world more and more often. These are different crises: migration, climate, economic, or pandemic ones. They affect our daily professional and personal lives. However, we must also be aware of the daily water crises. These are crises which affect all of us on a micro scale as everyday water users, but there are also large-scale crises which affect the functioning of our environment. These are felt not only in cities, but also in rural areas, and their effects have an impact on entrepreneurs, tourists, and residents. There are three categories of problems in Poland: too little water, too much water, and poor water quality. In addition, there is more and more talk about the water footprint that each of us leaves in connection with our daily functioning.

Considering the fact that we are dealing with very limited resources of potable water, this issue should immediately become the subject of in-depth research and implementation. We are striving to achieve the goals of sustainable development and to increase climate resilience. Unfortunately, without taking proper care of water, these goals will never be achieved, and climate change will hit us hard. The Water City INDEX should be treated as a preliminary diagnosis of the water problems we deal with in the Polish cities. Importantly, the ranking is designed not only to compare cities in the context of water management, but - above all - to show their strengths and encourage the sharing of knowledge and experience with others. It is also a starting point for in-depth, individual analyzes in cooperation with cities. We would like the Water City INDEX 2021 ranking to be a continuation of the discussion on both the problems and opportunities for water cities. Therefore, I recommend to you reading our study and discussing important topics, that is – water-related topics.

Jarosław Miziołek

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CHAPTER 1

BY WAY OF INTRODUCTION.

WHY HAVE WE DECIDED TO CONTINUE BUILDING THIS INDEX?

We are pleased to present to you the Water City Index 2021 (WCI2021). This is the third edition of the ranking of Polish cities based on efficiency of water resources use, developed annually by a team of experts. Free, full versions of the Water City Index from the years 2019 and 2020 can be easily found on the Internet.

The unwavering interest of local authorities, industry journalists, and scientists in the two previous editions of the Water City Index has strengthened our conviction that our efforts are needed and should be continued. It is important because, in our opinion, the Water City Index is the only comprehensive ranking of cities based on efficiency of use of water resources. Its comprehensiveness lies in the fact that we do not relate the issue of water resources solely to crisis phenomena and to measuring the quality of operation of municipal water supply companies. We approach the water management issue much more broadly, as indicated by four areas in which we measure the effectiveness of Polish cities, as discussed in more detail below. The continuation of this project is, among others, triggered by the growing interest in WCI results. Therefore, it is the duty of the authors to develop the report further and publish successive publications. We develop each subsequent edition with great joy and curiosity how the results of the rankings will be presented this time.



WATER CITY INDEX

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[» DOWNLOAD WCI 2019](#)

In comparison with the previous years, while working on WCI2021, we decided to expand the expert team. The team was therefore joined by Klara Ramm PhD, representing the Polish Waterworks Chamber of Commerce. The consultants in this year's edition were: Professor Anna Januchta-Szostak PhD Eng. of Architecture, Professor Zbigniew Kundzewicz PhD and Professor Elżbieta Nachlik PhD Eng.

Similarly to the previous years, the WCI2021 research results are based on quantitative data. This time, we expanded the scope of indicators by accessing new, more detailed quantitative databases. More information about them can be found in chapter 2. Access to new data resulted in slight changes in the research methodology. In order to render the results more objective, realistic, and more sensitive to changes taking place in cities, a slight change in the weights of individual indicators was implemented. The authors found it of great importance that the research methodology of WCI2021 be consistent (comparable) with the previous editions. By means of the applied method, we intended to make the research results the most objective, also within the context of the quite rapidly changing policy of individual cities in the area of urban water policy. Therefore, despite the changes, we strived to maintain the continuity between results of individual editions of the Water City Index. A new element has been added: the WCI2021 includes examples of foreign cities, where we found showcase solutions within the field of urban water policy. The below descriptions present initiatives taken up by the cities of Birmingham, Utrecht, and the Finnish Pori in the area of urban water policy.

The ranking results presented herein show the approach of the Polish cities to the water policy. Each time, it is a unique set of uncontrollable conditions and controllable factors of development, individual for each city, which can act either as an accelerator or a barrier to development. Each city has its own DNA code that distinguishes it. Even if we are dealing with similar development conditions determining the development, direction, and nature of the key growth factors, the elements distinguishing them are the activity of local government authorities in setting development directions for a given area, as well as the method of implementing adopted assumptions. That is why, when defining determinants of local development, also discussed are effectiveness and activity of the conducted policy of growing awareness of the held resources and development barriers as well as the manner of their use.

In urban water policy, cities where the likelihood of severe water crises is not high, for example due to the moderate climate, may still be extremely vulnerable to crises, for example due to poor quality water and sewage or flood protection infrastructure. Two cities may have a similar overall score for 'risk' or 'security' but differ in underlying factors: low risk may be associated with high vulnerability (e.g. poor infrastructure, mismanagement) to crises, while exposure to high risk may be associated with low vulnerability (good preparation). These situations can result in a similar 'overall' risk or levels of security, nevertheless, they are fundamentally different.

In one case, natural conditions may be favourable and the risk increases due to mismanagement, for example leading to water pollution and suboptimal water supply. Otherwise, natural conditions may pose various challenges, such as water scarcity and flooding, but proper management will help bring down the risks in this regard. For this reason, a clear distinction between exposure to a threat and a vulnerability that underlies a certain overall level of risk (uncontrollable conditions and controllable factors) is always necessary.

The year 2021 was quite untypical for Polish cities, also in the area of city water policy. First, we are still under the economic and social impact of the COVID-19 pandemic. Secondly, this year was full of many weather events which resulted in crisis situations and the subsequent consequences for the Polish cities. We mean the so-called flash floods, but also severe droughts. The year 2021 was something of a test for the Polish cities and their critical infrastructure in the area of flood risks, but also for crisis management. If there is any positive aspect related to the above-mentioned "weather incidents", it is the fact that urban water management has ceased to be a niche phenomenon; more and more often it becomes a general social issue. The urban community is aware of the seriousness of urban water policy issues, which should be already a good thing, because it is related to an ever increasing expectation of cooperation in creating solutions, also within the field of water policy. At the same time, the increasingly important role of culture in creating socio-economic development, especially in the development of social capital, is recognized, and one of the elements building up an advantage in this area is the development of the coastal infrastructure (waterfront). For the development of sport, leisure, and cultural resources in the city, as well as for improvement of the quality of life of the residents and for building the identity and emotional bond with the city, it is important, among other investments, to properly manage the waterfront. In addition to the level of earnings and job security, the sense of security, or the transport system, the quality of life and friendliness of the city are measured through the scope and management of the so-called blue-green infrastructure. Water is of equal importance within the context of development of transport routes, energy, and entrepreneurship.

How the city handles water-related issues shows, on the one hand, the potential institutional ability to coordinate complex issues of urban water policy development: how it communicates with residents, reacts to crises and changes, how flexible it is and adapts to changing challenges, how it can deal with the water crisis and manage it. And this is exactly what this ranking means to us. We congratulate the winners, while to the cities scoring lower in the ranking, we would like to propose to cooperate: together we will diagnose dysfunctions and plan for solutions aimed at improving quality of the city's functioning and development within the area of water management.

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CHAPTER 2

THE APPLIED RESEARCH METHODOLOGY

The Water City Index 2021 has been developed on the basis of the method used in previous rankings, however, every year minor changes are made in order to better reflect the implemented activities and the potential of Polish cities within the area of water policy. An important change in this year's ranking is the use of the Topographic Objects Database (Baza Danych Obiektów Topograficznych, BDOT10k) instead of the General Geographic Objects Database (BDOO). The quality, level of detail, and completeness of data available in BDOT10k significantly exceeds those available in BDOO. BDOT10k is a vector database containing the spatial location of topographic objects along with their basic descriptive characteristics. It includes information on the following topics:

- water network (sieć wodna, SW),
- communication network (sieć komunikacyjna, SK),
- utilities network (sieć uzbrojenia terenu, SU),
- land cover (pokrycie terenu, PT),
- protected areas (tereny chronione, TC),
- territorial division units (jednostki podziału terytorialnego, AD),
- buildings, structures and equipment (budynki, budowle i urządzenia, BU),
- land use complexes (kompleksy użytkowania terenu, KU),
- other facilities (inne obiekty, OI).

The Water City Index 2021 ranking has been typically developed for three categories of cities: metropolises (eight cities), other cities with poviát rights (58), and towns which do not have poviát rights, with at least 20,000 inhabitants (152)[1]. Separated from the group of cities with poviát rights, were eight metropolises, on the basis of such criteria as the number of inhabitants (at least 200,000 inhabitants), the level of technological advancement of the water and sewage infrastructure, and complexity of socio-economic problems.



The framework of the WCI 2020 includes four areas and 15 assessment categories. Their layout is shown in the figure below. The index of cities that are not cities with poviata rights was developed as part of a single collective category.

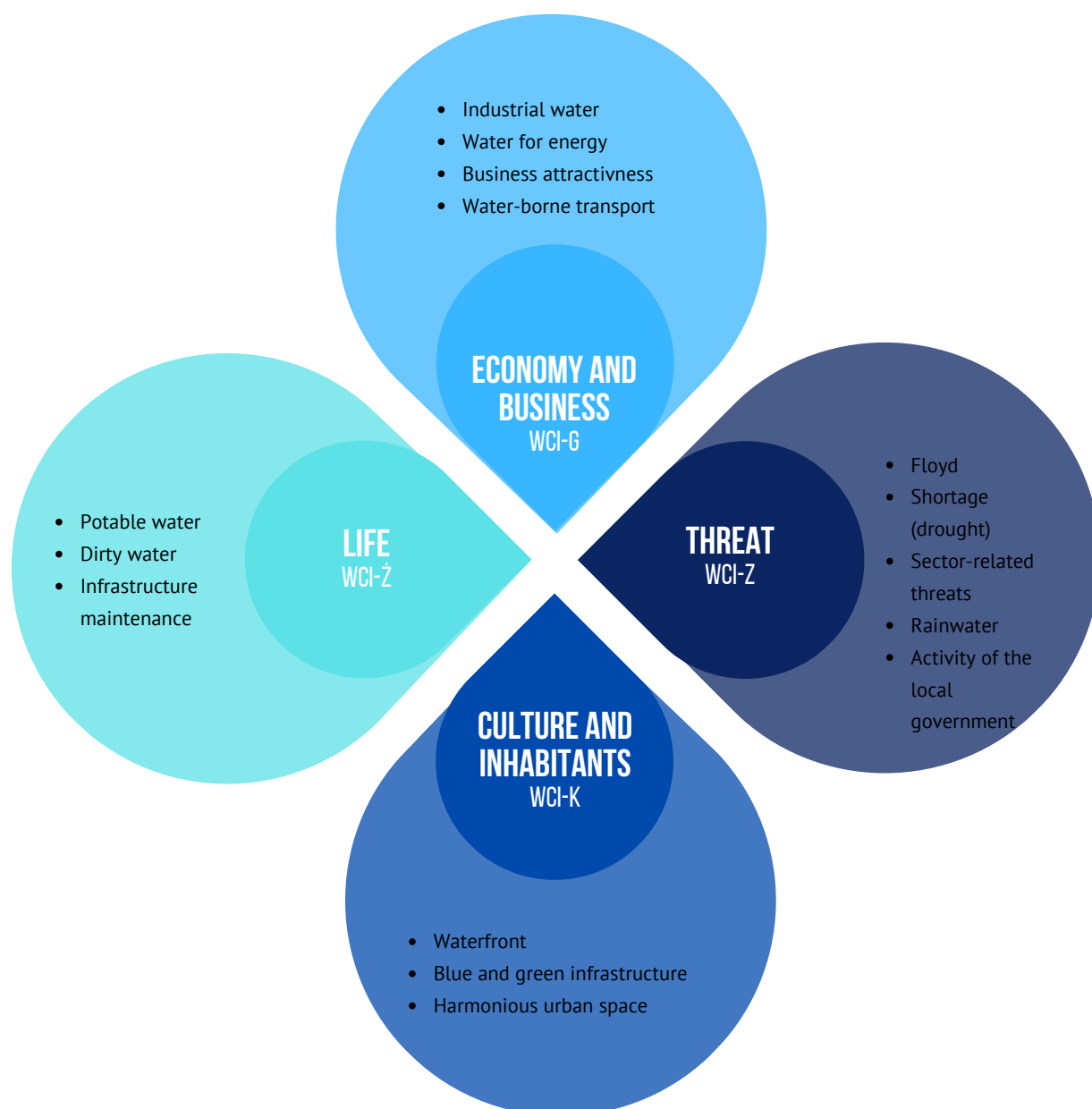


Figure 1. Areas and categories for urban water policy assessment

Source: own study

The weights adopted in the ranking for individual evaluation areas are presented below. The authors decided that the LIFE and THREAT areas are of the highest importance from the point of view of the city assessment, therefore they were assigned the highest weights. The quality of the data obtained in these two areas is also the highest. The ECONOMY and BUSINESS as well as CULTURE and INHABITANTS categories have a slightly lower significance for the final ranking, among others because there is slightly less reliable data that can be used to accurately calculate the final score. The assessment was supplemented by a survey addressed to the relevant units of city offices, which contained a number of qualitative questions. The responses were used to construct a synthetic result, the weight of which was set at 0.10. A relevant survey was also carried out in the city water supply and sewage companies (Przedsiębiorstwo Wodociągów i Kanalizacji, PWiK). The obtained results completed the assessment in the LIFE category.



In the calculation of the index for cities with powiat rights, there were used approx. **50 different indicators** obtained from the following sources:

- **Local Data Bank of the Central Statistical Office** (Bank Danych Lokalnych Głównego Urzędu Statystycznego, BDL GUS);
- **Topographic Objects Database** (Baza Danych Obiektów Topograficznych, BDOT10k);
- **Flood Risk Management Plans** (Plany Zarządzania Ryzykiem Powodziowym, PZRP);
- **Institute of Meteorology and Water Management - National Research Institute** (Instytut Meteorologii i Gospodarki Wodnej – Państwowy Instytut Badawczy, IMGW – PIB);
- **The Polish Waterworks Chamber of Commerce;**
- **A survey conducted among cities with powiat rights;**
- **A survey conducted at city water and sewage companies.**



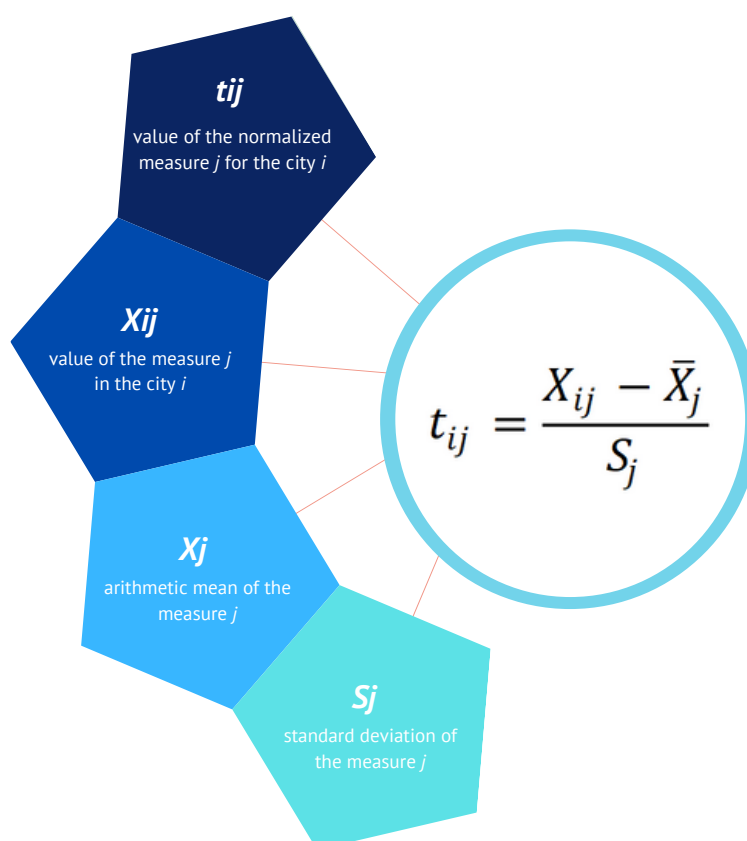
The rating in the **"Life"** category was based on, among others, the following indicators: the price and consumption of water in the city, the price and production of wastewater, the density of the city's water supply and sewage systems, and the city's expenditure on wastewater management and water protection.

In the **"Threat"** category, the index was calculated on the basis of such indicators as: the share of the city's area in the flood hazard area, the length of flood embankments in relation to the area of the flood hazard area in the city, annual rainfall per sealed area, the number of water supply failures per total the length of the network or the percentage of biologically active areas in the city area.

The index for the **"Economy and Business"** category was calculated, among others, on the basis of water consumption by industry, the number of enterprises operating in the water transport industry, or the number of crossings of watercourses (bridges) in relation to the length of watercourses in the city.

The last area (**"Culture and Residents"**) was based on such measures as: the length of the shoreline in the city, the percentage share of surface water in the city's area, the share of parks, green areas and estate green areas in the total area, or the city's expenditure on the maintenance of green areas per area green areas. A detailed list of indicators in each category is presented in Appendix no 1.

All indicators have been standardized using the following procedure:



As a result of the standardization, 15 sub-indices were created in individual subcategories, which then gave the basis to creating four indices for each assessment category (WCI-Ż, WCI-Z, WCI-GF, WCI-K) and one main index (WCI) respectively. The values obtained by metropolises and other cities with powiat status were used in the preparation of the main and detailed rankings (separately for each water policy area) presented in this report.



Figure 2. Water City Index structure

Source: own study.

The research method, applied as the basis for creating the ranking, draws on the three-years' worth of experience in developing the WCI index and takes into account such premises as objectivity, statistical significance of conclusions (credibility), as well as universality and inclusion of various development conditions in Polish cities.

Objectivity has been ensured by appropriate differentiation of data sources. The issue of water in the city has been divided into four research areas, which are described in detail in the third chapter of this study. For each area, there have been created categories described and interpreted with the use of indicators.

For each category functioning within the research areas, there was created a maximally long list of indicators which could be obtained from the above-mentioned sources, which were then verified in terms of usefulness (interpretation of information provided by the indicator), possible overlapping of indicators (hence the decision not to include some indicators in the study), weighing their significance, and the possibility of their quantification following the standardization process (data aggregation).

The high **statistical significance** of the research results is an effect of, firstly, the number of indicators applied in the study and the retrospective horizon, as well as the abovementioned significant diversification of data sources. The applied data satisfies basic requirements, characteristic of the indicators: quantification, variability over time, interpretability, normative character, subjectability to standardization processes, also in the context of assigning measures (significance weights) to individual indicators.

Universality of the method described below results, firstly, from the fact that a similar study can be conducted in every municipality in Poland, and secondly, it is possible to update the research by applying a similar method when more up-to-date information becomes available.

The method ensures **usefulness** of information. This study is not only a ranking. The described indicators are subject to interpretation due to the consequences of the applied municipal water policy and constitute an introduction to possible in-depth research and experts' proposals on the recommended directions of the applied water policy in each analyzed city as well as in each studied area.

Experts are aware that some of the cities' strengths and weaknesses in the framework of the Water City Index may result from natural conditions (determinants that are not controllable from the point of view of city authorities), while some result from controllable factors: spatial, environmental, economic, and social ones. Therefore, in the first step, the authors of the Water City Index analyzed the conditions (the number, types, surface of water bodies and watercourses; the average total amount of precipitation and the degree of sunshine in the analyzed cities), as well as the degree of sensitivity to the occurrence of floods (delimitation of floodplains). In the second step, the water policy of cities was analyzed within the context of diagnosed characteristics of the cities. For example, in the case of cities with a low total rainfall, which is conducive to the occurrence of drought, the activity to counteract the occurrence of drought will be more significant (weight of indicators) than in the case of cities where a similar problem does not occur. The sequence of actions is therefore as follows:

- division of urban water policy into 4 areas;
- division of areas into 14 categories;
- quantification of 14 categories with the help of a set of over 70 indicators;
- obtaining quantitative data;
- determining the features of specific cities;
- assigning weights to indicators and indices for individual categories;
- aggregation of results and data interpretation.

CHAPTER 3

KEY AREAS OF WATER RESOURCE MANAGEMENT IN THE CITY

The works on this year's index provided us with new information and broadened our cognitive horizons. Among the authors, we enjoyed the opportunity of discussing the last year's key events: sudden weather events and the consequences for Polish cities, subsequent so-called waves of the coronavirus pandemic, but also contextual phenomena: progressing globalization, digitization of the economy, climate change, or the model of urban development in Poland (in the context of managing their resources). We maintain our original division of urban water policy into areas, as applied in the years 2019 and 2020. Water policy in the city spans or should span four basic areas (there are numerous scientific and expert studies proposing a different division of areas of use and presence of water in the city, however, the authors – whilst not objecting to propositions - for the purposes of this study decided to apply the following division), which are presented below:

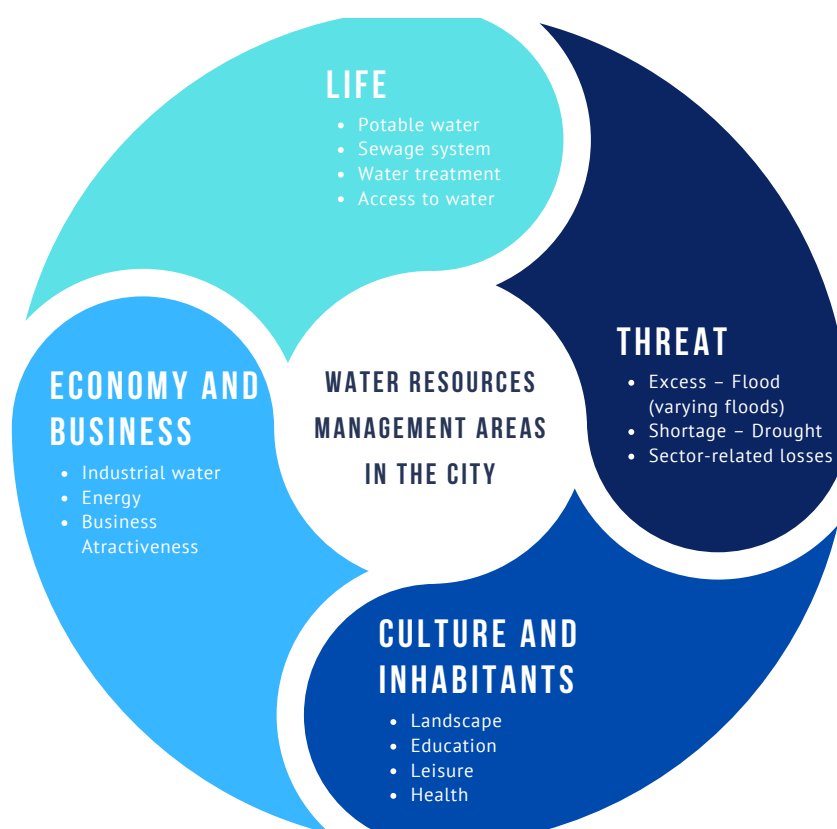


Figure 3. Water resources management areas in the city

Source: own study.



AREA 1

WATER AND THE QUALITY OF LIFE IN CITIES

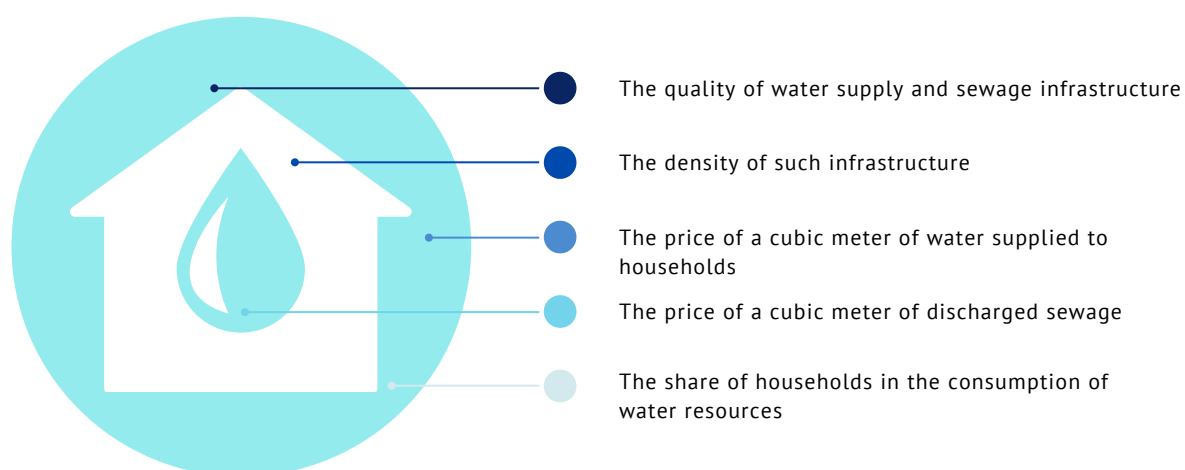
Water policy is one of the key elements determining the quality of life in cities. The classically understood issue of measuring the quality of life in cities is usually associated with the level of earnings, job security, access to specialized services, presence of institutions conditioning development, city's ability to absorb external development signals, or quality of the provided public social services. Quality (effectiveness) of the urban water policy is determined, on the one hand, by the ability to implement complex and capital-intensive technical (municipal) services; on the other hand, the manner in which the city authorities treat water resources points to awareness of the importance of this issue and the city's friendliness to its users.

Water is commonly known to be indispensable for the proper functioning of city users, and city authorities have learned (to a lower or greater degree) how they can meet the needs of residents, primarily in the area of municipal water and sewage policy, which includes water supply and sewage collection. Water supply and sewage services concern an increasing group of recipients, who are supplied with the appropriate quality and quantity of water. Such water must meet the ever increasing quality requirements and must be safe to drink. Therefore, municipal water supply infrastructure operators face the challenges generated by civilization pressure. These are new pollutants such as: pharmaceuticals, biocides, or perfluoroalkyl compounds (PFAS), but there is also resources-oriented competition across other sectors (industry, agriculture), or the need to respond to growing demands of customers. Provision of good quality sewage services is a comparable challenge. The quality of treated wastewater must meet the ever increasing environmental requirements.

In addition, wastewater treatment is related to development of technologies for the recovery of energy and valuable substances from such wastewater. There are more and more biogas plants (biogas is used for manufacturing electricity and heat, or for driving vehicles), composting plants, installations for the production of fertilizers and heat recovery from wastewater. Water and sewage services must take into account the issue of a broad understanding of possibilities of using water resources for the optimal functioning and development of cities.

The key to the "Life" category, or more precisely "Water and life quality in cities", is the question of measuring the quality and availability of drinking water and the degree of its consumption, the manner of collecting waste, the method and costs of its use and neutralization, along with analysis of the consequences for the natural environment, quality of water and sewage infrastructure, neutrality for the natural environment, adaptation to the upcoming expectations of future users of water infrastructure, accessibility and friendliness of this infrastructure, but also activities aimed at educating residents within the area of using water resources limited in principle, and thus at reducing the "water footprint".

In this area, we measure, among others:



“Quality (effectiveness) of the urban water policy is determined, on the one hand, by the ability to implement complex and capital-intensive technical (municipal) services; on the other hand, the manner in which the city authorities treat water resources points to awareness of the importance of this issue and the city's friendliness to its users.”

AREA 2

WATER AS A THREAT TO CITIES

The basic dilemmas and challenges related to urban water policy are contained in the short phrase: "too much", "too little", and "too dirty", although we have assigned the latter to the Area 1 described above. Excess and shortage of water are both dangerous to the urban space and users. In the case of Polish cities (but not exclusively) this problem will continue to grow. Sealed subsurfaces, which are common in cities, especially in those with intense urbanization processes, are a challenge in the event of heavy and concentrated rainfall.

On the one hand, rainwater plays an important role in the context of regulating the city's microclimate, lowering the air temperature and at the same time cleaning it of pollutants, on the other hand, however, when rainwater is not able to drain away in a natural way (lower runoff caused by its not soaking up and disturbances in the natural runoff), surface runoff increases, which in turn contributes to the occurrence of local flash floods. This is where a need arises to include in the quantitative analyzes the activity of city authorities for both creation of permeable areas and limiting reduction of natural areas, or development of small water retention. The violent weather events which have taken place in Poland in the recent years, but especially in 2021, require both experts on the urban water policy and city authorities to re-examine the degree of preparation for water crises. Spring and summer months present a problem. More intense weather events are bound to occur in Poland between April and September. We do not wish the water policy to be similar to the slogan: "Road workers surprised by winter yet again".



In fact, the level of preparedness of the authorities, that is the awareness and intent to prevent deep water crises was best shown in the reaction to the 1997 and 2010 water crises (although they were of a slightly different nature than those expected nowadays which consist mostly in the so-called flash floods), or to the 2021 water crisis, while being fully aware that such events are going to be more and more common, violent, and severe. We are dealing with diverse floods, an ever increasing part of which are the so-called flash floods, and with more and more diverse consequences of long-term droughts, not only in agriculture (which happens to be a non-urban issue), but also in relation to health issues of inhabitants. These include, for example, cardiological problems (also caused by heat), problems with access to water, also sector-specific losses, which are bound to affect as more and more. Therefore, in the context of responding to the threats resulting from excess and shortage of water, one should be aware of the need to have a comprehensive infrastructure, which includes not only the flood protection infrastructure, but also a variety of solutions enabling us to retain water, which will be used when needed.

Therefore, the method (degree) of reaction to threats is measured, first, by solutions and measures which, in a manner that is effective and at the same time neutral for the natural environment (as far as possible), secure the water away from people and people away from water (this is difficult in the case of quantitative research, but may be done by estimating the number and significance of the assumed solutions).

Other solutions are those aimed at creating conditions allowing for coexistence with water: for example, implementation of solutions enabling temporary flooding of areas along with their appropriate management. Another solution are buffer parks in the 100-year-old water hazard zone and/or amphibious architecture which helps to improve resistance to flooding.

As for the issues related to water scarcity, one should mention the importance of development of the so-called small water retention but also the urban policy resulting in alleviating the degree of long-term heat and drought, e.g. by protecting and expanding the so-called green infrastructure which should accompany the so-called blue infrastructure, thus reducing the occurrence of urban heat islands (urban heat islands contribute to the occurrence of droughts to a limited degree, but are closely related to air temperature). Within the context of droughts, of crucial importance is effectiveness of activities of the city authorities aimed at building a retention system and solutions favouring the renewal of water resources.



“*In the context of responding to the threats resulting from excess and shortage of water, one should be aware of the need to have a comprehensive infrastructure, which includes not only the flood protection infrastructure, but also a variety of solutions enabling us to retain water, which will be used when needed.*”

The dynamics of global technological, cultural, economic, and political changes taking place in recent years, in a specific manner renders obsolete a number of the so far common conclusions about the urban water policy.

Our times are characterized by the cult of efficiency, optimization of development processes, expansion of commercial companies, and technological progress, with a simultaneous decline in empathy, importance of intangible resources and, in general, in reflection on the social costs of development activities carried out in cities.

Opportunism has led to particularism, which is well observable in certain sectors of entrepreneurship, e.g. among some development companies. Expansive policy of companies building apartment buildings and department stores in the very city centre is both ruthless and destructive for the urban space and social ties. We are dealing here with the phenomenon of "shredding" space and "appropriating" the landscape. Due to irresponsible policies, cities are "perfectly prone" to flash floods. That the city authorities have lost control over the urbanization process of cities may bring about tragic consequences.

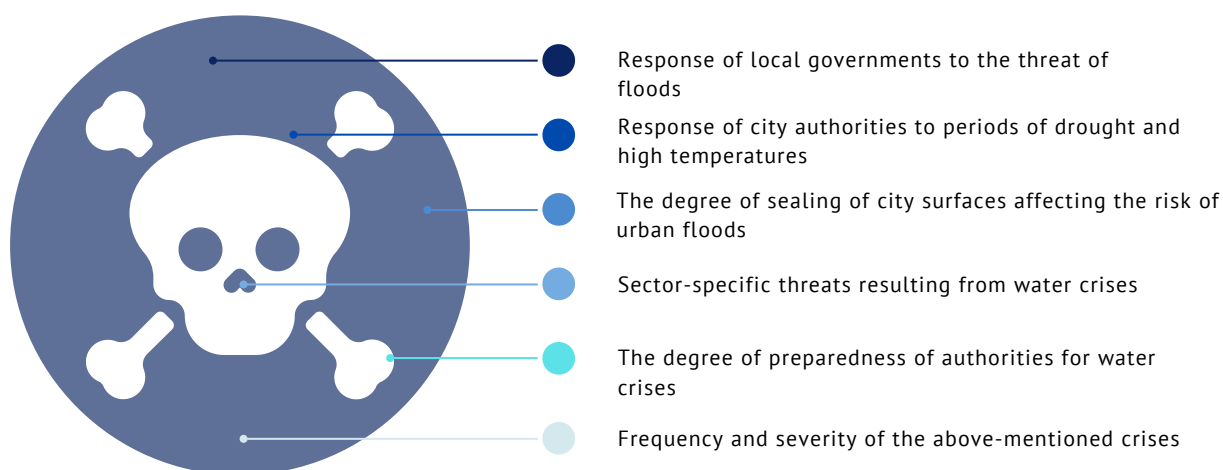
Extreme weather events will occur more and more often, which, along with sealed ground and relatively limited blue-green infrastructure (organized green areas and waterfront) will have increasingly severe social and economic effects. Only this year's August in Krakow has seen more floods than over the total of the last five years. Violent weather events are also known to include tornadoes, droughts, and hail. Moderate weather events in our latitude are now a thing of the past.

When considering flood hazards (within the context of the so-called traditional flood, also referred to as "big wave"), on the basis of theory, one is able to point out certain courses of action - as already mentioned above: moving water away from people and moving people away from water. The first group of solutions is related to the construction of capital-intensive flood protection infrastructure. The second case concerns more restrictive solutions within the area of spatial policy on floodplains.

Both the first and the second courses of action are threatened by social resistance, which is why the third course gains more recognition: balancing between the scale of threats and urban pressure (consent to specific risks with high social benefits) and adapting multifunctional development to the needs, opportunities, and threats.

In this area, we check and evaluate the **awareness** and **efforts** undertaken by the city authorities in order to limit the occurrence of crisis phenomena within the field of water policy and their effects. This relates to the infrastructure preventing crisis phenomena and consequences of unavoidable events as well as soft activities, e.g. educational activities. Some cities are more exposed to specific climatic and weather events, the consequence of which may be water shortage or excess in such city. Commonly known in Poland is seasonality of weather events (although, of course, deviations may also occur): spring floods arising from intense rainfall and thaws, often followed by droughts in the summer. Flash floods, on the other hand, depend on numerous factors and occur mainly in the warm months. Cities in Poland must therefore be prepared for the occurrence of two extreme phenomena.

In this area, we measure, among others:



AREA 3

WATER AS A FACTOR IN THE ECONOMIC DEVELOPMENT OF THE CITY

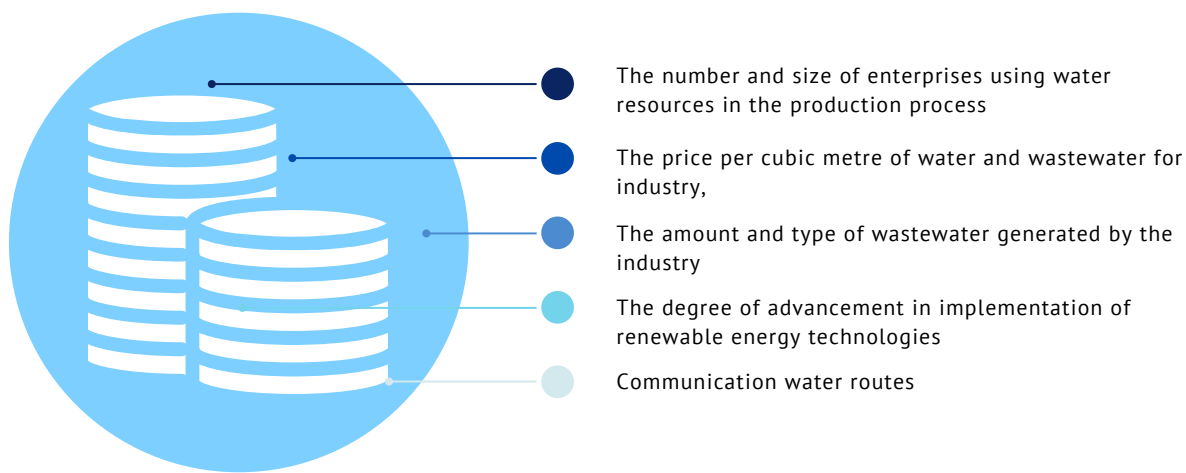
Water infrastructure may motivate the city's development by attracting new users: residents, entrepreneurs, and tourists. The use of water which directly incentivises economic development is still a niche element, resulting more from conditions and certain historical and physical conditions, rather than from creativity of city authorities in Poland.

Linking water resources to development of a modern urban economy is not common in Poland. In the business context, water remains an industry resource, a production resource, and a resource for certain declining, archaic sectors of the economy. Meanwhile, the question arises: how are water resources used in modern A-class office buildings? Is the so-called "gray water" an element of building environmental awareness, also related to the efficient use of water resources? Can water be used to produce energy, or can we start getting used to the idea that in 10 years' time water will be of significant importance in this context? Is water part of the construction of communication routes? Is water used to build the image of a city that is modern, responsible and open to new solutions? Do city authorities analyze the problem of the "water footprint" in the development process? Perception of water as a development factor may be an element of the city marketing strategy. It is important to be able to notice one's own resources, as well as the changing needs and perception of also business-friendly cities, so that water resources may serve as means of improving competitiveness of cities (location attractiveness)



In the WCI 2021, similarly to the previous year's edition, we no longer use the indicator of energy production from hydropower plants, due to the lack of statistically significant data for all surveyed entities. Lack of data is still an obstacle preventing us from including this important issue in the calculations. However, we have high hopes for the future. Cities in Poland, as one of the main energy consumers, will be doomed to implement activities aimed at diversification of energy sources.

Measured in this area are, among others:



AREA 4

WATER AS AN ELEMENT OF LANDSCAPE, CULTURAL DEVELOPMENT, AND LEISURE

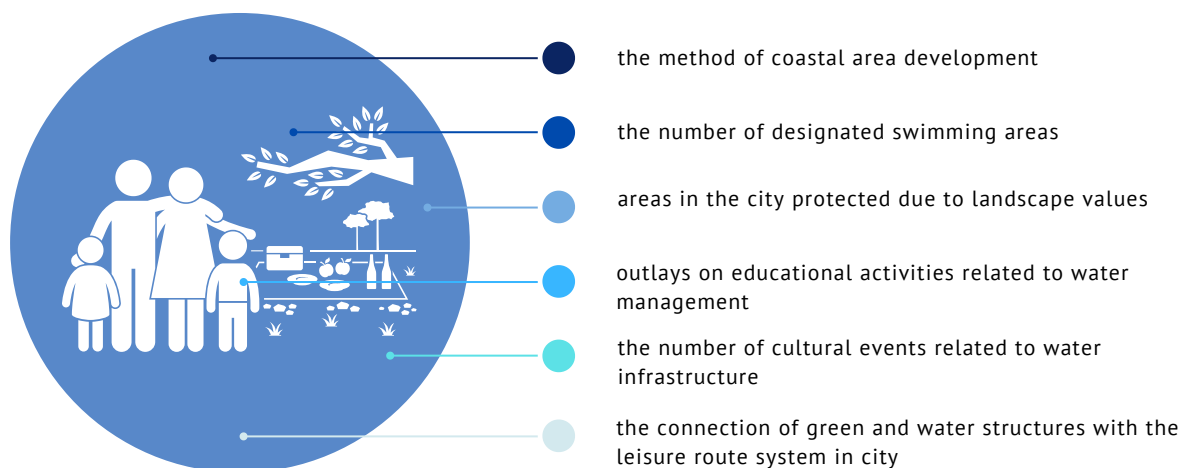
The starting point of analysis in this area was an assertion that importance of the area in research on water policies in Poland and abroad is growing. This is related to a rather disturbing tendency related to development of the so-called urban diseases. As an urban society, we are increasingly exposed to civilization diseases, some of which have been deepened by social isolation resulting from the coronavirus pandemic. This primarily concerns cardiological diseases, but also those related to depression, neurosis, and a sense of social marginalization, which paradoxically accompanies people living in high-density communities. And it is related to the social need of communing with nature and green areas. Inhabitants are paying more and more attention to the leisure and sports infrastructure.

Significance of social capital is also growing. Paweł Adamowicz said that the direction and dynamics of social and economic changes in each city - and in the country - depended on three types of capital: human, social, and financial. According to Adamowicz, Poles have increased their human capital, are better educated than in the early 1990s, more resourceful, wealthier, care more about their health, and spend more time on sports and leisure. We do not excel at multiplying social capital, though[3][4]. Therefore, city authorities, in order to meet expectations also within the culture area, invest in development of infrastructure, which is to serve relaxation and leisure purposes. Hence the ideas for city beaches, pocket parks as well as walk and cycle paths. Water is perfect for such solutions, which is why the development of quays presents a variety of benefits.



In the above context, the main subjects of the city's development in the culture area are the inhabitants. Created for them are solutions, in which we assessed, among others, whether there has been maintained appropriate balance between the commercialization of space (which gives measurable benefits only to a small group of people, for example, developers) and solutions which are beneficial to the general public. This refers specifically to a coastal space which is common and benefits the commonality of society. We are talking here about space, which forms basis for the construction of infrastructure important for maintaining the appropriate quality of life of residents and an appropriate balance between work and leisure. Worthy of mention is also the natural capital. This concerns social awareness of ecosystem services, which still is marginal, but seeing the urban landscape also from this angle seems just as important.

Measured in this area are, among others:



CHAPTER 4

RANKING RESULTS

On the basis of the above-mentioned methodology, there was created a water ranking of cities in Poland. The ranking results are presented below in the following order[5]:

THE RANKING LAYOUT

WATER CITY INDEX 2021



THE MAIN RANKING FOR METROPOLISES

1. Ranking for metropolises in the "Life" area
2. Ranking for metropolises in the "Threat" area
3. Ranking for metropolises in the "Economy and Business" area
4. Ranking for metropolises in the "Culture and Inhabitants" area



THE MAIN RANKING FOR CITIES WITH POVIAT RIGHTS

1. Ranking for cities with poviats in the "Life" area
2. Ranking for cities with poviats in the "Threat" area
3. Ranking for cities with poviats in the "Economy and Business" area
4. Ranking for cities with poviats in the "Culture and Inhabitants" area



THE MAIN RANKING FOR MID-SIZED CITIES

The ranking is based on partial values of indicators in four areas:

- Life
- Threat
- Economy and Business
- Culture and Inhabitants

WINNERS

WATER CITY INDEX 2021



THE MAIN RANKING
FOR METROPOLES

I PLACE

GDAŃSK

II PLACE

KRAKÓW

III PLACE

WROCLAW



THE MAIN RANKING FOR
CITIES WITH POVIAT
RIGHTS

I PLACE

GLIWICE

II PLACE

GORZÓW WLKP.

III PLACE

ŚWINOUJŚCIE



THE MAIN RANKING
FOR MID-SIZED CITIES

I PLACE

AUGUSTÓW

II PLACE

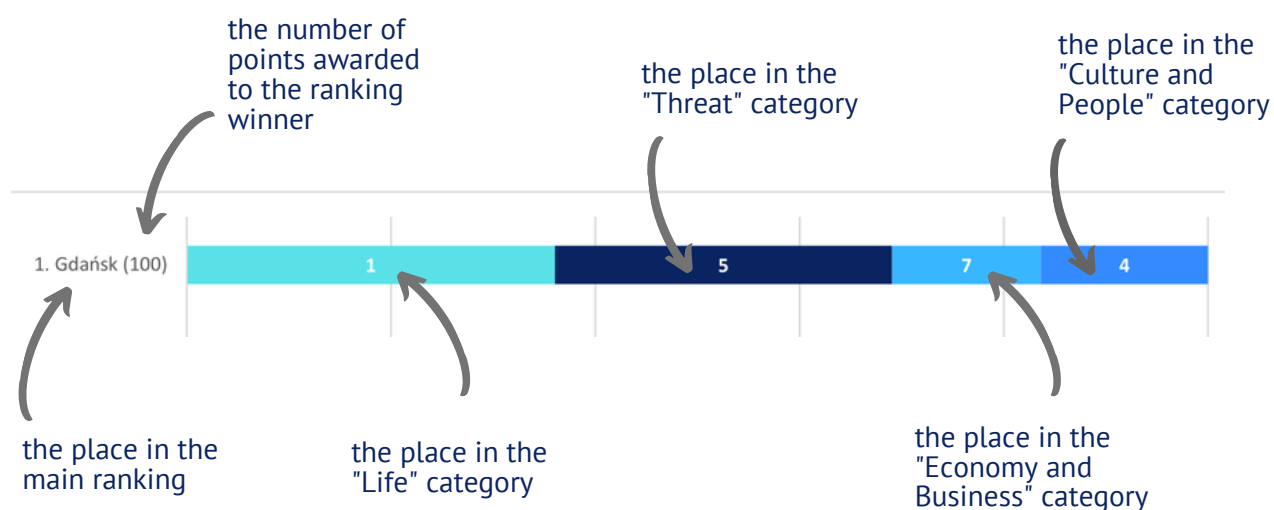
LUBLINEC

III PLACE

ŻYWIEC

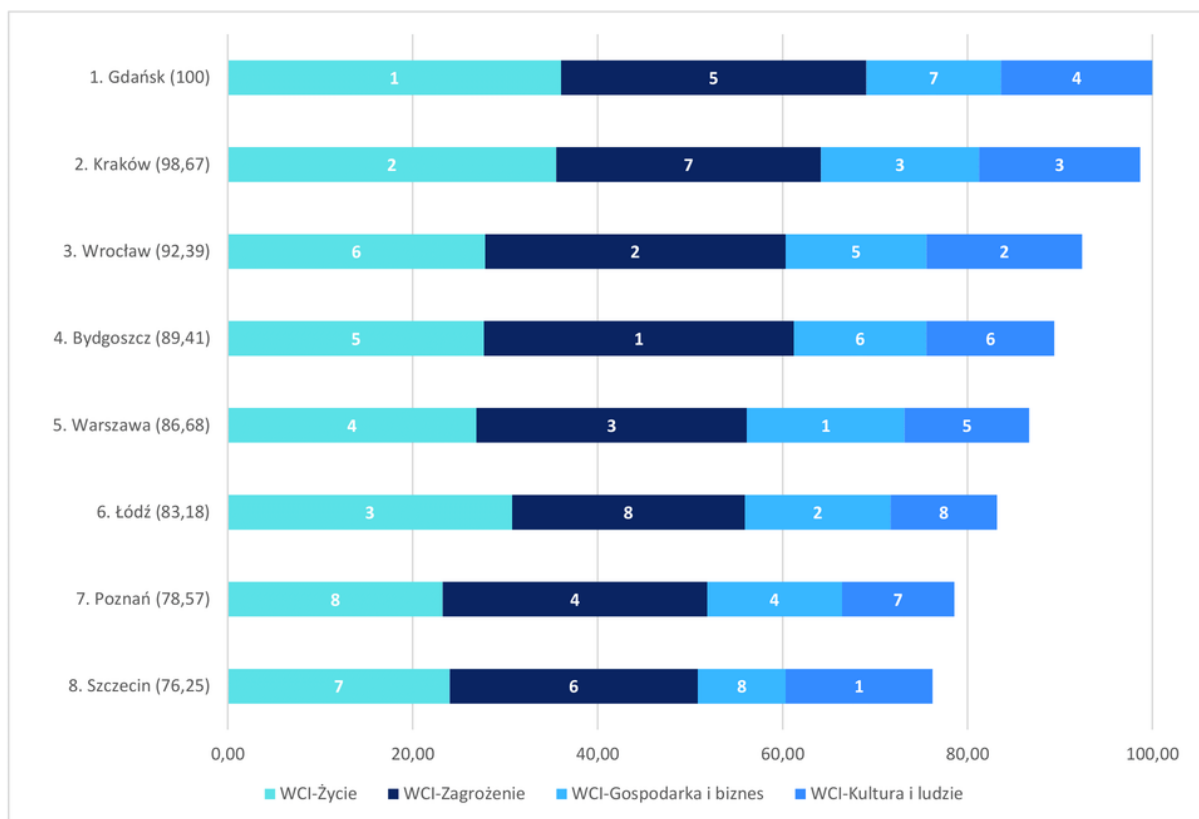
INTERPRETATION OF THE RANKING

- In relation to metropolises and cities with powiat status, the main ranking lists results of rankings in individual categories: Life, Hazard, Economy and Business, Culture and Inhabitants. The results are presented in the form of numbers specifying the position taken by a given city in each category, shown on the appropriate bar of the graph.
- In the case of the charts prepared for the ranking for metropolises and the ranking for cities with powiat rights, the width of individual blocks in the chart reflects the share of a given category in the overall assessment of the city, and, since different weights have been used for the four categories in the final assessment, the width of these blocks is not always comparable between cities.



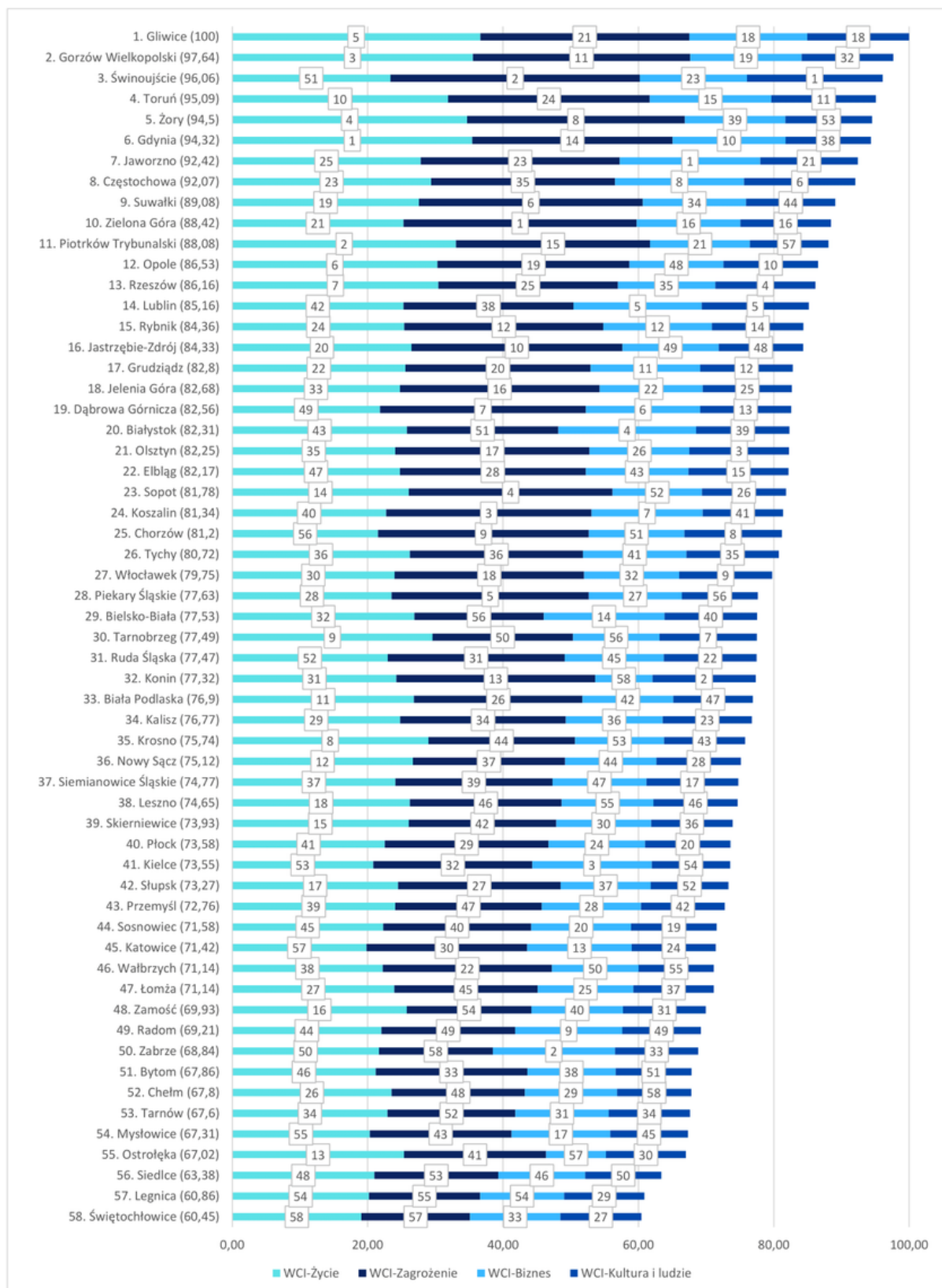


THE MAIN RANKING FOR METROPOLISES



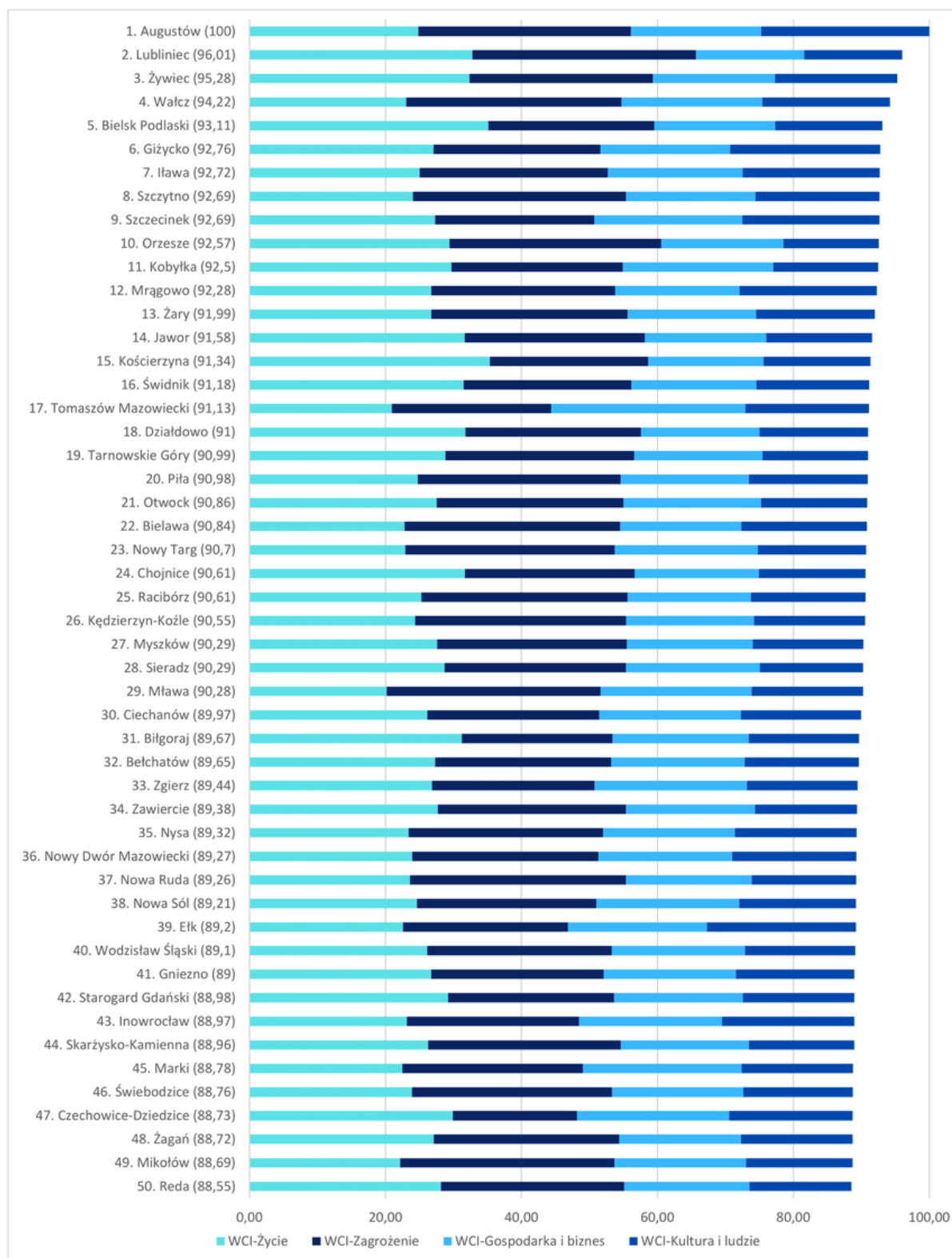


THE MAIN RANKING FOR CITIES WITH POWIAT RIGHTS



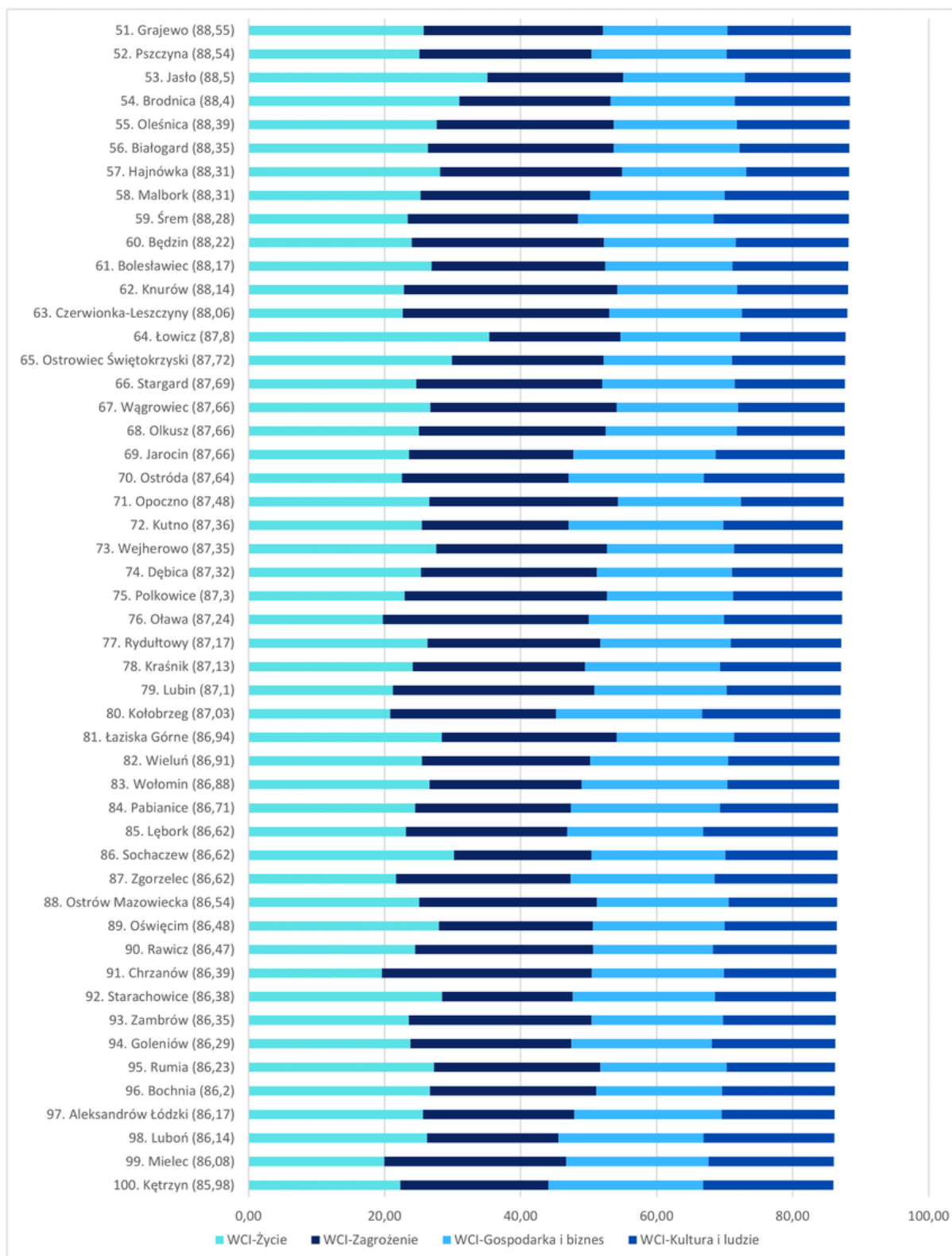


THE MAIN RANKING FOR MID-SIZED CITIES



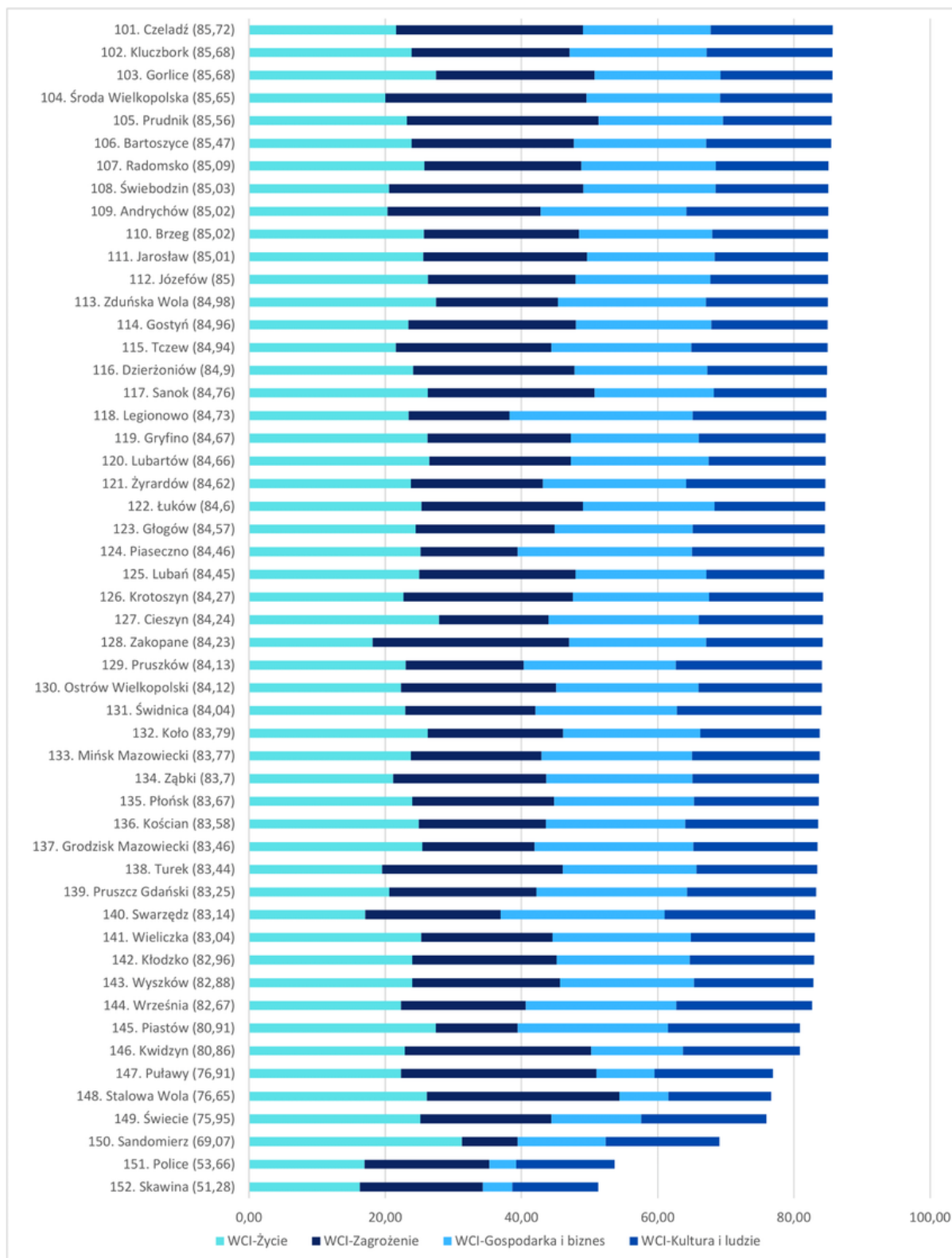


THE MAIN RANKING FOR MID-SIZED CITIES CD.





THE MAIN RANKING FOR MID-SIZED CITIES CD.



CHAPTER 5

MODEL SOLUTIONS IN THE FIELD OF URBAN WATER POLICY AS SEEN IN FOREIGN CITIES



BIRMINGHAM RESILIENCE PROJECT

The main goal of the Birmingham Resilience Project (BRP) is creating alternative water supply for Birmingham, one of England's largest cities[6]. One of the largest resilience projects, the project is to be implemented in the UK, with an investment exceeding £ 250 million. The Elan Valley Aqueduct (EVA) has been providing water from central Wales to Birmingham for over 100 years. In order to extend its service life, scheduled maintenance works should be performed thereon. However, as it is Birmingham's main water supply, shutting it down for an extended period of time without interrupting supplies is virtually impossible. In order to ensure the maintenance of the EVA, alternative supplies will be provided from the Severn. Water will be sourced from the river and pumped to the Frankley Treatment Plant. To enable this, the project will consist of the following elements:

1. A new collection point and pumping station;
2. A new main line to water treatment plants (Frankley Water Treatment Works: WTW);
3. A new parallel treatment system at Frankley WTW which is to supply additional water from the River Severn.

The project will render the infrastructure more resilient to possible water crises in two key ways:

1. Redundancy through the development of alternative water supply sources for the city. As a result, there is no need to rely exclusively on the EVA.
2. Enabling the shutdown of the EVA for several days a year without compromising the quality and quantity of the water supplied to consumers, so that proactive maintenance of the infrastructure can be carried out in order to increase its durability and reliability.

At the moment, the infrastructure consists of two parallel process treatment streams fed from an external reservoir and an on-site reservoir, where both streams are fed with water from the Elan Valley. Current treatment processes evolved from the original sand filters and include far more modern treatment processes involving: dissolved air flotation (DAF), rapid gravity filters (RGF), granular activated carbon filtration (GAC), and pH correction.

The treated water is chlorine disinfected using contact reservoirs. GAC adsorption is dedicated to one stream following the RGF and allows the treated river water to be mixed. In addition, two new Powdered Activated Carbon (PAC) systems were built to remove pesticides from the River Severn water; one on each of the two raw water supply pipelines. Each system doses the PAC into the associated raw water network and there is ensured contact time as the water flows to the WTW. The main supply line is discharged into the on-site reservoir, which ensures that excess PAC is deposited prior to WTW's water treatment processes.



A new treatment stream under construction

Source: https://waterprojectsonline.com/custom_case_study/birmingham-resilience-project-treated-water-project/



AQUATOR

The Severn Trent Water uses the Aquator simulation model for the purpose of optimizing the use of water resources. It is a powerful application for creating and running simulation models of natural rivers and water supply systems. The simulation package facilitates the construction of models consisting of a number of components representing sources, demand centres, and their connections. These components may then be customized to simulate a wide range of scenarios and operational rules.

The Aquator is used for modelling of the complex nature of a water resource system. The model includes the following components:

Raw water sources: Raw water sources or source groups are represented in each zone. The input data includes their power outputs and details of any downstream resulting from license limitations, resource availability, pump power, treatment capacity, or transmission capacity. In the case where the source is supplied by a reservoir, the control rules for such reservoir are used in order to determine the source's safe performance over the course of the year. For flow-through sources, included in the model have been any abstraction permits or specific flow restrictions. Each reservoir and river on the model have their own catchment areas, where each is assigned a daily series of tributaries. The data covers a period of over 100 years, starting in 1920.

Groundwater sources: Performance of each groundwater source is analyzed from an individual perspective as well as considered as a group of sources. This method forms the basis of the assessment of groundwater sources, in accordance with the detailed UK Water Industry Research guidelines. For groundwater sources, the average annual and peak operational efficiency were calculated and included in the groundwater component of the Aquator application. For most groundwater sources, the abstraction license is the limiting factor, although there are hydraulic or operational limitations in some sources. The subscription license may have daily, annual, or multi-year conditions, and these are appropriately represented in the Aquator model. Additionally, some of the requirements for mixing water from multiple sources in order to obtain adequate quality at given locations are incorporated into the model as operational variables.

Aqueducts and Distribution Ties: Aqueducts and Distribution Ties are considered between the sources and the demand centres, and there are entered their maximum throughputs. The model allows to identify location of distribution bottlenecks, which limit the ability to supply water where it is needed.

Imports and Exports: These variables reflect transfers between zones and the bulk supply of water from other companies.

Demand Centers: There are one or more demand centres in a single zone. They represent the areas, where both private and industrial customers exist and use water.



RESTORING THE ORIGINAL FUNCTIONALITY OF THE BLUE INFRASTRUCTURE AREAS

Utrecht was founded by the Romans around 50 AD. In 1122, Utrecht was granted city rights and following that year a city wall with a moat dug around it was built. The moat was supplied with water through a change in the course of branches of the Rhine and Vecht rivers. The wall served its function for about 700 years, however, at the beginning of the 19th century, the embankments were no longer needed, and the wall was pulled down in the years 1830-1872. The southern and eastern sides of the former city wall were transformed into an English-style park. The remains of the moat were incorporated into the park's layout. In the north-west part of the city there was a city port, and part of the moat had quays, to which ships docked. This changed at the beginning of the 19th century - the port was moved to the outskirts of the city, and an increase in car traffic in the centre followed. For this reason, in the late 1950s, the city of Utrecht hired an engineer, who proposed to fill the entire city moat in order to use its space for building a bypass around the historic city centre. Ultimately, due to the opposition of a large part of the public and the fact that the eastern and southern parts of the former moat were granted the status of a protected monument, the city decided to convert solely the part of the canal from the north and west into a motorway. The construction of the motorway began in 1968 and was launched in subsequent stages from 1973. The motorway having been launched, it turned out to be rather short, did not connect with other wider roads, and therefore was practically useless. Its entire length could be covered in one minute. In 1989, the city agreed to test the possibility of reopening the canal. In 1999, the Utrecht city council finally decided to restore the historic city moat. Works were commenced from the northern part of the buried canal, which had not been turned into a road, but had been used as a parking lot. On 18 December 2015, a greater part of the canal was reopened. The residents welcomed this investment with great enthusiasm.

Ultimately, all works were completed in 2020, by which means Utrecht successfully brought the almost 900-year-old city moat back to life. The removal of the motorway is in line with Utrecht's new policy, which states that the main road users in the city are cycling and walking people, and not private car users.



Source:
<https://bicycledutch.wordpress.com/2016/01/05/motorway-removed-to-bring-back-original-water/>

<https://bicycledutch.wordpress.com/2020/09/16/utrecht-corrects-a-historic-urban-design-mistake/>

<https://bicycledutch.wordpress.com/2020/09/09/cycling-around-the-restored-utrecht-moat/>

Possibilities of implementing the solution

Turning a 2-lane highway back into a canal was a bold and large-scale undertaking, showing that urban space must be carefully shaped, taking into account all aspects of people's lives. In 2015, when the first part of the canal was reopened, the entire investment had not yet been completed, with several hundred metres of the canal still to be completed. However, the response of the inhabitants to the re-opening of the canal left no choice to the city authorities to complete this investment. This shows how important for the city's community is harmoniously management of its space and taking care of every aspect of people's lives, not only those related to transport infrastructure. This is worth bearing in mind also when planning the development of Polish cities and undertaking equally bold and large-scale undertakings.

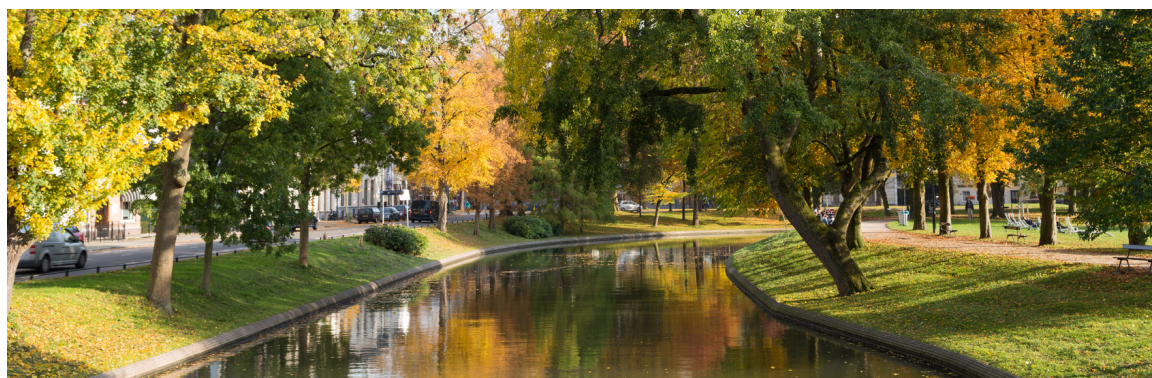


GREEN ARCHITECTURE PLAN

Description of the model solution

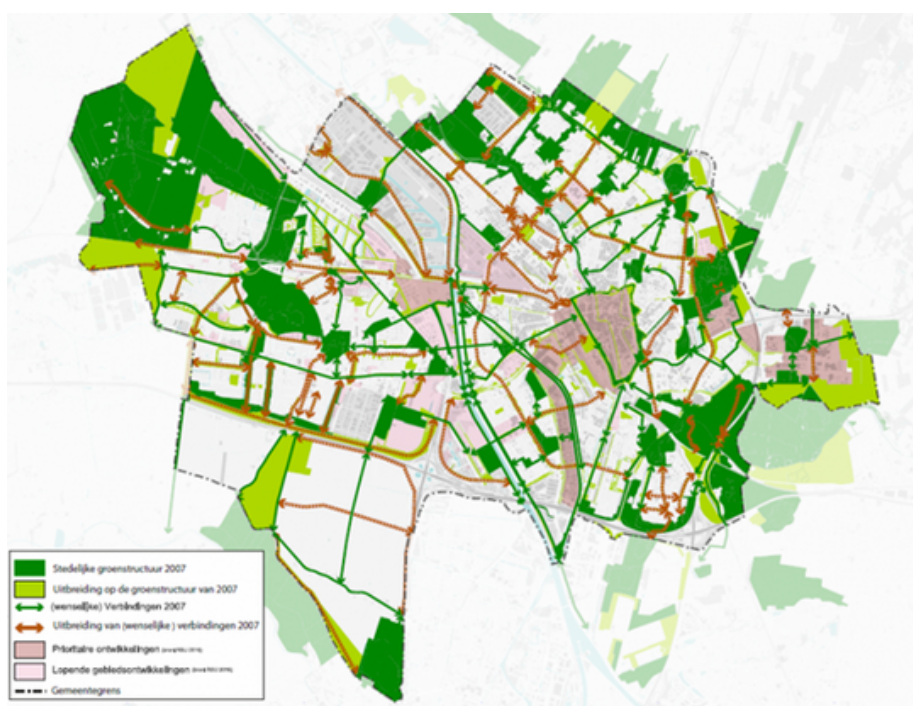
Utrecht is a city which goes to great lengths in order to make its development sustainable, and the city as friendly as possible to its inhabitants. At the same time, Utrecht is an important transport junction, connecting road, rail, and river transport. In addition, the city is developing very dynamically - it is the fastest-growing city in the Netherlands (its population is estimated to increase up to 430,000 by 2040). This presents a number of challenges, also those related to the planning issues. Due to the growing population density, the pressure on green public space in the city is increasing. The city aims to promote a healthy lifestyle through an integrated and systemic approach combining local climate regulations, noise reduction, leisure, and cleaner air. With this in mind, the city developed an instrument for the protection and improvement of green areas. This is the 2007 Green Structure Plan. The actions of the Green Architecture Plan are targeted at sustainable urbanization, through actions conducted with a view to: reducing and slowing down car traffic, using climate and energy neutral construction, efficient water management, and enlarging green spaces for a pleasant and healthy life in the city. Utrecht intends to be a city, where a healthy living environment and sustainable development are core values. The updated 2017-2030 Green Architecture Plan is targeted at making even better use of green and blue infrastructure and the reconstruction of ecosystems. The Green Architecture Plan is closely related to other multi-annual environmental programmes, which define in more detail the actions to be taken, the manner of financing these actions, and the schedule for their implementation. The programme emphasises cooperation between various institutions and local government as well as state and European Union authorities as having great impact on green infrastructure investments. Utrecht strives to be a city where a healthy living environment and sustainable development are core values. The updated Green Architecture Plan for the years 2017-2030 aims at making even better use of green and blue infrastructure and the reconstruction of ecosystems. The Green Architecture Plan is closely related to other multi-annual environmental programmes which in greater detail define activities to be taken, the method of their financing, and the schedule for implementation. The programme emphasizes the importance of cooperation between various institutions and local government within the realm of investments in green infrastructure, as well as cooperation with authorities at the state or European Union levels.

The Utrecht Trees Policy is another document promoting the above-mentioned values. This document emphasizes that trees have their own spatial dimensions and problems that merit specific policies on issues such as tree spatial structure, instruments and guidelines for their care and maintenance. The city authorities created a map of the desired spatial structure of trees in the city area.



The map shows the currently existing rows of trees, parks, as well as missing elements in the spatial structure. The tree policy pursues, among others, the following objectives:

- 1) creating a coherent tree structure in the city on the basis of cultural, historical, spatial, and ecological conditions;
- 2) supplementing, improving and developing this structure;
- 3) greater care for monument trees located in the municipality area and as private property;
- 4) more adult trees in 2030 as compared to 2008;
- 5) improving communication with residents about how the community takes care of its trees;
- 6) simplification of regulations for citizens.



Source:

<https://oppla.eu/casestudy/19311>

<https://oppla.eu/casestudy/19453>

Henninger D.J.S., Mosaic Governance: Combining Strategic Greenspace Planning with Urban Green Active Citizenship to Enhance Urban Green Infrastructure, 2018, Utrecht University Faculty of Geosciences Theses (a Master's thesis)

Possibilities of implementing the solution

These two documents are a perfect example of the importance for a city of managing green and blue infrastructure. Building a city that is friendly to its inhabitants and resistant to climate change requires a number of integrated activities. The existence of a document, which precisely defines the directions of the city's development in terms of green and blue infrastructure is a great solution, which, as it seems, may be successfully implemented in many Polish cities. The Urban Plans for Adaptation to Climate Change, already existing in a number of cities, are a step in the right direction. However, it seems in following in the footsteps of Utrecht, one should take a step forward and implement further plans so as to make the city a friendlier environment to live in.



WATER SCIENCE AND MANAGEMENT – UTRECHT UNIVERSITY

Description of the model solution

Utrecht is a vibrant student city in the heart of the Netherlands. It houses the largest and most prestigious university in the Netherlands (Utrecht University). Also located in the city are a large number of schools and educational institutions. In total, over 70,000 students live in Utrecht, which is an impressive 20% of the city's population. The Utrecht University is the largest university in the Netherlands (with over 35,000 students) and one of the best universities in the world. The Shanghai ranking places the university first in the Netherlands and 50 in the world (2021). One of the fields of study offered by the University of Utrecht is Water Science and Management. This two-year study programme in Water Sciences and Water Resource Management provides an in-depth understanding of modern water management techniques and water policy from a sustainable development perspective. The programme was created in response to the growing trends in sustainable development, economic responsibility, and stakeholder participation in water resource management. Therefore, the Water Science and Management programme integrates knowledge in the field of natural and social sciences in response to emerging needs in this field. Moreover, close cooperation with companies across the water sector, such as Arcadis, Grontmij, DHV, or Deltares, enables conducting research and internships, thus ensuring acquisition of practical experience.

Source: <https://www.uu.nl/>

Possibilities of implementing the solution

The emphasis on education within the field of water management is of great importance also in the Polish water management reality. In the context of population growth, development related to the sealing of the area or climate change, Polish cities create more and more new problems in the field of broadly understood water resources management. Therefore, coming to the fore are the shortage of specialists in this area as well as poor cooperation of scientific and research units and companies from the water sector.



PORI, FINLAND



POPULATION
83 809 (2020 r.)

AREA
1372,04 (including the land area 517,14) km²

POPULATION DENSITY
162 person / km²



NATIONAL URBAN PARK - GREEN AND BLUE INFRASTRUCTURE

Description of the model solution

National Urban Parks is an idea that has been taken over from Sweden. The parks are created by a network of Finnish cities united by the desire to develop and preserve their valuable architectural, cultural, and environmental heritage. There are four criteria developed by the Ministry of the Environment, which guide creation of the parks:

- 1. Content criterion:** A national urban park must cover natural areas important to the preservation of urban biodiversity as well as culturally important areas, along with structures which are deemed to be meaningful for understanding of the national history or stages of city development. The park should also include green areas of architectural or aesthetic importance. A significant advantage is the inclusion of reservoirs or flowing waters.
- 2. Scope and integrity criterion:** An urban national park must be large enough, with an undisturbed blue-green area, and uniform enough to allow people to move through it from one neighborhood to another.
- 3. Ecological and continuity criterion:** From the ecology point of view, it is important for the site to have ecological corridors allowing species to migrate and interact, to ensure its continuity i.e. direct connection to natural areas outside the city or to the surrounding countryside.
- 4. Criterion of city centrality:** The park must be located in the centre of a city and must form an integral part thereof. At the consent of the municipality, a decision to establish a national city park may include provisions necessary to preserve the essential values of the area.

Pori is fortunate enough to have been located by the river. It is the Kokemäenjoki River and its mouth that form the heart of the city. Along it, settlement, culture, and new currents spread over time from coast to land. The landscape is characterized by numerous branches and islets.

In the center of Pori, on the north bank of the river, there are monumental industrial buildings, and on the south, the rich houses of the former bourgeoisie. They tell the story of industrialization and development of trade as well as the nineteenth-century architecture of the city.

The Pori National Urban Park was established by means of the decision of the Ministry of Environment of 06 May 2002 and was enlarged on 14 December 2006. The Park is divided into three parts: the island area, the city centre, and the Pori forest and sports centre. Each area fulfills a specific task and values important for the inhabitants. There are both an old agricultural landscape and a post-industrial area, but also a region for cultural and leisure use along the River Kokemäenjoki. It is the river that marks part of the natural boundaries of the park. The National Urban Park tells about the stages of development of one of the most important rivers in Finland and the settlement of Finns, it is part of the Finnish history of urban development, where the Jokisuu Market has become a post-industrial centre of knowledge. From the northern end of the park there extends the widest estuary in the Nordic countries, its natural values internationally recognized. Especially for birdwatchers, the estuary offers a unique environment, where one may learn about the nature of the estuary up close by sailing or kayaking towards the sea.

The park area serves thousands of Pori residents in their daily lives. Aesthetics of the urban landscape, consistent greenery, and sustainable development of the city are the main challenges for the proper management and maintenance of the park. Worth emphasising is a requirement for the National Urban Park to integrate the natural environment with cultural heritage and practical function of the city. Residents come here for leisure purposes, and the running paths along the river clearly stand out. However, the park is also a communication corridor and an important element mitigating river floods and backwaters from the sea. Flooding does pose a significant threat to the city.

Possibilities of implementing the solution

Cities of all sizes, especially those located by a river or lake, should be interested in creating parks which are part of preservation of the local heritage, and have both leisure and utility values (flood protection). This solution may be of particular interest to post-industrial cities intending to revitalize their degraded, post-industrial part, often located by a canal, river or, a retention reservoir. Creating park areas that would be able to fulfill numerous functions is an ideal objective, yet not always possible. Most likely, the pressure from developers bringing income to the city, ready to develop post-industrial areas, especially if such are located in the centre of the city, poses a significant obstacle. It is important to strive to reconcile the general interest of residents who need common, generally accessible green areas and the interests of investors.





SEWAGE MANAGEMENT OUTSIDE OF THE REACH OF THE SEWAGE NETWORK

Description of the model solution

In 2004, Finland introduced the first regulation on waste water management in sparsely populated areas. At that time, all real properties were covered with a 10-year period to undertake all necessary actions. For many residents, especially older people or those who hold old properties, implementing the regulation proved to be more difficult than expected. In February 2015, a working group was set up to prepare a revision of the legislation on sparsely populated areas. The law was changed to improve the process of organizing the wastewater management where there is no sewage network.

Wastewater from sparsely populated areas carries the largest after agricultural sector load of phosphorus to water reservoirs. Therefore, all real estates located in a sparsely populated area require orderly sewage management and an assessment of the impact of sewage treatment installations on the environment (there are dedicated guidelines).

Wastewater treatment systems in sparsely populated areas must have the efficiency brought to the level required in an agglomeration (the latter determined in the waste water directive), or to the requirements of the Finnish law (outside agglomerations).

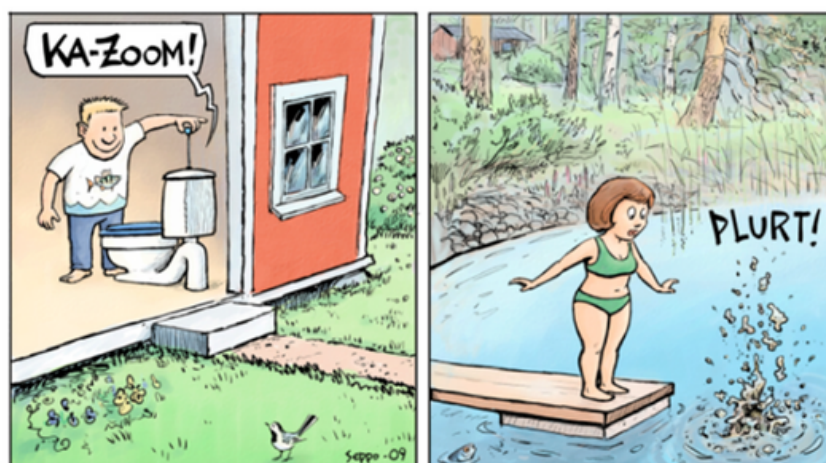
The very first duty of a property owner is to connect the property to the sewage system. Where this is not physically possible, combining multiple properties into a common system and building a common sewage treatment plant should be looked into. Only in cases where it is not possible to implement a common solution, an individual one is taken into account. Elderly people living alone may conditionally be exempted from this obligation. Temporary exemption (for no more than five years) may also be obtained for certain social reasons (unemployment, illness), or when the area is known to be included in the future sewage system.

On the other hand, a derogation related to the efficiency of the system may be granted on the basis of an environmental impact assessment, when the number of people living in the property, the frequency of staying therein, or the quality and quantity of sewage produced do not significantly differ from the average situation of sparsely populated areas. In practice, the number of people living in the property may not exceed two or three, depending on the purpose of the facility (e.g. a house or a holiday home, type of toilet).

The owner of an individual treatment system is obliged to maintain the infrastructure in a proper technical condition. They may apply for a subsidy for the renovation or revamping of their system.

Particularly restrictive requirements, already at the stage of the building permission, apply to the buildings located in groundwater protection areas and at a distance of less than 100 metres from surface waters and the sea.

Organizing wastewater management in sparsely populated areas is one of the elements of the city's strategy for the proper management of nutrients' recovery. That is why the municipal environmental protection office checks the residents for the correct operation and cleaning of individual systems, and the systematic disposal of sludge to the sewage treatment plant. The office provides residents and builders with advice on wastewater management. The state environmental administration also provides information on proper sewage management in sparsely populated areas. There are water protection associations and regional environmental service centres.

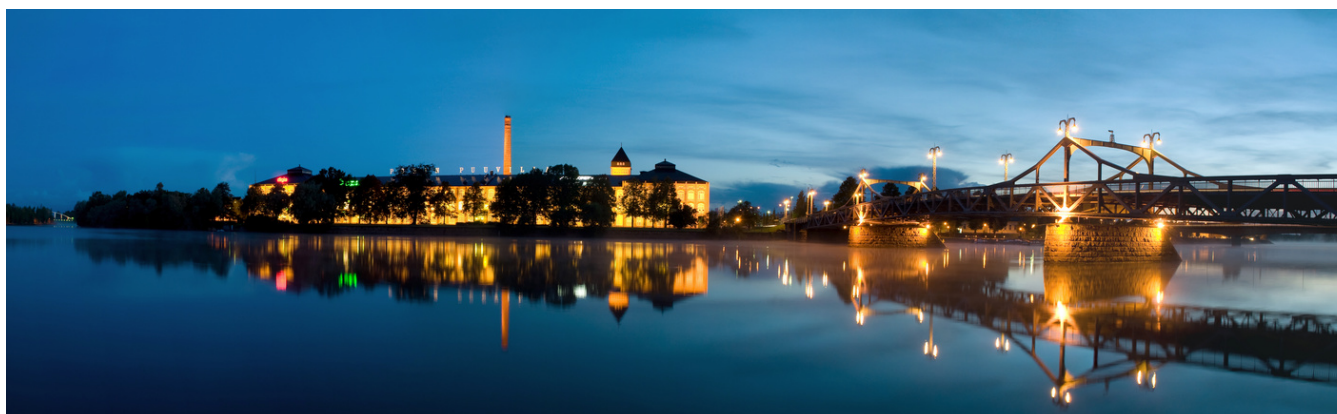


Source: An educational cartoon <https://huussi.net/kuivakaymalat/lainsaadanto/>

Possibilities of implementing the solution

Adequate sewage management in areas where there is no sewage system poses a serious problem for Polish cities. This is due to lack of control over individual systems such as household sewage treatment plants or septic tanks. In the majority of towns, the proper operation of domestic sewage treatment plants is not controlled, nor is systematic discharge of sewage from septic tanks monitored, and the latter, unfortunately, are leaky and a great number of them is not emptied.

The solutions employed in Pori and other Finnish cities should serve as an inspiration for city authorities. They are also a good example for politicians who should propose legal solutions (obligations, education, and support) so as to effectively reduce significant soil and water pollution with sewage from households.



CHAPTER 6

WATER POLICY OF THE POLISH CITIES

The value of water goes beyond the basic human rights. It not only contributes to human health and well-being, but also contributes to social equity, environmental protection and a sustainable economy. It plays an important role in mitigating and adapting cities to climate change and contributes significantly to the implementation of the European Green Deal. Uninterrupted access to clean water is an obvious matter for most city dwellers, but in the European Union, some 2% of the population do not have running water or a toilet in their homes, and 20% of European wastewater is not treated. And yet the adoption by the United Nations of the 2030 Agenda and its 17 Sustainable Development Goals was a historic milestone in 2015 also for water management. In the context of urban functioning, water makes its strong mark, especially through the sixth goal: "Clean water and sanitation for all", goal 11 "Sustainable cities and communities" and goal 14 "Life under water", but also through the goal 15 "Living on land".

Undoubtedly, the approach employed for purposes of assessing the water policy of Polish cities in four main categories: Life, Threats, Economy and Business, as well as Culture and Residents, still requires fine-tuning in order to raise the level of objectivity of the assessment. This is impacted by the following factors:

- diverse databases, the quantitative data of which may have an impact on the quantitative measures of individual categories in detailed analyzes,
- our ambitious pursuit to include as many sub-indicators as possible, which may have an impact on the weighting of the main categories by varying the number of factors determining quantitative measures in these categories,
- the analysis does not take into account local values increasing attractiveness of survey-based assessment conducted among residents, which applies especially to cities with a lower number of residents,
- in large cities, the survey-based assessment and the assessment based on databases are affected by the complexity of these organisms, which inevitably translates into a general – final assessment, which focuses on the city's friendliness in terms of water policy.

However, regardless of the shortcomings of the approach on which we are continuously working, the results obtained in the ranking indicate cities doing well, less well, or worse.

Therefore, publishing these results makes sense primarily for local governments, but also for those professionals dealing with water policy and management, who are, after all, inhabitants of these cities. The report draws attention to problems and perhaps prompts deeper reflection on a local scale.

If we make a rough - quantitative analysis of the first three ranking places, in terms of metropolises, other cities with powiat status and medium-sized cities, certain regularities may be observed. In the main ranking, these regularities are partially confirmed by the above-mentioned factors influencing the quantitative assessment of cities.

In accordance with the analysis of detailed index values, the rating for cities with a decreasing number of inhabitants, i.e. from large to medium-sized cities, is increasing. This is confirmed by the fact that, by their very nature, smaller cities have less significant problems resulting in a negative assessment, and additionally, often cities which enjoy an attractive geographic location related to water and its ecosystem (e.g. Augustów, Żywiec, or Świnoujście), may dominate positive assessments.

Of course, one should bear in mind that the use of a fully quantitative assessment renders difficult objectivity of assessment of a highly diversified group of medium-sized cities. Certainly, the natural conditions and the city's prosperity significantly affect the WCI result. The authors are constantly improving the process of methodology verification in order to eliminate subjectivism of the assessments. The result is highly impacted by the survey, therefore, cities are encouraged to complete it each year.



METROPOLISES

Cities play a special role in the development of water services and water management, but are particularly sensitive to the water cleanliness, shortage, or excess. Climate change and natural disasters render cities very vulnerable. Therefore, water management in a city, and even more so in a metropolis, is a difficult task, one that requires expertise, patience, and significant financial outlays.

The largest cities are particularly vulnerable to errors in water management. Polish metropolises are constantly expanding, often sprawling in an uncontrolled manner, constantly posing new challenges and problems. After the initial miracle of urbanization, they reflect on the comfort of life of the inhabitants. Therefore, implementation of blue and green infrastructure is gaining popularity, as it protects cities against floods and droughts, strengthens resilience, and mitigates negative effects of economic losses. Water must therefore play a key role in urban planning.

The leader of the WCI2021 is Gdańsk, which has a natural unfair advantage resulting from its location both by the sea, on the Motława River and a special river called the Martwa Wisła /Dead Vistula/. Such location requires a special approach to the management of the urban tissue.

A seaside and riverside city, Gdańsk is able to respond to the challenges posed by civilization pressure. The water management authority of the city of Gdańsk (The Gdańsk Waters) was the first in Poland to simulate heavy rain on the city surface. This allowed to identify places that can be used as small municipal retention facilities, and consequently, in 2020 eight such facilities (rain gardens) were established. The city also conducts investments related to the natural treatment of rainwater polluted by runoff from the road surface. Special plantings of vegetation are used for this purpose.

Gdańsk is definitely looking to the future and for this reason the city organized the first Gdańsk Climate Change Forum. The topic is rather serious as the city suffers from climate change in a particular way. The prognosis for the next generations is pessimistic since part of the city will most likely find itself under water. In addition to achieving the highest score in the main WCI2021 ranking, the city took was ranked first in the Life area, having achieved a high score for the infrastructure maintenance index.

The second place in the WCI2020 ranking has been taken by Krakow, with its entirely different location in the south of Poland, at the junction of several geographical regions. Krakow is not afraid of innovation, especially in the context of advanced water and sewage management. Whilst it was not ranked first in any of the four areas, it did very well overall. The "infrastructure maintenance" category indicator in the Life area and measures taken to counteract water shortages in the Threat area received high notes. The activity of the Waterworks of the City of Krakow remains in high regard. As in the case of Wrocław, but also "not a metropolis", such as Katowice and large cities in Poland, the quality of public services provided, openness to innovation and flexibility in the use of modern solutions for self-development should be appreciated.

Among the leaders of the metropolis ranking there is also Bydgoszcz - the winner of the ranking in the Threat area. The city gained an advantage thanks to activities related to its rainwater management. The long-term Bydgoszcz Retention programme serves as a model for many cities. It contributes not only to reducing the risk of urban flooding, but also reduces the effects of drought and makes the city more beautiful. In turn, the winner of the Economy and Business category was Warsaw. It scored high for business attractiveness, which proves that the city is making good use of its capital city status.

The smallest metropolis in the ranking, Szczecin, also deserves attention. Szczecin is a winner in the area of Culture and Residents. It received a very high mark for the blue and green infrastructure, which proves that it makes perfect use of its location and natural values.



Other cities with poviat rights

Polish medium-sized cities are faced with problems that are different from those encountered by metropolises. Some of them are being depopulated due to migration of inhabitants to rural areas or metropolises. Oftentimes, local problems are aggravated by a particular location. This situation is particularly acute in Silesian cities, which are forced to undergo economic transformation. These cities are threatened with a shortage of good quality water. Serious consequences of water conditions transformed by mining activities will pose a great challenge for future generations. Underground water from mines subject to closures is pumped onto the surface in order to maintain safety of the mines, which are still operating. As mines are being closed down, the problem of disturbing the flow of groundwater and washing out pollutants from deeper and deeper layers will worsen. The Silesia region is therefore in a dire situation, which is continuously worsening due to urban pressure.

Therefore, the victory of ranked among medium-sized cities is all the more pleasing. Gliwice did not receive the maximum number of points in any of the four areas, but it is relatively high in all of them. The maintenance of infrastructure in the Life area in combination with the local government's activity in the Threat area was rated particularly high.

The city of Gliwice is consistently implementing small-scale projects which bring about significant and positive consequences. The city uses rainwater to water the city's greenery and encourages its residents to follow suit. The Gliwice Canal, the original purpose of which has been abandoned, is now a trending tourist attraction and an important spot on the city map. The Gliwice Canal, via the Oder River, takes straight to the Baltic Sea.

Gorzów Wielkopolski has taken the second place, chiefly thanks to the very high mark in the assessment of the infrastructure maintenance index in the Life area. Since 2016, the city has been implementing a rainwater management programme through investing in small retention.

The third place was taken by Świnoujście thanks to high scores for rainwater management and a decisive victory in the area of Culture and Residents. Świnoujście is an extraordinary city, located on numerous isles, closely related and dependent on the sea. Taking care of residents and tourists is a very important goal here, and the city wins awards for the best-arranged urban spaces, such as its seaside promenade.

Gdynia was the winner in the Life area, taking 7th place in the overall ranking. The maintenance of the infrastructure was rated particularly highly. Zielona Góra (11th place in the overall ranking) is the leader in the Threat area. This is due to significant expenditures made on activities related to the reduction of threats resulting from both the shortage and excess of water. In the Economy and Business area, Jaworzno scored best thanks to its highly rated business attractiveness.

Interpreting the ranking results is not a simple matter. We do not develop the results of the ranking ourselves. After entering the numerical data, the order of the cities in the ranking appears automatically. Then, the authors of the ranking reflect on the ranking results. In the case of Gliwice, the victory was largely due to the fact that the city has fairly balanced prices of water and sewage (at the level of the national average) and high expenditure on sewage management and water protection (per one inhabitant). Gliwice boasts a relatively low failure rate of the water supply network in terms of its length. In the remaining categories, Gliwice did not score worse from the average, which proves a balanced water policy.

In the case of Jaworzno, industrial water consumption (approx. 3,000 dam/10,000 inhabitants) is quite high, though lower than in many other large-scale industrial cities (e.g. Konin 135,000 dam or Ostrołęka 64,000 dam). Jaworzno boasts a dense water supply and sewage system, despite the large area of the city (over 150 km²). In addition, consumption of water and sewage by the city's inhabitants is relatively low. Despite its typically industrial character, Jaworzno manages its water resources in a very reasonable manner.

This year's report was abound with discussions, partial research analyzes, as well as reflections on what is the most up-to-date in the municipal water policy in Poland. Hence our decision to summarize it with the following observations:

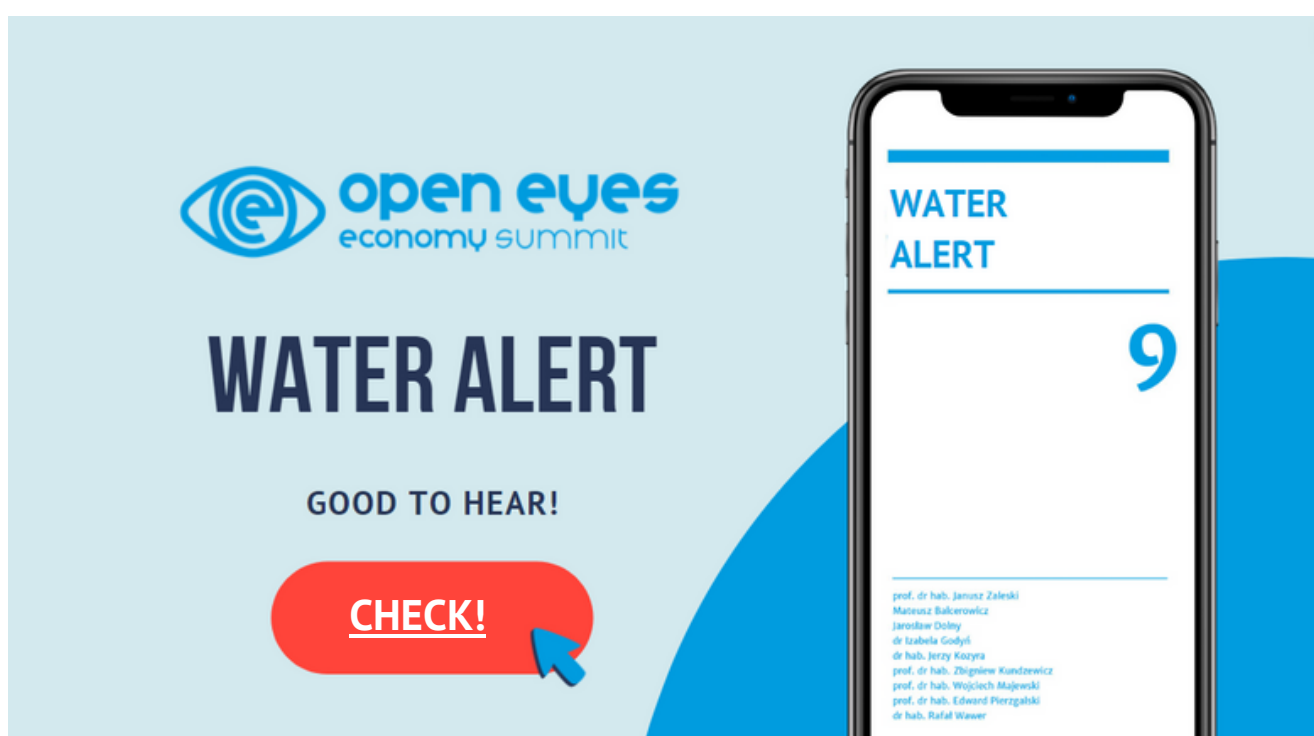
1. "All" that is good in the context of urban water policy begins with increasing the awareness of local authorities about the development needs and complementing the city's water policy. The analyzes conducted by scientists and experts provide an answer to the question: how should water resources be managed in the light of the latest trends in this regard. However, the question arises as how authorities put their knowledge to use. The most common barriers to policy implementation are:
 - a. An overly imperative approach to the implementation of public policies. As a result, e.g. the city does not implement a specific solution because the city mayor does not support it.
 - b. An overly interactive approach to the implementation of solutions which in turn leads to diffusion of responsibility, but also to reaching a "bad compromise."
 - c. Financial barriers. High capital intensity of investments oftentimes leads to abandonment of activities if long-term benefits and the common good are not taken into account.
 - d. Much of the wrong in the context of urban water policy, in our opinion, begins with a bad act on planning and spatial development, which, among other things, leads to bad solutions in the context of the development of flood protection infrastructure (which are usually associated with flood embankments and not with improvement of the urban catchment retention capacity). Worth emphasizing is the fact that it is not only about unsealing the ground, but also about creating a possibility of safe gathering of rainwater in the vicinity of precipitation thereof.
2. Uncoordinated, spontaneous spatial policy of cities prevents or limits possibilities of designating corridors for large linear investments. For the same reasons, possibilities of planning the location of investments deemed as strategic for the city are limited, also from the point of view of water policy. Planning must take into account the space for the so-called blue infrastructure. The Act on spatial planning and development is, in fact, "developer-friendly law". This means liberal statutory provisions favoring waste of space, in particular when it comes to the construction of real estate with the so-called "View from the window" and it is markedly visible in areas with high landscape values – e.g. on the outskirts of legally protected areas, parks, and water courses. This is accompanied by continual decrease of green areas in the largest cities in Poland, through the gradual felling of trees, which is a consequence of constructing housing estates and service buildings based on the Land Development and Management Conditions.
3. There are numerous public entities and organizational units dealing with municipal water policy. On the one hand, it is understandable, on the other, there remains a question about the effectiveness of such approach: there may arise concerns about the smoothness and consistency of actions, the ability to respond promptly to situations requiring it, and the risk of dilution of responsibility.
4. Water policy requires financial outlays. It is necessary to support municipalities in building friendly infrastructure, creating green and blue areas, preventing activities that may be harmful for the protection of the environment and the well-being of inhabitants. In order to achieve this, appropriate mechanisms of financial support are necessary.

A LIST OF THE APPLIED QUANTITATIVE INDICATORS

Area	Assessment category	Indicator
LIFE	Potable water	price of 1 cubic metre of cold water in the city for a private user (in PLN)
		average water consumption (in cubic metres) per an inhabitant
		length of the water supply network per 10 thousand inhabitants
	Dirty water	price of 1 cubic metre of sewage collected in the city for a private recipient (in PLN)
		average amount of sewage discharged into the sewage system (in cubic metres) per 1 inhabitant
		length of the sewage network per 10 thousand inhabitants
	Development of infrastructure	expenditures in chapter 90001 (Sewage management and water protection) per 1 inhabitant
Survey	synthetic result calculated on the basis of survey questions addressed to the city water supply and sewage company (PWIK)	
THREAT	Flood	share of the city area in the flood hazard area
		length of flood embankments in relation to the surface of the flood hazard area in the city
	Drought	sun zone according to the maps of the Institute of Meteorology and Water Management
	Sector-related threats	share of industrial areas in the flood hazard area
		share of residential areas in the flood hazard area
		share of commercial and service areas in the flood hazard area
	Rainwater	percentage of sealed areas within the city area
		rainfall zone per sealed Surface
	Local government activity	expenditure in chapter 90001 (Wastewater management and water protection) per network length
		number of water supply failures per network length
ECONOMY AND BUSINESS	Industrial water	water consumption in industry
		production of wastewater by industry
	Business activity	number of enterprises registered in section H division 50 (water transport)
		number of private enterprises registered in section E divisions 36 and 37 (collection, treatment and supply of water, discharge and treatment of wastewater)
	Transport	number of crossings of watercourses (bridges) in relation to the length of watercourses in the city
	length of railway and road lines in the flood hazard area in relation to the total length of transport lines in the city	
CULTURE AND INHABITANTS	Waterfront	length of the coastline in the city (rivers, lakes, sea)
	Blue and green infrastructure	percentage share of surface waters within the city's area
		share of parks, lawns and estate green areas in the total area
	expenditures in chapter 90004 (Green maintenance in cities and municipalities) in relation to the municipality's own income	
SURVEY	Synthetic result calculated on the basis of questionnaire questions addressed to relevant city offices	

FOOTNOTES

- [1], [2] On the basis of data from the Local Data Bank of the Central Statistical Office for the year 2020.
- [3] The survey was addressed only to cities with powiat status, hence the ranking of medium-sized cities adopted a slightly different system of weights: WCI-Ż: 0.3; WCI-Z: 0.3; WCI-G: 0.2; WCI-KiM: 0.2.
- [4]. P. Adamowicz, Gdańsk as a challenge /Gdańsk jako wyzwanie/, Obraz, słowo, terytoria Publishing House 2008
- [5] Human capital (so-called "hard", countable) related to citizens' competences, age, productivity, professional experience, etc.). Social capital (the so-called "soft", quantifiable, but associated with a sense of emotional bond with a given territory, citizenship, empathy, willingness to dialogue and civic activity).
- [6] Each ranking is relative, where the benchmark is the result of the best city which was awarded 100 points.
- [7] For more information about the described project see the annual reports on its implementation: <https://www.annualreports.com/Company/severn-trent-plc>



The graphic features the 'open eyes economy summit' logo on the left, consisting of a stylized eye icon and the text 'open eyes economy summit'. Below the logo, the words 'WATER ALERT' are written in large, bold, dark blue letters. Underneath, the phrase 'GOOD TO HEAR!' is displayed in a smaller, dark blue font. A prominent red button with the word 'CHECK!' in white, underlined text, and a blue mouse cursor arrow pointing to it is positioned at the bottom center. On the right side, a smartphone mockup displays a 'WATER ALERT' notification with a large blue number '9' and a list of names at the bottom: prof. dr hab. Jacek Zaleski, Mateusz Bakierowicz, Jarosław Dobny, dr Izabela Godyń, dr hab. Jerzy Kozyna, prof. dr hab. Zbigniew Kundzewicz, prof. dr hab. Wojciech Majewski, prof. dr hab. Edward Pierzgański, and dr hab. Rafał Wawer.

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RECOMMENDING THE WCI RANKING ARE ...

Having no access to water, the city is unable to function. The importance of this access is key for a large metropolis as well as small towns and cities, but more importantly for their inhabitants, if we understand the concept of a city in terms of a social, and not just a spatial function. The basic subjects are people who create a community, for which the quality of life and prospects for its improvement are the most important values. Attention should be paid to the fact that the our management of resources and the aquatic environment matters for us, but also for future generations. Therefore, let us check how others do it as part of the Water City INDEX and learn from the best.

Jakub Mielczarek
Director of the Office of the Union of Provinces of the Republic of Poland

From the perspective of the Union of Polish Towns, providing residents with good-quality water, efficient sewage disposal, rational management of rainwater, and flood protection are matters that must be solved almost every day by presidents, mayors, and village heads in virtually every city, town, or urban-rural communes. The Water City INDEX ranking helps to conduct policy of water resources management in cities and integrated water management that is appropriate and relevant for the changing climate.

Grzegorz Cichy
President of the Board of the Union of Polish Towns

Access to clean water is a fundamental right of every human being, repeatedly emphasized by the UN General Assembly, and finally distinguished in the 2030 Agenda for Sustainable Development adopted in 2015 as 6 out of 17 Sustainable Development Goals. The importance of water is emphasized not only by the above-mentioned point, but also in the definitions of many other Goals - both those relating to the natural environment and those related to human activity, including urban development. Water happens to be one of the basic resources without which we cannot function - neither we, humans, nor nature. In the era of intense climate change, the effects of which are more and more noticeable, especially in cities, the need to raise social awareness in the field of sustainable management of water resources is clearly visible. Water City INDEX is a valuable source of knowledge and inspiration for everyone involved in water education. The presented classification allows to look at this issue in a broader context.

Elżbieta Wołoszyńska-Wiśniewska
Education and Geoinformation Director at the UNEP/GRID-Warsaw Centre

Water on our blue planet is common, but when we look at its availability through the prism of urbanization, universality of water is no longer a common thing. Increasingly larger cities and agglomerations need water not only to meet the basic needs of their inhabitants, but also for many other aspects of urban life. Economic zones need more or less of it to produce various goods and services. The social sphere stands for all forms of leisure and recreation by the water, and in addition there are hidden qualities of water that are not directly visible - such as irrigation of green areas that are shared by blue-green veins and lungs of cities. These blue-green areas are refuges for biodiversity, zones that reduce noise and purify the air, and reduce the city's heat island. We do not see many of these advantages of water directly, just as we do not see that they are at the same time a receiver of everything that rainfall is washing out of the cities. All pollution and rubbish on paved surfaces flows to the sewage system, and then to rivers, with which it flows to lakes and the sea. In this way, urban areas affect water quality in places far away from them. For all of these reasons, the Water City INDEX knowledge of urban water management helps to identify strengths and weaknesses in these areas.

Sebastian Szklarek PhD
Founder of the website "Świat Wody"

RECOMMENDING THE WCI RANKING ARE ...

The beginning of many cities is tied with rivers, which helped transport goods, acted as natural boundaries, and fed the inhabitants of settlements. In the course of intensive development, we began to concret the river beds, hiding them under roads and buildings. Today we are dealing with the consequences of these actions – but what are they and what is their scale? We can learn this from the Water City INDEX ranking, which indicates good practices of local governments towards water management and promotes sustainable development.

Sebastian Pyłacz
Editor-in-chief of "Śląska Opinia"

Life and threat - these are two of the four areas making up the framework of this year's edition of the Water City INDEX ranking. This juxtaposition itself is food for thought. Something that allows us to live is also something that can ruin our life, make it unpleasant, take it away. Some problems can be caused by the lack of water, others will be caused by it as temporary and instant excess. In times of climate crisis, the contrast between the benefits and risks of water will become more and more visible. Cities that are best prepared for this, however, may hope that water will prove to be life in the first place.

Szymon Bujalski
Author of the blog "Journalist for Climate" on Facebook and Instagram
Journalist of "Gazeta Wyborcza" and portals "Nauka o Klimacie" and "Ziemia na Rozdrożu"

Water resource management issues are becoming more and more important for the Polish cities. Especially now in the era of a changing climate, when rainfall is sudden, violent and short-lived, often preceded by weeks of drought. On top of this, we have a crisis related to water pollution. Their consequences are long-term, and the effects are felt in the perspective of many years. Therefore, I hope that the conclusions drawn from the analyzes included in the Water City INDEX ranking will help the authorities of our cities to develop common standards for rational and effective management of water resources, which in turn will translate into improvement of the living conditions of local communities.

Rafał Rudka
Editor-in-chief of the daily "Warto Wiedzieć"

The Water City INDEX ranking assesses the effectiveness of water management in the largest cities in Poland. It should be remembered that the basic principle of water management is sustainable development, within which we shape, protect, use, and manage water resources in an efficient manner. Cities are special spatial units in the field of water management. Rational and comprehensive treatment of surface and groundwater resources, taking into account their quantity and quality, is a challenge that the best can meet.

Mateusz Balcerowicz
Deputy Editor-in-Chief of "Gospodarka Wodna"

In Poland, we waste huge amounts of water. While in autumn and winter this is hardly noticeable, in summer, drought becomes the no 1 problem. On the other hand, cities are struggling with more and more frequent flooding caused by torrential rains and not always efficient infrastructure, which is not able to deal with the task of draining huge amounts of water over a relatively short time. In times of drought and flooding, we tend to forget that water is also an important element of the city's functioning. It is also thanks to its good management that culture, entertainment, sport, and leisure may develop. The challenge can therefore be a real opportunity for the city. Which cities use water better and which still have a lot of homework to do? Find out from the Water City INDEX – a city ranking. It is worth reading and using it, because, at present, every initiative and valuable publication (and this ranking meets these criteria) aimed at increasing the efficiency of water resource management must be given a thought.

Szymon Pewiński
Managing Editor of the monthly "Wodociągi-Kanalizacja"

SCIENCE PATRONAGE WCI 2021



MEDIA PATRONAGE WCI 2021

