European Funds
Infrastructure and Environment

Republic of Poland

MINISTRY OF THE ENVIRONMENT

European Union
Cohesion Fund

Let's feel the climate!

www.44mpa.pl

CLIMATE CHANGE ADAPTATION PLANS IN 44 POLISH CITIES

Development of Urban Adaptation Plans for cities with more than 100,000 inhabitants in Poland

IOŚ-PIB

IETU

ARCADIS Design & Consultancy for natural and built assets

Communication and Promotion. Subcontractor: Deloitte.

Project website nad social networks:

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Climate change adaptation plans in 44 Polish cities

Summary report

WARSAW, 2018

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From the Minister of the Environment

MINISTRY OF THE ENVIRONMENT

Dear Sir or Madam,

Climate change is a fact which is becoming more and more perceptible. Long periods of drought, heatwaves or cold spells, cloudbursts, strong winds are extreme weather events which are occurring more and more often each year in Poland. Their environmental, social and economic effects influence the quality of life of all Polish people, and city residents in particular.

In 2013, the Polish government adopted a Polish National Strategy for Adaptation to Climate Change 2020 with the perspective by 2030 adaptation plan for sectors and areas vulnerable to climate changes until 2020, with an outlook to 2013, developed by the Ministry of the Environment. The document specified the development of urban spatial policies which take into account climate changes as the key measures. As a result, the Ministry of the Environment decided that adaptation plans needed to be developed for the 44 largest urban centres where as much as 30% of the entire population of Poland lived. The scale of and systematic approach to adaptation to climate changes in Poland have no precedents in the European Union.

Our aim is to shape modern urban policies in response to identified climate risks. By participating in the project and using consistent methodologies developed by Polish experts, 44 cities prepared documents which set out the directions of the measures undertaken to mitigate the unfavourable consequences of climatic threats and form a basis for effectively obtaining resources for urban investment projects.

I am pleased that the cities have managed to create a platform for cooperation between many stakeholders with a view to adapting to climate changes. The construction of such a platform is a way not only to equip the cities with the ability to handle climatic hazards, but also to build urban civic communities which will be able to set urban development goals taking into account various challenges, including environmental, cultural, etc.

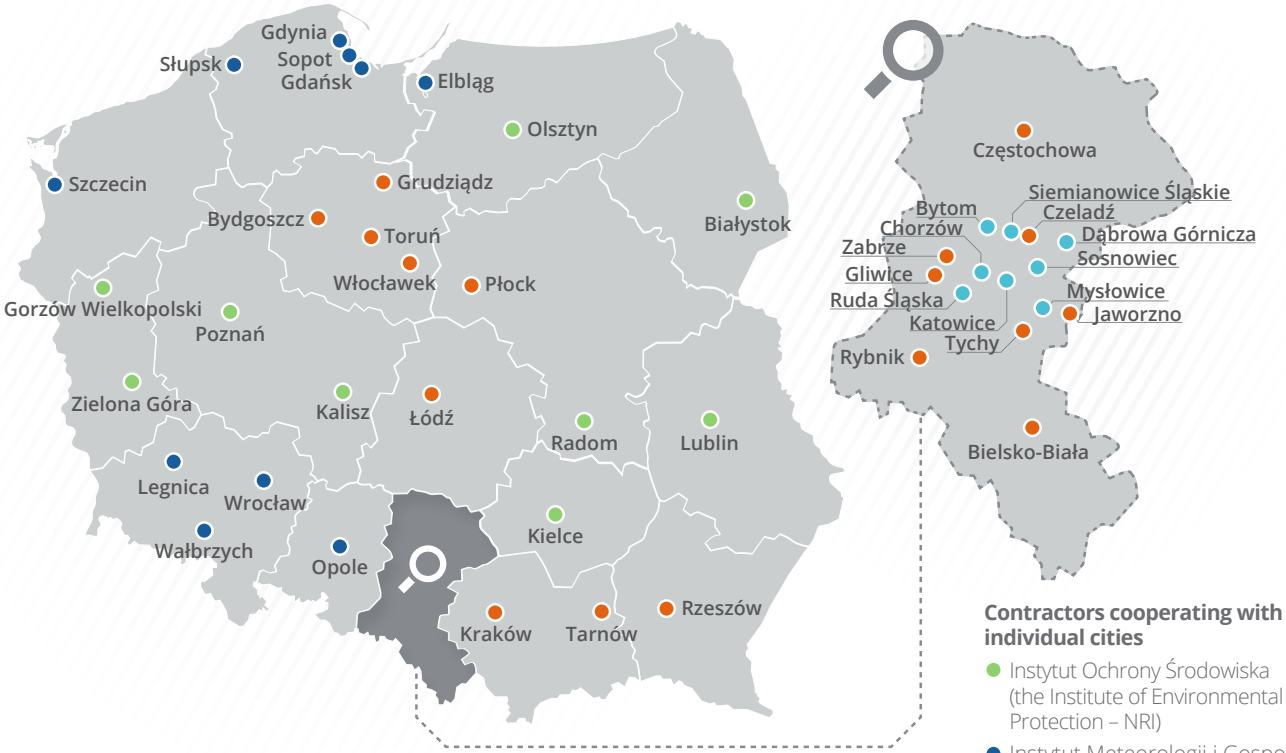
I would like to thank the local authorities and experts who participated in developing and consulting 44 urban adaptation plans. I am confident that these plans will bring the expected outcomes. I strongly encourage other Polish cities to take advantage of the lessons learned from this project and to develop their own adaptation strategies.

Henryk Kowalczyk

Henryk Kowalczyk
Minister of the Environment

Project partners and contractors

The partners of the project Let's Feel the Climate are **44 cities** which joined the project based on agreements concluded with the Ministry of the Environment. Of these cities, **37 have more than 100,000 inhabitants.** They were joined by cities with lower populations – **three cities with between 90,000 and 100,000 residents and four with less than 90,000.**



Contractors cooperating with individual cities

- Instytut Ochrony Środowiska (the Institute of Environmental Protection – NRI)
- Instytut Meteorologii i Gospodarki Wodnej (Institute of Meteorology and Water Management)
- Instytut Ekologii Terenów Uprzemysłowionych (the Institute for Ecology of Industrial Areas)
- Arcadis Sp. z o.o.

Deloitte. A subcontractor for the promotional and organizational activities relating to the project. An international consulting firm providing services in the area of audit, tax and legal, business and sustainable growth advisory.

▸ www.deloitte.com/pl

Environmental Protection Institute – National Research Institute

IOŚ-PIB Instytut Ochrony Środowiska Państwowy Instytut Badawczy is a research institute supervised by the Minister of the Environment, carrying out research and R&D work contributing to the development of the national economy in the field of environmental protection, sustainable development, counteracting climate change and adaptation to the effects of climate change, and promoting rational utilization of the environment and environmental resources. The Institute also carries out comprehensive environmental research and assessments, including monitoring of the environment.

▸ www.ios.edu.pl

Institute of Meteorology and Water Management – National Research Institute

has the necessary experience and resources to identify and predict natural meteorological hazards, taking into account climate change scenarios, and to manage the risks associated with these hazards by increasing the resilience of social and ecological systems to extreme weather events.

▸ www.imgw.pl

Institute for the Ecology of Industrial Areas

IETU conducts research in the area of environmental management, from estimating emissions to monitoring and assessing environmental and health hazards to ecology-oriented policies at various levels of management. The research and services offered by IETU focus on the environmental challenges of industrial and urbanized areas in the context of the circular economy, efficient resource management and adapting to and mitigating the effects of climate change.

▸ www.ietu.pl

Arcadis Sp. z o.o.

ARCADIS is an international consulting and engineering firm with expertise in, among other things, water management, the environment, planning and adapting to climate change. It has broad experience in the Polish market and strong support from its global structures. Moreover, ARCADIS has a strong record of participation in pilot projects for the EU relating to adapting to climate changes in major urban agglomerations.

▸ www.arcadis.com

Partner cities

The residents of 44 cities participating in the project account for 30% of the country's total population and one half of the total population of Polish cities. Large urban centres have a number of common features which were relevant in assessing their sensitivity to climate changes. Urban areas are characterized by large numbers of inhabitants, a significant concentration of urban functions and the resulting density of built-up areas and infrastructure. In addition to having common features, which enables developing a uniform approach to preparing urban adaptation plans, each city has its own specific conditions and characteristics resulting from its location, topography, spatial planning, types of housing and historical context, and the evolution of social and economic processes.

The majority of Polish cities are situated along river banks. As a result, water management issues (particularly floods and flooding) are addressed in all the plans. The vulnerability to flooding differs in the various cities, depending on their specific location in river zones. The larger part of Poland is located in the basins of two large rivers: the Vistula and the Odra river. The Vistula's basin is 173 289 sq. km, i.e. 55% of the whole country. In this area, 27 cities covered by urban adaptation plans are situated. The Odra river basin occupies almost 34% of the surface area, i.e. 105 639 sq. km with 17 cities covered by urban adaptation plans.

Two years of Let's Feel the Climate have passed. In less than 20 months, expert teams together with representatives of the cities have performed a great deal of work which concluded with urban adaptation plans for 44 Polish cities. In each city, we identified the climatic hazards by analysing a multitude of meteorological and hydrological data. We assessed the cities' vulnerability to these hazards and drew conclusions from large sets of spatial, social and economic data. We developed climate change scenarios to identify the changes for which the cities must prepare. We learned about the development policies of each of the cities, their natural, social and economic conditions and their aspirations. We looked for the best adaptation measures, taking into account many criteria which enabled the selection of the best measures for each of the cities – effective, sustainable and those bringing the most benefits to the residents.

We were confronted by complex interdependencies between the climate and a city. Due to the experts' competencies, and experience and the detailed methodology developed, we were able to systematically and consistently strive to understand, describe and explain these interdependencies. This was extremely important, since in addition to developing urban adaptation plans, our aim was to share our knowledge on climate changes and their effects. In parallel to working on the plans, we prepared a vast body of educational materials for both adults and children (films, brochures, training sessions, newsletters, quizzes, competitions). We also organized conferences and a debate.

A structured approach in the Let's Feel the Climate project enabled us not only to organize the process of developing 44 urban adaptation plans, but also to reach the project goals, regardless of the multiple tasks, tight schedule and the large number of stakeholders involved. It was a great venture and an organizational challenge. We carried it out together – experts, representatives of the local communities, officials, managers of urban utilities and properties, activists, scientists and business people. Because of such broad participation, the project Let's Feel the Climate has a unique value.

Today, nobody questions climate changes. They are a fact and we notice them every day, and scientific research confirms that climate changes have accelerated with the development of industry. Scientists have warned us that the changes we can identify today will bring other changes in natural and social systems, which we are still unable to predict today. We may be uncertain what urban life in Poland will be like in 50 years, but I am convinced that the implementation of urban adaptation plans will improve the functioning of cities. This means investments of approximately PLN 30 billion by 2030.

The awareness that adaptation to climate changes is akin to the protection of our health, and often life, is the foundation of all actions. It also means limiting the costs of mitigating the effects of damage to properties and infrastructure.

The project Let's Feel the Climate has been an important experience for all of us. We feel jointly responsible for improving the resilience of cities to climate change. Whether the project turns out to be a success will depend on the determination of our Partners – the cities. I would like to thank our Partners for their excellent cooperation and hope that the urban adaptation plans will be implemented and contribute to improving the

Barbara Rajkowska
Project Manager

About the project

PROJECT GOALS
Increasing the resilience of cities to hazards relating to climate change

SCOPE
44 cities in Poland

TIMEFRAME
from 12 January 2017 to 12 January 2019

What made the project unique?

- For the first time systematic actions to improve resilience to climatic hazards in 44 large cities has been taken in Europe on such a scale.
- For the first time in Poland, urban hazards relating to climate change have been identified using a uniform methodology.
- In 44 cities, the sectors and areas most vulnerable to climate changes have been identified.
- Many different adaptation measures have been identified to effectively reduce the unfavourable impact of climate changes.
- Plans for adapting to climate changes have been prepared for 44 cities.

How was the project carried out?

- A systematic concept of simultaneously developing 44 adaptation plans has been adopted.
- A broad partnership consisting of the Ministry of the Environment, local authorities and other stakeholders has been established.
- A uniform methodology for developing urban adaptation plans addressing the specific characteristics of each city has been developed.

The Sensitivity of a city is a degree of its susceptibility to the effect of climatic phenomena. The city responds to these phenomena depending on the characteristics of its population, infrastructure, ecosystems and spatial structure. In addition, a city has the capacity to adapt to climate changes. In the face of a hazard, the city may use its resources: people and their knowledge, funds, infrastructure. These resources are referred to as **the adaptive capacity.** Estimating the levels of sensitivity and adaptive capacity enables evaluating vulnerability, i.e. the extent to which a city is incapable of dealing with the negative effects of climate changes.

Vulnerability tells us if the city, with its residents and functional and spatial structure, using all of its resources, is able to respond to hazards in a sufficiently efficient way.

Resilience to climate changes is what cities are aiming for. It is a characteristic of the city decisive to its ability to effectively and efficiently respond to extreme weather phenomena when they occur. A resilient city is able to rebuild and flexibly adapt to changing conditions.

PROJECT STAGES AND DELIVERABLES

1 STAGE — INITIATION OF THE PROCESS

- establishing co-operation between experts and city representatives;
- identifying stakeholders;
- agreeing the vision and overall goal of an Urban Adaptation Plan.

2 STAGE — ASSESSMENT OF VULNERABILITY

- identifying the impact of climate phenomena on a city;
- identifying the most sensitive sectors and social groups;
- evaluating a city's adaptive capacity;
- identifying the city components most vulnerable to climate changes.

3 STAGE — RISK ANALYSIS

- identifying future climate hazards;
- identifying the risks for the most vulnerable components;
- identifying opportunities for a city relating to climate changes;
- setting priorities for adaptation measures.

4 STAGE — DEVELOPING ADAPTATION OPTIONS

- determining detailed goals to improve a city's resilience to climate changes;
- proposing three packages of optional adaptation measures.

5 STAGE — ASSESSING AND SELECTING OPTIONS

- selecting the package of those adaptation measures which are the most efficient, sustainable and socially acceptable.

6 STAGE — PREPARING THE DOCUMENT

- developing a draft Adaptation Plan;
- developing an environmental impact assessment of the Adaptation Plan project;
- conducting social consultation.

IMPLEMENTATION OF THE PLANS

ENGAGEMENT

44 partner cities

4 contractors

450 experts

>700 representatives of municipal offices and collaborating units

ACTIVITIES

44 cities with the identified major hazards relating to climate changes

44 cities having the identified sectors and areas most vulnerable to climate changes

44 cities with selected adaptation measures and their effectiveness evaluated

132 workshops conducted as a form of consultation with social and economic organizations, associations and residents

Almost **7000** hours of workshops, meetings, consultations

DELIVERABLES

44 Urban Adaptation Plans

44 strategic environmental impact assessments

EFFECTS

44 cities have developed documents to shape their future policies for the adaptation to climate changes to be implemented by 2030

documents necessary to apply for external funds for adaptation measures

MPA IMPACT

increasing the safety of city residents, improving protection against the harmful effects of climate changes

improving the quality of life in the cities

increasing the competitiveness of the cities

an example to follow by other cities

Photo źródło: pixabay.com

Climate changes as a hazard to Polish cities

Poland's geographical location and topography play an important part in shaping the weather, including extreme weather phenomena which are particularly dangerous to cities. The horizontal arrangement of the main regions favours free zonal circulation. As a result, collisions of maritime and continental air masses can frequently be observed in Poland. The southern part of the country has a diversified topographical relief which shapes the local weather conditions, while the northern part of Poland is a coastal zone where the impact of the Baltic sea can also be seen. As a result there are significant differences in the weather in Poland.

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2013), in the 21st century, each year after 2001 has been among the warmest years since 1880 globally. High annual averages of air temperature exceeding 9°C were also noted in Poland (2016 – 9.2°C; 2014 – 9.7°C; 2015 – 9.6°C).

The spatial annual average air temperature for Poland (excluding mountain areas) is 8.1°C (1951–2016). Based on an analysis of the air temperature trend since 1951, it can be concluded that a slight cooling occurred only in the 1960s and 1970s, while an upward trend has been maintained since the end of the 1970s.

Among the most frequent hazards occurring in the Polish cities are heatwaves, frost, intensive precipitation and storms, urban floods, floods, coastal flooding, landslides, droughts, windstorms, and a rise in the sea level. Each of the 44 cities selected the most important climate hazards which could significantly hamper their development. In the face of these hazards, the cities decided to plan a number of adaptation measures intended to mitigate the unfavourable effects.

Heatwaves, i.e. periods of at least three days with the maximum temperature exceeding 30°C, are the most common in western and central Poland, and the least frequent in the coastal region. They already started occurring in the 1990s. None were noted in the previous 20 years. The longest heatwave lasting 17 days was noted in 1994.

Precipitation is characterized by significant spatial and temporal differentiation. In 1951–2016, the average spatial precipitation for Poland was 633 mm. The lowest values are noted in central Poland, on the Central Poland Plain and Polesie (548 mm). The structure of precipitation in summer has changed, with a marked increase in the number of days with intensive daily precipitation of >30 mm and >50 mm, in the southern part of Poland in particular. The frequency of the occurrence of daily precipitation of ≥30 mm in Poland, excluding the coastal region and north-eastern parts of the country, has increased by more than three days per decade, and by two days per decade in the case of daily precipitation of ≥50 mm in southern Poland (mainly in the Beskidy region), central Poland and in certain places in the north of the country.

Contemporary temperature and precipitation conditions in Poland result in changes in the water balance. As actual and potential evaporation increases, water resources are shrinking, due to shorter periods with and the thinning of snow cover. Moreover, the soil moisture level is falling at the beginning of the growing season. This represents a hazard, since Poland's water resources are now rather sparse. The increase in the annual average air temperature contributes to the higher intensity and frequency of weather phenomena which are largely unfavourable to people and the environment. Sometimes, such phenomena become extreme. It is to be expected that further climate warming in the future will result in more extreme weather events, i.e. sudden phenomena with high intensity, such as heatwaves, cold spells, intense precipitation, floods and windstorms which are not only resulting in financial losses but sometimes also fatalities. Long-term phenomena, such as a draught, the shrinking of water resources, soil erosion and coastal erosion will also become stronger. The sea level will rise.

In Poland, we can expect more severe floods in the basins of both lowland and highland rivers, and long periods of strong drought caused by water deficits. Among the temperature-related events which are unfavourable and burdensome to both the environment and society, the severe heatwaves affecting Poland, in particular since the 1990s, should be mentioned.

Catastrophic winds taking the form of cyclonic hurricanes with wind speeds temporarily exceeding 30–35 m/s, have been observed in Poland more than 15 times since 2005. Among the areas most vulnerable to such winds are the central and eastern part of Wybrzeże Słowińskie, from Koszalin to Rozewie and Hel, and a wide latitudinal belt of northern Poland stretching to the Suwałki region, Beskid Śląski, Beskid Żywiecki, Pogórze Śląskie and Podhale to Pogórze Dynowskie, as well as the central part of Poland with the Masovia region and the eastern part of the Wielkopolska region.

Winds in the form of tornadoes occur in the Małopolska Upland and Lublin Upland, stretching in a wide belt in a SW–NE direction through the Kutno Plain and Masovia to the Podlasie region and the Masurian Lake District. In the years 1979–2017, as many as 173 tornadoes were noted in this area.

The effects of climate change are particularly visible in cities where the type and density of built-up area increase

climatic hazards or create new city-specific risks. Urban Heat Island (UHI) effects are observed in all the cities. They consist of increased air temperature in the city compared with the surrounding suburban areas. The UHI effect is caused by many factors, but some of the most important are the properties of materials covering the surface which absorb more sunlight than they reflect, as well as a small proportion of biologically active surfaces. In large cities, the intensity of the UHI effect may negatively affect the thermal comfort of residents.

The type of built-up area also determines air circulation. Maintaining the right proportions between built-up and green areas contributes to thermal contrasts which give rise to local air circulation. This helps to mitigate the effects of heat and lower the concentration of pollutants. However, there are disturbances in the air circulation in cities and, as a result, air pollutants tend to remain in place. In certain weather conditions, smog tends to arise.

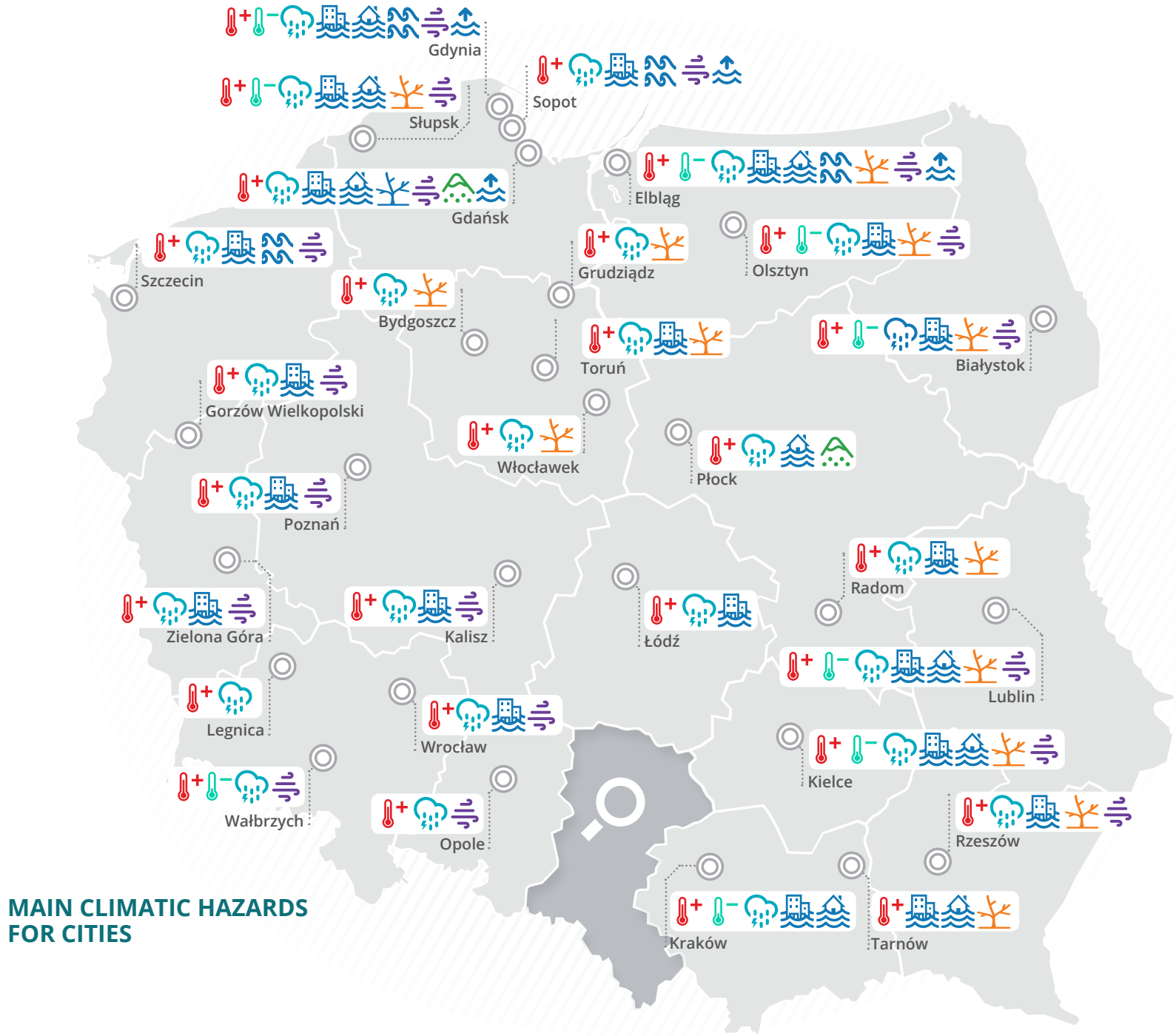
In each of the 44 cities, the most sensitive sectors were selected, taking into account the scale of unfavourable consequences which may be caused by extreme weather events. It is also worth noting that frequent and intensive extreme weather phenomena and long-term climate changes may also result in cross-sectoral effects.

IMPACT OF METEOROLOGICAL AND HYDROLOGICAL HAZARDS ON URBAN SECTORS/AREAS

	Heatwaves	Frost	Intensive precipitation and storms	Urban flooding	Floods	Coastal flooding	Drought	Windstorm	Landslide	Rise in sea level
Water and waste water management	+	−	⛈	🏙	≈	≈	🌳			↑
Public health	+	−	⛈	🏙	≈	≈		💨		
Transport	+	−	⛈	🏙	≈	≈		💨		
Energy	+	−					🌳			
Spatial management	+			🏙	≈	≈				
High-density areas	+	−	⛈	🏙	≈	≈		💨		
Biodiversity	+		⛈				🌳	💨	⛰	↑
Tourism	+	−		🏙	≈	≈		💨	⛰	
Heritage	+	−		🏙	≈				⛰	

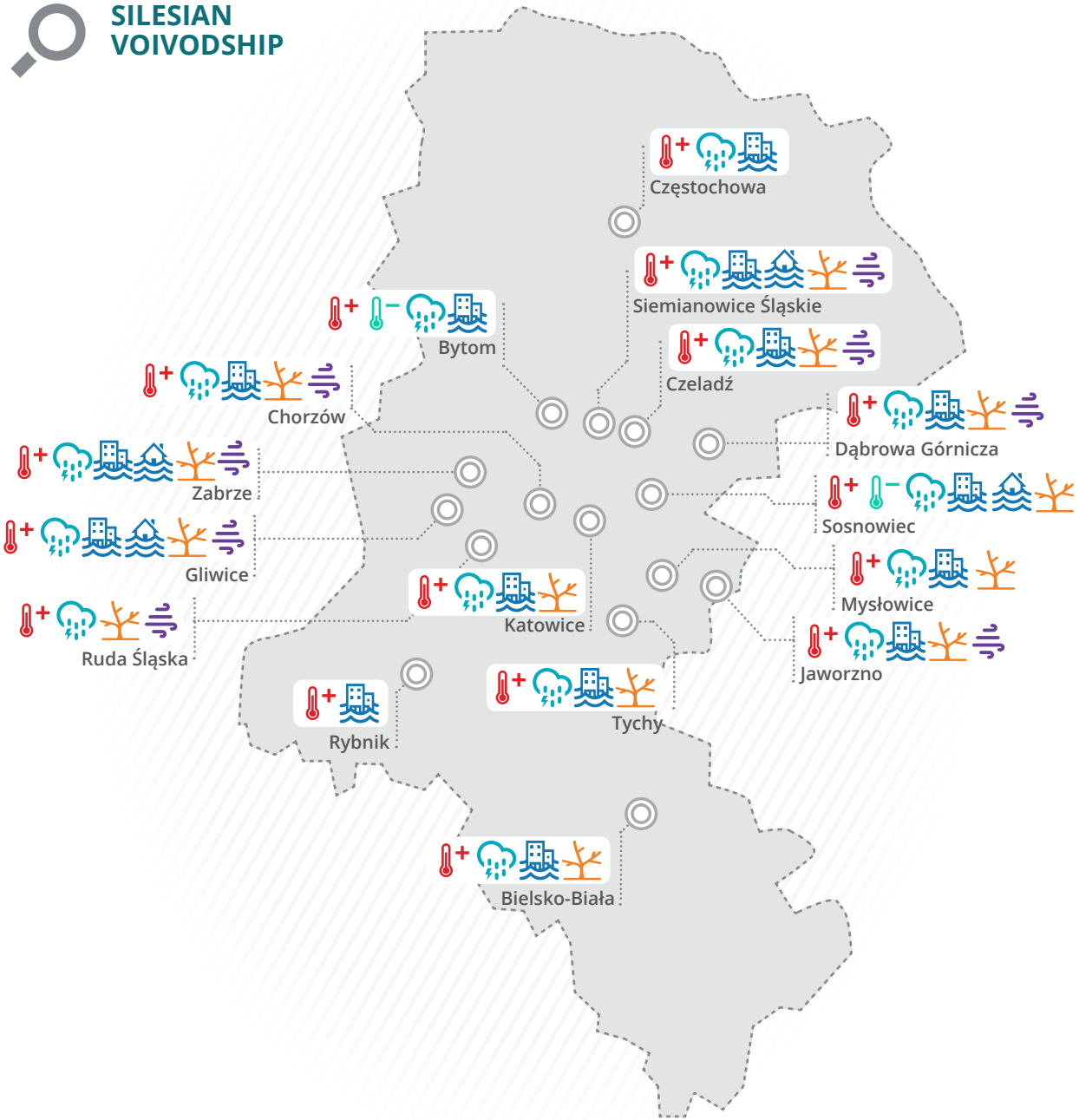
MAP KEY

- Heatwaves
- Frost
- Intensive precipitation and storms
- Urban flooding
- Floods
- Coastal flooding
- Drought
- Windstorm
- Landslide
- Sea level rise



MAIN CLIMATIC HAZARDS FOR CITIES

SILESIAN VOIVODSHIP

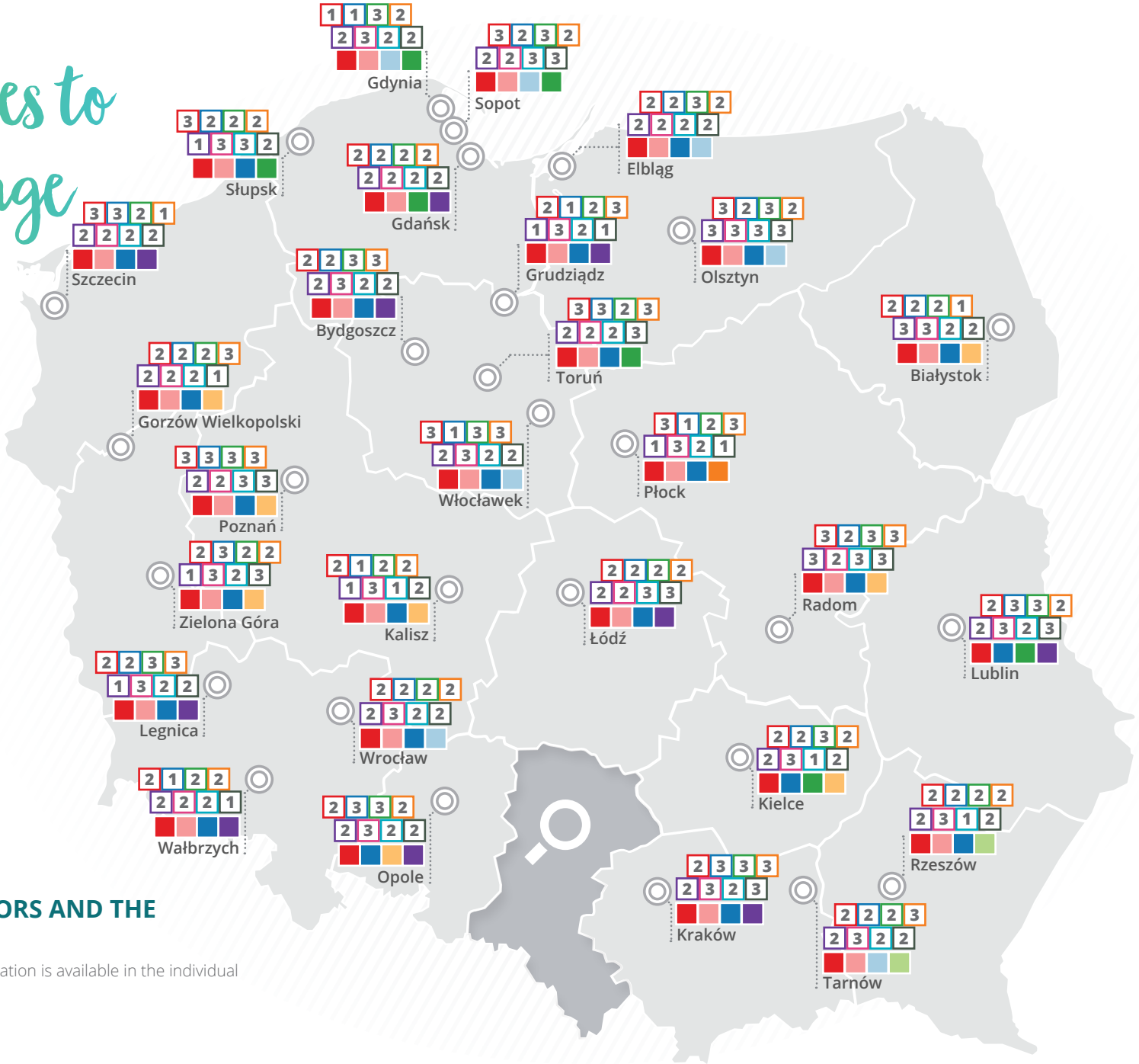


Vulnerabilities to climate change

Urban vulnerability to climate change depends on a city's sensitivity and adaptive capacity. The sensitivity of a city as a whole depends on the characteristics of its population and land use, functional and spatial structure and geographical location. Certain sectors or sector components may be more sensitive than others, e.g. the elderly population is more sensitive than the population of people of working age, and a residential area with a lot of sealed surfaces will be more sensitive than one with a large share of biologically active surfaces.

An assessment of vulnerability consisted firstly of a detailed analysis of the sectors and their components from the perspective of sensitivity to individual climatic factors. As the next step, a multi- dimensional evaluation of the city's adaptive capacity was performed. The adaptive capacity directly affects the scale of unfavourable effects of climatic factors in a city.

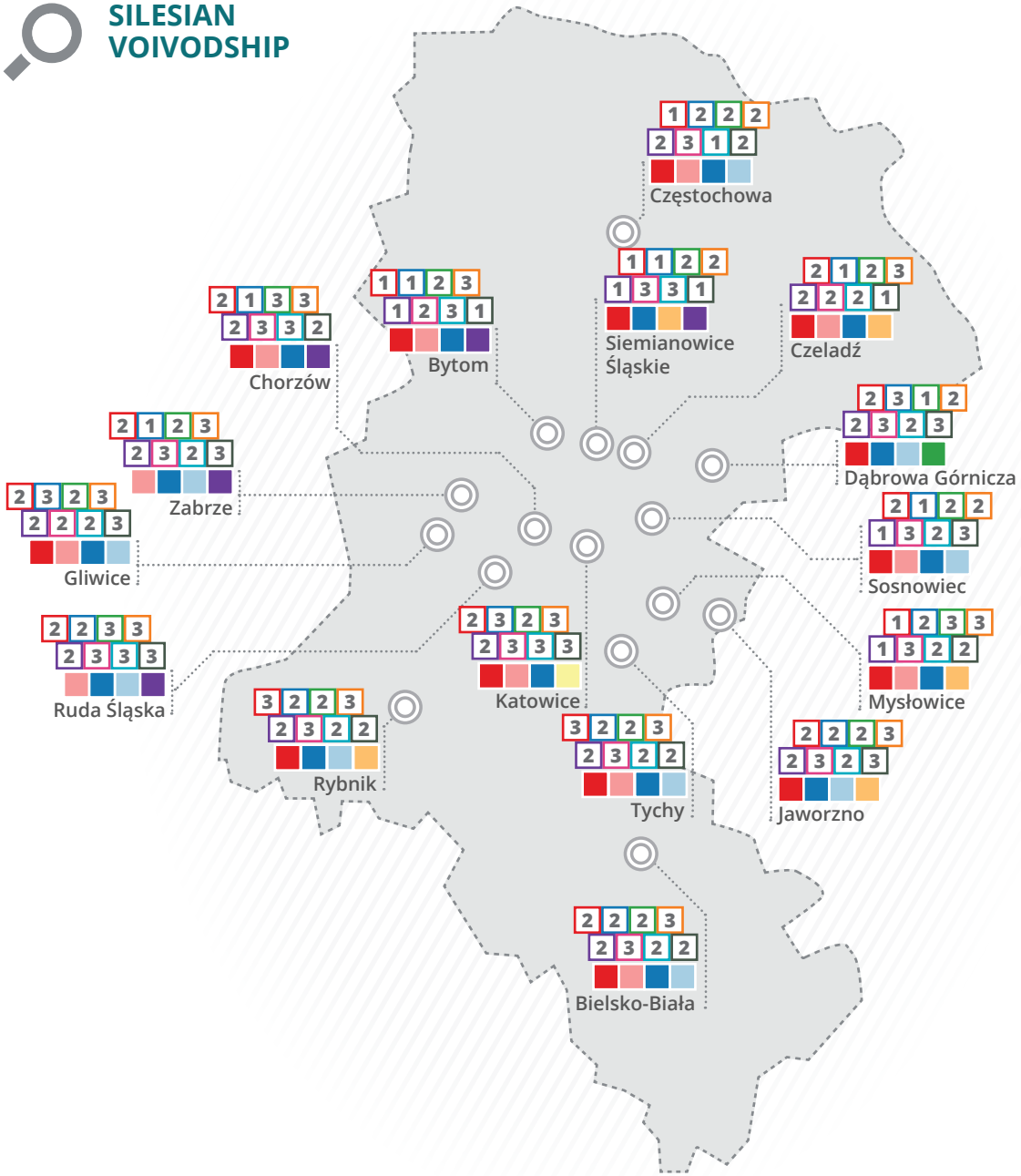
The adaptive capacity may be too low to mitigate the unfavourable effect of climatic hazards on a sector or sector component, or it may be sufficient to protect the city against the hazard.



THE MOST VULNERABLE URBAN SECTORS AND THE ADAPTIVE CAPACITY OF CITIES*

* – some cities identified more than 4 sectors; detailed information is available in the individual Urban Adaptation Plans

SILESIAN VOIVODSHIP



MAP KEY

Vulnerable city sectors

- Public health
- Transport
- Water management
- Energy
- Biodiversity
- Tourism
- Heritage
- Spatial management
- High-density residential areas
- Other infrastructure
- Undeveloped areas

Adaptive capacity

- Financial means
- Social capital
- Preparedness of the municipal services
- Environmental hazard information and alert systems
- The network and equipment of municipal institutions in the healthcare and education sectors (hospitals, schools, pre-schools)
- Organization of crisis management cooperation with the neighbouring communes (access to rescue equipment and teams)
- Systematic protection and shaping of urban ecosystems (green and blue infrastructure)
- The existing innovation infrastructure: research and scientific institutes, universities, eco-innovation firms

Level of adaptive capacity

1 Low
2 Medium
3 High

ADAPTATIVE CAPACITY OF THE CITIES

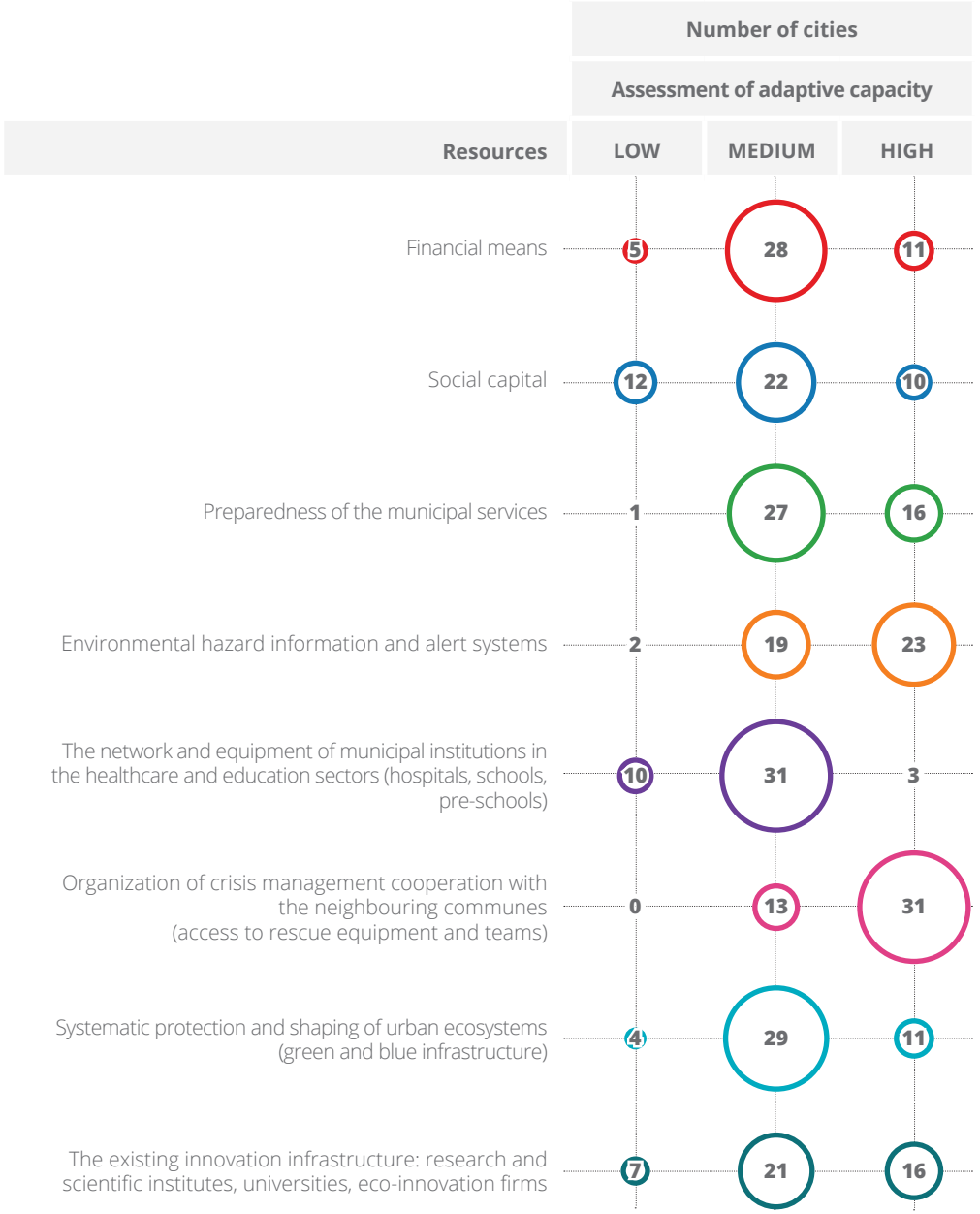
Urban adaptation to climate changes is a process consisting of structured measures which shape a city's ability to mitigate the negative effects and properly use the positive effects of climate change.

Adaptive capacity depends on the level of social and economic development. Developed, democratic and rich societies are better at dealing with climatic hazards. Therefore, the adaptive capacity of a city depends on the adaptive capacity of the respective country and region. Financial means, human resources, institutional resources, infrastructure and knowledge have a direct impact on the level of the adaptive capacity. These resources may be used by the city in response to a hazard resulting from extreme weather events (e.g. during a flood), but also to plan longer-term measures, e.g. to develop a flood risk management plan.

An assessment of the adaptive capacity in 44 cities consisted of obtaining answers to the following question from the city representatives: **are the city's resources sufficient for addressing climatic hazards?**

The majority of the cities assessed their adaptive capacity in all categories as medium. The ability to finance adaptation measures, taking into account the availability of own funds and to attract funds from external sources was assessed as medium in 28 cities and high in 11 cities. The assessment identified a low level of social capital in 12 cities and a low quality of the network and equipment of municipal institutions in the healthcare and education sectors (hospitals, schools, pre-schools) in 10 cities. It should be noted that the adaptive capacity of the network of institutions in the healthcare and education sector was assessed as high in only three cities. On the other hand, it is worth mentioning that the organization of crisis management cooperation with the neighbouring communes (access to rescue equipment and teams) was assessed as very highly in 31 cities. In 23 cities, environmental hazard information and alert systems were assessed as a factor of high adaptive capacity.

Climate changes forecasted based on climatic scenarios until 2015 will result in an increased number of hot days, a higher intensity of heatwaves, and an increased number of days with high precipitation. These two hazards – heatwaves and heavy precipitation – will affect individual sectors, but may also bring cross-sectoral effects.



Nearly all the cities concluded that public health was the urban sector most vulnerable to hazards relating to climate change and required the most immediate intervention. Only two cities decided that the public health sector did not require intensive adaptive measures to be undertaken in the first planning period. The vast majority of the cities pointed to transport and water management as the sectors of high vulnerability to hazards and requiring adaptive measures to be implemented very urgently. Other sectors/areas the cities often considered to require urgent action included power generation, spatial planning, and high-density residential areas. Only a few cities mentioned tourism, biodiversity, cultural heritage and undeveloped areas as those sectors/areas which should be taken into account when preparing the first round of Urban Adaptation Plans.

Photo S. Nagórka

As a result of future climate changes, the following may be expected in the cities:

- an increased risks to human health and life, a higher incidence of diseases and higher mortality, an increased risk of climate-dependent and vector-borne diseases
- an increased number and range of run-offs, more frequent urban flooding
- a decrease in safety in public spaces
- an increased risk of damage to the technical infrastructure, sewerage system, power transmission lines, roads, railroads, decreased durability and shorter life cycle of infrastructure
- more obstruction in the transport system, including disturbances in the operation of public transport
- an increased risk for ecosystems of the rivers to which rainfall and waste water is discharged, and for the functioning of waste water treatment plants
- major difficulties in the functioning of the water supply system
- major difficulties in the functioning of power plants which need water for their technological processes
- an increased hazard for green areas in a city and for urban animals
- an increased risk of damage to urban forest stands, and forest fires
- loss of species and habitats, especially water, water-dependent and coastal habitats

Adaptation measures may, to a certain degree, limit the effects of the projected hazards and reduce a city's vulnerability to climate change.

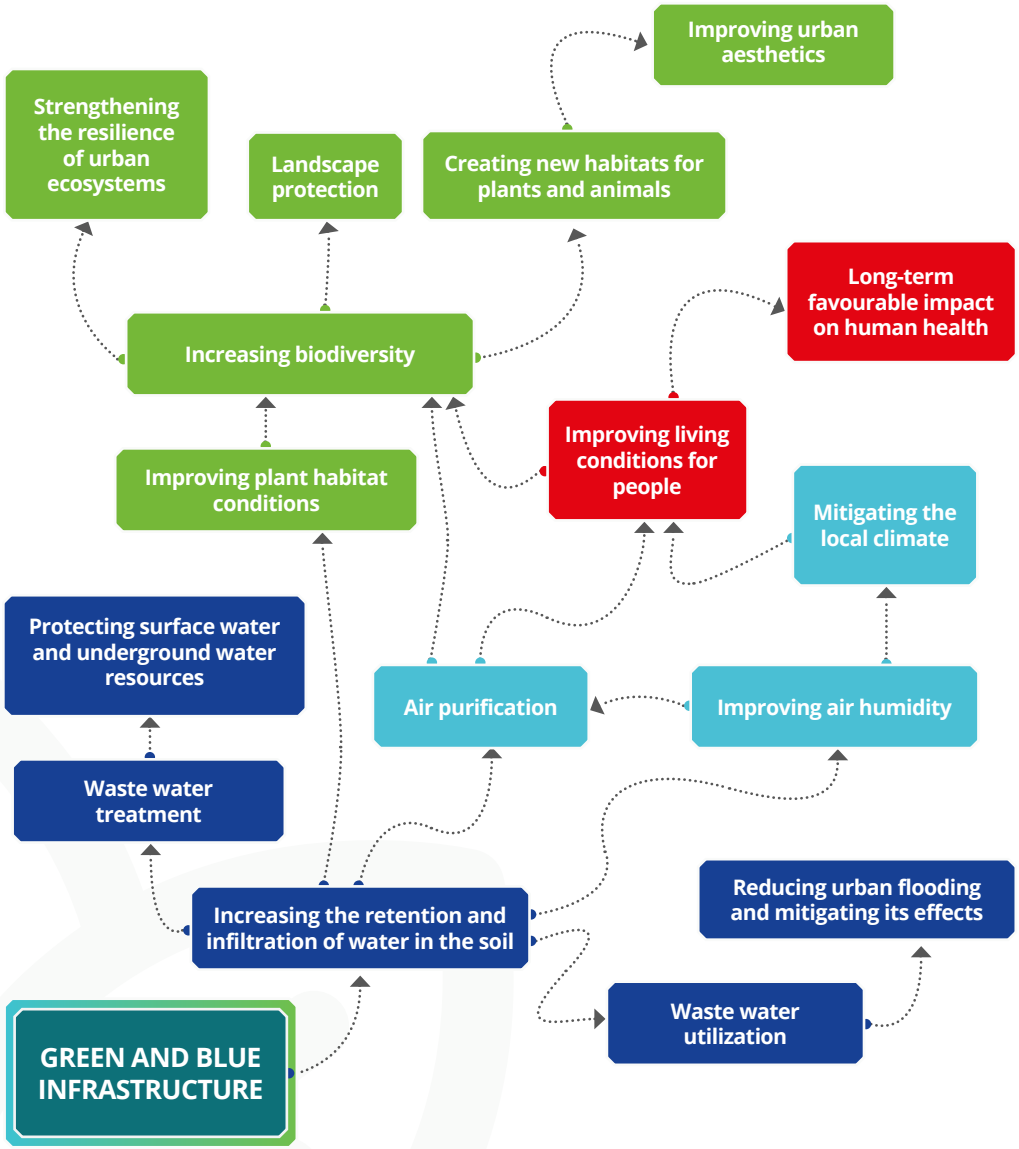
Adaptation measures

Urban Adaptation Plans are strategic documents which reflect municipal policies aimed at mitigating the effects of major hazards resulting from climate change.

The objectives set out in Urban Adaptation Plans are a response to the most frequent hazards occurring in the cities: hazards relating to urban air temperature, hydrology, concentration of pollutants in the air, and strong winds. The objectives set out in UAPs reflect the direction of future adaptation measures for each of the cities. Adaptation measures are addressed to specific city components and specific locations; they reflect the genuine problems and needs of a city in the context of climatic hazards. They may be classified as information and educational, organizational and technical measures. An individual measure (or a group of harmonized measures) often serves to meet several different objectives. In every city, adaptation measures strengthen the city's resilience to climate change by enhancing its capacity to deal with the effects of climate change and by shaping social awareness and civic attitudes.

The 'win–win' principle is one of the key principles of urban adaptation. It should be understood as the basis for selecting those adaptation measures which, while meeting one specific objective, at the same time contribute to meeting other important social, environmental and economic goals. The construction of green and blue infrastructure or the thermal modernization of buildings are good examples of such measures. Both measures are aimed at minimising the effects of a hazard – of heavy rainfall, storms and urban flooding in the first instance, and the hazard of heatwaves in the second. However, the implementation of these measures has many other favourable consequences, in addition to mitigating the effects of a specific climatic hazard. The green and blue infrastructure is beneficial for human health, the quality of air and biodiversity. The thermal modernization of buildings brings financial savings and mitigates the human imprint on climate change. The win–win solutions must be contrasted with measures which are undertaken in order to reduce the vulnerability to climate change in one sector or area, but increase the vulnerability of other sectors or social groups. Cooling tramway tracks with water or the construction of rainwater drainage are good examples of such maladaptation, since such measures have an unfavourable effect on the resources and quality of water. Instead of such solutions, sustainable options should be pursued instead, as far as possible, e.g. building green tramways or rain gardens (stormwater gardens).

THE GREEN AND BLUE ARCHITECTURE, OR ONE MEASURE SERVING MULTIPLE GOALS



TYPES OF ADAPTATION MEASURES

Informational and educational measures

aimed at building cooperation, educating and providing information on hazards, planned and implemented adaptation measures and on the existing monitoring and alert systems, as well as promoting good practices.

Organizational measures

enforcing changes in spatial planning, organization of public space, changes to the local law, developing guidelines on what to do when a hazard materializes.

Technical measures

hard/investment measures enabling a city's quick adaptation to climate change.

Adaptation measure	Type of measure		
	Educational -promotional	Organizational	Technical
Developing systems for the monitoring of and gathering data on hazards associated with climate changes and their effects	+	+	+
Developing systems for the monitoring of and providing information on hazards associated with climate changes	+	+	+
Reviewing and updating plans, programmes and strategies to include the need for adaptation to climate change	–	+	–
Building a cooperation network for the implementation of an Urban Adaptation Plan (in the city: organizations, businesses, outside: functional areas, associations of communes, partner cities)	–	+	–
Securing critical buildings and infrastructure located in hazard zones	–	+	+
Removing/changing the function of the infrastructure located in hazard zones	+	+	+
Developing recommendations for the existing facilities located in areas susceptible to river or coastal flooding concerning the possible ways of protecting the facilities against losses resulting from flooding	+	+	+
Adapting the urban traffic management system to the needs of adaptation to climate change	+	+	+
Building a municipal water supply and utilization system	+	+	+
Protection and extension of the areas which generate fresh/cool air, ventilation corridors in urban areas	+	+	+
Developing spatial/urban planning guidelines on shaping space taking into account the needs of adaptation to climate changes	+	+	–
Building a system of solutions to ensure the thermal comfort of the residents	+	+	+
Building and developing a green and blue infrastructure system	+	+	+
Developing guidelines for addressing adaptation needs in procurement processes (including procurement of construction services)	+	+	–
Adapting the public transport system to the effects of climate change	+	+	–
Increasing the ratio of biologically active surfaces by reducing or reverting soil sealing	+	+	+
Strengthening rescue services to increase the effectiveness of their operations when responding to extreme weather events	+	+	–
Conducting educational and promotional activities relating to climate change, its effects and adaptation measures	+	+	+
Modernizing or extending the flood protection system, including restoration of dune sections and levees destroyed by storm surges, heightening and extending levees	+	–	+
Constructing seashore protection structures in areas vulnerable to waves	+	–	+

Selected urban adaptation measures

Photo S. Nagórka

Bydgoszcz

„Rain is profit" – modernization of rainwater sewers

The construction of 14 km and modernization of 90 km of rainwater sewers and 81 rainwater management facilities (reservoirs, rainwater pre-treatment plants, watering installations) will make it possible to utilize approx. 37,000 m³ of captured water.

For several years, actions have been taken in Bydgoszcz to prepare the city for climate change. The city authorities are planning to reduce rainwater disposal through sewers and reorganize the urban space so that it functions like a sponge, capturing rainwater for use in periods of drought.

One of the projects conducted is a capital expenditure project called "Rain is profit – Construction and modification of rainwater sewers and adaptation of the rainwater sewerage network in Bydgoszcz to climate change", for which the company Miejskie Wodociągi i Kanalizacja [Municipal Water Supply and Sewerage System] received European funds from the Operational Programme Infrastructure and Environment. The project began in 2017 and will be completed in 2021. Total expenditure will exceed PLN 216 million, of which almost PLN 130 million will be financed from the European funds.

The whole process has been divided into two stages. The first stage comprises the construction of approx. 14 km of new rainwater sewers, 6 reservoirs, 22 rainwater treatment plants, 11 outlets to bodies of water and the modification of rainwater sewers. Additionally, facilities for rainwater treatment for the purposes of watering green areas will be built. During the second stage, the existing rainwater sewer network, which is approx. 90 km long, will be cleaned and renovated.

As a result of carrying out this major project, approx. 37,000 m³ of rainwater will be captured and used for watering green areas, or discharged into ponds (after pre-treatment). The solutions applied will help reduce the occurrence of flooding of buildings and streets and the use of municipal water for watering green areas.

Gdańsk

Drainage system

Gdańsk is located on moraines, coastal lowlands and depressions (Żuławy Gdańsk) and, due to the differences in elevation exceeding 180 metres, it requires special protection against the risks of coastal floods, snowmelt water flow and torrential rainfall.

The flood protection system in Gdańsk is based on a network of more than 50 reservoirs with a combined capacity of approx. 700,000 m³, built on streams in cascades, in a manner unknown in the other Polish cities. The city plans to build more such reservoirs. The drainage system also comprises more than 20,000 wells and 18,000 street inlets, 317 km of streams and ditches, 751 km of rainwater sewers, 15 km of levees and 3 rainwater gardens.

In the years 2001–2015, the city built drainage and anti-flood infrastructure with a value of PLN 380 million, and the water capture capacity increased more than 5 times. If one were to compare the outcome of two of the most extreme rainfalls in Gdańsk, the amount of losses caused by heavy rain decreased from PLN 130 million in 2001 to PLN 10 million in 2016.

At the same time, the flood warning systems were extended, improving the safety of residents.

Photo Gdańskie Wody Sp. z o.o.

The Gdańsk Hydrological Monitoring System is one of the best developed systems of this kind in Poland. It has been undergoing modernization since 2000, and it now consists of 25 rainwater stations and 75 stations for measuring water levels in reservoirs, natural and encased streams. There are two stations for measuring the water level in the Gdańsk Bay and the Martwa Wisła river. In addition, the system contains two weather stations.

Investors carrying out construction projects in Gdańsk must comply with the rainwater management rules. The actions aimed at preventing the effects of climate change are described in the document entitled "Landscape planning conditions and directions for the city of Gdańsk".

Educating and supporting the residents, so that they are able to build small water retention facilities themselves, are a major component of the comprehensive rainwater management strategy for Gdańsk. The first part of the "The Gdańsk water retention guidelines" – "Rain garden in 5 steps" is available at www.gdanskiewody.pl.

Katowice

Black to Green

Culture and new technologies in post-industrial areas fit into the social space of Katowice, creating the city's new image. The development of post-industrial areas could also contribute to increasing the city's resilience to the effects of climate change, provided that such adaptation is part of the whole process of area transformation, from cleaning and reclamation to the implementation of new functions.

The facilities of the Katowice Culture Zone (Katowicka Strefa Kultury), which occupy the area of the former Katowice coal mine in the heart of the city, are the most recognizable. The green roof of the International Congress Centre (Międzynarodowe Centrum Kongresowe, MCK), located behind the Spodek arena, is open to the public. Not only do the green terraces of the MCK look beautiful, they also function as a biologically active area. The solutions applied provide drainage of grass-covered areas and, additionally, allow water capture. The "green valley" leads to one of the most modern concert halls in Poland – the Polish National Radio Symphony Orchestra building. The building is integrated with its surroundings: gardens, fountains, an amphitheatre and a green maze. In the recreational space an illuminated fountain gushes out of a square surface, inviting people to play with water.

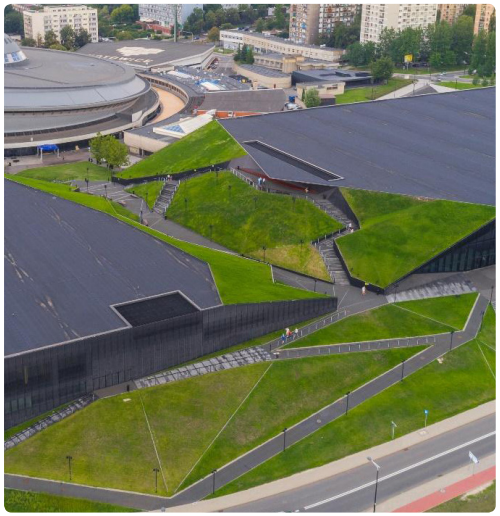


Photo UM Katowice

Plants covering the underground Silesian Museum building are another element of the project. On the Museum roof there is a geometrical garden composed of various grasses and shrubs in shades of rust, matching the historic brick buildings. The species were specially selected to survive low temperatures, wind blows and periods of water scarcity, and they include showy stonecrop and interesting grasses, such as blue fescue and tufted hairgrass. Lavender and sea holly, which are drought-tolerant plants, have been planted next to the Warsaw shaft. The Culture Zone borders with the Bogucki Park, whose revitalization has just begun. The plants will be rearranged. Activity zones for both adults and children and an underground rainwater container will be built.

Other facilities built on post-industrial sites include the GPP Business Park (Górnośląski Park Przemysłowy) and the Euro-Centrum Science and Technology Park (Park Naukowo-Technologiczny Euro-Centrum). The investors combined the development of post-industrial areas with elements of climate protection and adaptation to climate change. After the reclamation of such areas, biologically active areas were created and sustainable, highly energy-efficient office buildings were built. Such buildings use energy-saving technologies providing highly efficient combined sources of heat, cooling and electricity.

Kraków

The Collectively application

Collectively is a new application for communication between residents and the Kraków Urban Greenery Department. The base of this mobile application is a map which the residents of Kraków can use to give suggestions, praise, and report problems or defects. They can also report issues that require intervention, suggestions for the arrangement of urban green areas or ideas for events that could be organized there. The aim of the application is to enable cooperation both between the residents and the Urban Greenery Department and among the residents.

Collective action means that residents may react to certain defects themselves, e.g. pick up rubbish or remove branches, or report a particular event to the competent authorities. Such actions allow us to take better care of our surroundings, in accordance with the motto "My city is my concern".

The application is currently available for Android devices and through a web browser at www.kolektywnie.org. Users can also log in using their Facebook accounts. The application will be available for iOS in November. The interface is relatively simple and allows easy access for residents of different ages.

The Collectively application provides a number of benefits and improvements, e.g. an issue can be reported from any place almost immediately (the mobile version), the information posted is visible for all users, and progress can be monitored on an ongoing basis. The application allows the residents to cooperate and gives them an opportunity to intervene.

The Urban Greenery Department is already planning further development of the platform, which will allow automatic communication with other institutions (the Municipal Cleaning Service, the Municipal Infrastructure and Transportation Department, etc.), as well as automatic qualification of reports.

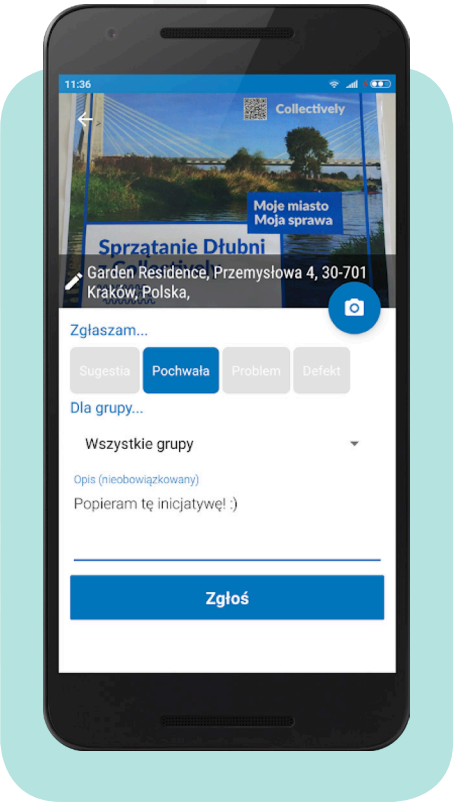


Photo UM Legnica

Legnica

The municipal Medium and High Plants Renovation Programme

For several years, new green areas have been set up in Legnica each year by a joint effort of the local government and residents. The idea is simple: the municipal government buys planting material and offers it free of charge to interested persons/entities, who must collect the plants, plant them in accordance with an approved plan and the art of gardening, and take care of them afterwards.

The Medium and High Plants Renovation Programme has been carried out for several years with the participation of real estate managers, housing cooperatives, road administration, educational institutions, healthcare institutions, individual gardeners, business people and other local organizations. New green areas are established on wasteland. Trees and shrubs, which were removed from construction sites or due to a loss of viability, are replaced.

All entities which are interested in participating in this project apply for an allotment of planting material. The applicants receive trees and shrubs free of charge, provided that they declare responsibility for planting them correctly and taking care of them afterwards (in particular, watering them in dry periods, shaping them, fertilizing them, etc.). The participants must collect the plants themselves and plant them in accordance with the presented plan and the principles of gardening.

In 2017, almost 400 trees and 6,000 shrubs were planted as part of the programme. The green initiative of the municipal authorities is becoming the common cause of the people of Legnica. To date, the experience of cooperation in the area of urban greenery renovation between the local authorities of Legnica and the administrators of housing estates, roads, educational and healthcare institutions, individual gardeners, businesses and other entities and, in particular, the local communities, has been extremely positive and encouraging. It can be an inspiration to other municipalities.

Lublin

Revitalization of the Bystrzyca river valley

The city is located on the Bystrzyca river and its tributaries – the Czerniejówka and Czechówka. The river valleys are known as the green salon of Lublin. Due to the specific geological structure of the area, there also are a number of dry valleys and ravines in Lublin which have a significant impact on the local climate. The rivers flowing through Lublin are partially regulated, and a part of the Czechówka flows in a covered canal. In spite of this, the city appreciates its rivers and their valleys and wants to make the best possible use of their natural potential.

In 2017, the "Revitalization and development programme for the Bystrzyca river valley in Lublin" was prepared. The document was created in stages, with the participation of the residents of Lublin. They proposed their solutions for connecting the city with the river and the river with the city. Numerous meetings were held and the residents could also send their proposals. Public consultations were held several times. A great number of comments and proposals were received, and most of them were reflected in the programme. The task team also organized conferences and worked with the local media.

As a result of these activities, a document containing 25 projects was prepared. Their purpose was to fully utilize the potential of the Bystrzyca river valley and to improve flood security. The programme contains plans for rebuilding polders and reservoirs, revitalizing the existing parks, building new ones and connecting them with green passages. One of the purposes of this green system will be to mitigate the impact of climate change on the city, in particular relating to intensive precipitation, floods and high temperatures. Moreover, the cycle path network in the Bystrzyca river valley will be extended, street furniture will be installed and a municipal beach will be arranged. All these actions will bring the river closer to the residents and encourage them to visit the valley during heat waves, when it provides shade and air. The ideas contained in the programme were included in Lublin's climate change adaptation plan.

The work on the programme and its results are described on the Lublin City Council's website at https://lublin.eu/mieszkancy/srodowi-sko/rewitalizacja-doliny-bystrzycy/.

Photo UM Lublin

Łódź

Deszczówka.info portal and guidance on nature-friendly rainwater solutions

"Valuable rainwater – a short guide on how to capture it in your garden", an instruction manual prepared for the residents by Łódzka Spółka Infrastrukturalna (Łódź Infrastructure Company), will tell you how to prepare a rainwater barrel, an absorbing well, a rain garden or a pond.

In an effort to meet the residents' expectations, the Łódzka Spółka Infrastrukturalna established the portal Deszczówka.info, which promotes the issues of sustainable meteoric water management in urban areas. The portal was developed in consultation with and with the participation of the European Regional Centre for Ecohydrology of the Polish Academy of Sciences.

Knowing the methods of capturing rainwater is important both for those who have already set up their gardens and those who are in the process of building a house and planning the green surroundings. The portal encourages the use of rainwater capture installations. Such water can be used to water plants or to feed a pond or stream. In order to increase water retention, it is recommended to preserve the natural landforms, such as dips or hollows, and use a paved, water-tight surface on a limited area only. The portal presents various rainwater management solutions. The details will be discussed in a guide containing recommendations on which solutions to avoid or what to invest in to have a beautiful and environmentally-friendly garden. Using environmentally-friendly rainwater solutions will also help to reduce the cost of watering.

The guide stresses the importance of using native plant species for sunny or shady spots, water reservoirs or rain gardens.

Wrocław

Systemic action – implementation of the principles for sustainable meteoric water management

The first systemic action aimed at changing the approach to the issue of meteoric water in Wrocław is the implementation by the Mayor of the "Principles for sustainable meteoric water management".

The decree of the Mayor of Wrocław no. 6541/17 of 17 March 2017 imposed an obligation on all municipal entities to manage meteoric water in the place of its origination at every stage of an investment process – from spatial planning through design and project execution to finished project maintenance. The proposed and recommended solutions include: limitation of the use of water-tight surfaces and decreasing the degree of water-tightness of drained surfaces, building surface and underground reservoirs, absorbing tanks, grassy ditches, infiltration ditches, basins and absorbing wells, retention and infiltration boxes, dry tanks with or without constant flow. Another solutions concerns pre-treatment of meteoric water from polluted areas, e.g. with the use of constructed wetlands. It is particularly important to use vegetation for the purposes of retention and evapotranspiration (evaporation), e.g. by setting up rain gardens, green roofs and walls.

The change in the methods of rainwater and meltwater management will create opportunities for using such water resources to improve the condition of the natural environment in urban areas. Using the recommended solutions aimed at increasing meteoric water retention and utilization will make it possible to reduce expenditure on the construction and maintenance of rainwater and combined sewerage systems and, above all, reduce the occurrence of local floods.

In December 2017, at the city's request, a team of experts from the Wrocław University of Environmental and Life Sciences prepared "Good Practices – principles for the sustainable management of meteoric water from road surfaces". The solutions described in the document can be useful not only for planners, designers and city officers. The city and the authors hope for its wide public reception, so that the residents of Wrocław understand that the projects carried out in their city will contribute to an improvement in the quality of life.

The Good Practices (in Polish only) are available at https://www.wroclaw.pl/srodowisko/files/dokumenty/8811/Kata-log%20Dobrych%20Praktyk%20-%20drogi.pdf.

Urban adaptation plans from the point of view of cities

Statements of the employees of town halls of partner towns and cities, who managed the urban teams and played an active part in the development of urban climate change adaptation plans, testify to the awareness of the problem and the openness of local governments to taking steps to improve the quality of life of residents of the towns and cities.

What special attention should be paid to when implementing the Adaptation Plan

"Special attention should be paid to the involvement of the largest possible group of stakeholders from various social environments when implementing the Adaptation Plan. It is very important to correctly diagnose the phenomena that can pose the greatest threat to the city in connection with climate change, so as to be properly prepared for them and to be able to plan appropriate actions."

Małgorzata Skiba
Manager, City Development and External Funds Department
Czeladź Town Hall

"The key issue is the promotion of information and education activities raising environmental awareness among residents. We often have to deal with the situation where a significant proportion of the community declares that it behaves environmentally, without actually displaying this; raising ecological awareness will avoid such conduct and enable the community to become more active and understand its important role in undertaking all activities in the town, including those related to adaptation to climate change."

Andrzej Szczerba
Manager of the Environmental Protection, Agriculture and Forestry Department
Częstochowa City Hall

"I believe the implementation of the Adaptation Plan in individual activities should be correlated with investments, plans and concepts in all areas of the functioning of the city. The implementation of the actions of a given city should simultaneously be considered in terms of the activities of the neighbouring municipalities and towns (as supra-regional activities), e.g. in cases of:
• floods from a river flowing through the area of multiple towns and municipalities;
• transport."

Roksana Burzak
Deputy Manager of the Economic and Municipal Services Department
Gliwice Town Hall

What steps should be taken by local governments to efficiently and effectively implement the adaptation measures included in the climate change adaptation plans

"All Polish towns and cities are in the same climate zone and have very similar development conditions. Hence the ability to implement good solutions in a similar manner in every town. This means that system solutions or key educational activities can be handled by ministries or government institutions uniformly throughout the country. From this point of view, the voice of all local governments and the development of recommendations for the implementation of the best solutions in Polish conditions by local governments are important. Such a task is primarily performed by the Association of Polish Cities, which has frequently taken stances on issues related to both legislative proposals and the dissemination of knowledge on best practices."

Piotr Niesłuchowski
Department of Development and Economic Policy of the City
Płock City Hall

"Organizational and personnel solutions (units and people responsible for implementing the Adaptation Plan) should be implemented and financial resources should be provided for efficient and effective implementation. Individual, annual reporting on the implementation of the Adaptation Plan should be introduced as a separate, specific task of the Municipality."

Mirosław Hagemejer MSc. Arch.
Director of the Planning Department
Lublin City Hall

"Inter-municipal and inter-county cooperation need to be strengthened, as many activities extend beyond administrative boundaries. Bilateral cooperation with government units is very important (Wody Polskie, Voivodship Environmental Protection Inspector, Sanepid – Sanitary and Epidemiological Station)."

Marek Kaczanowski
Environmental Protection Department,
Tarnów City Hall

"The efficient and effective implementation of measures included in the adaptation plans will mainly be based on securing appropriate funding in the city and making every effort to obtain external funds. In particular, with regard to the performance of highly efficient technical activities bringing rapid results contributing to the adaptation to the changing climatic conditions."

Michał Baryła
Director of Environmental Protection and Agriculture Department
Łódź City Hall

Which problems can arise during the implementation of the adaptation plan

„The greatest challenges may be insufficient knowledge and understanding of the need to protect the climate and adapt to the effects of climate change on the part of decision-makers and residents, difficulty in specifying indicators measuring the city's susceptibility to climatic phenomena and the effects of the adaptation measures, laboriousness and the lack of resources for preparing adaptation projects, as well as the lack of funds to finance a wide range of adaptation activities, giving a noticeable effect."

Andrzej Łazęcki
Deputy Director of the Kraków City Hal
Municipal Services Department

"Cities may require support in obtaining funding (including EU funding) for activities related to adaptation to climate change. Financing projects related to the adaptation of cities to the climate will require the use of various sources of funding. Furthermore, it should be borne in mind that financing activities exclusively with public funds may be insufficient. Potential changes in the applicable provisions of the law, which are reflected in the adaptation of cities to climate change may also be a problematic issue."

Jolanta Błaszczak
Ecology Department
Zabrze Town Hall

"The problem may be urban, architectural and legal barriers, an undeveloped information system about climatic threats, a lack of adaptive studies to date and limited sources of financing."

Katarzyna Guzewska
Director of the Municipal Services and Environmental Protection Department
City Hall in Słupsk

"The implementation of climate change adaptation plans will mainly depend on the availability of funds for financing the planned activities. If the sources of financing indicated by the Ministries of the Environment are suitably efficient, the performance of activities in accordance with the plan and schedule will depend on the city caretakers. Without significant additional resources, city budgets will be unable to bear the additional tasks, even the most justified ones. Therefore, the fundamental problem is the guarantee of the provision of co-financing from the Ministry of the Environment."

Zdzisław Zdanowski
Director of the Environmental Department
Olsztyn City Hall

Advice and suggestions for local governments which are starting or planning to start preparing climate change adaptation plans

"Local governments that are starting to prepare or planning to start preparing climate change adaptation plans should take steps to share experiences with other local governments that already have a great deal of experience in this area. The involvement of people with experience in various areas in the preparation of the document – both in the Urban Team, as well as stakeholders invited to collaborate is also important."

Justyna Kowalczyk
Director of the Strategy and Development Department
Elbląg City Hall

"A detailed diagnosis of the local effects of climate change appearing within the area of a given local government in consultation with its residents. Secondly, the establishment of a team, which, alongside specialists, will also have representatives of the residents and local social organizations. I primarily mean building acceptance of the local community from the beginning for later activities, while educating them on diagnosed threats."

Grażyna Krugły
Environmental Protection and Agriculture Department
Radom City Hall

"The employees first need to be trained at the initial stage of project implementation on strategic planning and programming, as well as preparation of Strategic Environmental Assessment, before proceeding to prepare the Urban Adaptation Plan. Furthermore, the membership of the urban team should be thoroughly analysed in the context of the city's needs, its functional and organizational structure and human resource capabilities (as extensive a selection of professionals as possible)."

Ewa Kurjata
Integrated Territorial Investment Coordinator,
Strategy Office of the Szczecin City Hall

Social awareness of adaptation to climate changes

The adaptive capacity of the local communities is the key element contributing to improved resilience of the cities to climate change. Cooperation between local authorities and residents who are aware of the effects of climatic hazards may stimulate adaptation activities. Commonly implemented measures forming part of the adaptation effort may give residents a sense of belonging to the local community.

Surveys conducted by various institutions show that the awareness of the effects of climate change and the need to undertake adaptation measures is growing in Poland. According to the Eurobarometer's survey of 2015, 86% of Polish respondents perceived climate change as a serious problem, and as much as 56% considered it a very serious problem.[1]

A survey by CBOS conducted in 2018 shows that the sense of having influence on local affairs is also growing. Nearly two thirds of the respondents stated that the voice of the residents of a commune/city is taken into account by the local authorities when making decisions affecting the residents.[3]

As part of the "Let's Feel the Climate" project, two surveys were conducted, with question on, among other things, the perception of the effects of

INTEREST IN ADAPTATION

93% **of the respondents are interested in adaptation to climate change**

- **16%** Very interested
- **37%** Interested
- **40%** Moderately interested
- **4%** Hard to say
- **3%** Not interested

WEATHER EVENTS AFFECTING THE LIVING COMFORT IN A CITY

81% **of the respondents consider heatwaves as the most severely felt effect of climate change**

- **56%** Precipitation and storms
- **49%** Drought
- **35%** Strong winds
- **22%** Flood
- **15%** Severe frost

UNFAVOURABLE EFFECTS OF CLIMATE CHANGE EXPERIENCED BY THE RESPONDENTS

86% **of the respondents believe that they have noted a significant impact of climate change on urban life**

- **74%** Dried-out lawns
- **50%** Overflowing sewer drains
- **63%** Street flooding
- **42%** Urban heat island
- **59%** Poor thermic conditions
- **42%** Destruction of property

The majority of the respondents associate the effects of climate change with financial consequences

- **61%** Destruction of property
- **54%** Investments in air-conditioning and thermal modernization
- **51%** Lower comfort of life
- **35%** Increased mortality
- **29%** Increased incidence of climate-dependent diseases
- **45%** Increased living costs

[1] Special Eurobarometer 435 "Climate Change", Report EN, 2015.6169, doi:10.2834/447336.

[2] Press release by CBOS "The citizens' sense of agency in public affairs", March 2018 (comp. by R. Boguszewski).

[3] Press release by CBOS "Cooperation of local authorities with residents", April 2018 (comp. by R. Boguszewski).

climate change, the need for adaptation to climate change, involving residents in the adaptation process and the financing of adaptation measures.

The respondents believe that what is missing is the involvement of the city's residents, legal regulations and the local authorities not having expert knowledge on adaptation to climate changes. Every third person mentioned lack of access to data and information. Education and information are those measures which, according to 75% of the respondents, are the foundation for obtaining long-term social support and the sustained involvement of the public in urban adaptation measures in Poland.

In the case of municipal infrastructure of land use, decisions are made with a horizon of several decades. They affect residents' health, urban aesthetics, landscape and economic conditions, both of the city itself and of its residents. Consulting the plans with the residents and public communication of the adaptation measures implemented by the municipal authorities are necessary according to, 49% and 45% of the respondents respectively. More than one half of the respondents suggest that the local authorities should dedicate part of the funds in the participatory budget to adaptation measures. This may contribute to increasing the residents' involvement in the execution of projects which increase urban resilience. The respondents would also welcome more educational campaigns for the residents' councils, boards of housing cooperatives and residential building managers. More than 53% of respondents indicated this was useful.

The functioning of the local authorities is determined not only by legal laws and regulations, but also by material reality. Therefore, the concerns voiced by both local authorities and the residents about the availability of funds for the implementation of adaptation measures should not come as a surprise. On the other hand, the examples of adaptation measures already implemented in many cities as well as analyses conducted by the local authorities show that the local authorities are ready to innovate to solve specific local issues.[4]

WHO HAS A ROLE TO PLAY IN PREPARING AND IMPLEMENTING URBAN ADAPTATION PLANS

62%

of the respondents equate climate change with its negative effects

- **86%** Local authorities
- **28%** Utility operators
- **25%** Urban planners, architects
- **49%** Residents
- **25%** NGOs
- **15%** Local businesses
- **34%** Media
- **25%** Scientists

WHAT IS NECESSARY TO STRENGTHEN THE IMPLEMENTATION OF ADAPTATION MEASURES

Ankietowani dostrzegają znaczenie świadomości społecznej, edukacji oraz zaangażowania mieszkańców w działania adaptacyjne

- **68%** Financial resources
- **33%** Cooperation between the private and public sectors
- **28%** Access to data
- **23%** Technology
- **61%** Social awareness of the effects of climate change
- **30%** Legal regulations
- **24%** Educational activities
- **20%** Involving residents in adaptation measures

LOCAL AUTHORITIES MAY INCREASE AN INTEREST IN ADAPTATION BY...

70%

of the respondents indicated that the Polish cities are not currently well adapted to climate changes.

- **55%** Dedicating funds for adaptation projects in participatory budgets
- **53%** Educational campaigns addressed to the residents' councils, boards of housing cooperatives and residential building managers
- **49%** Consulting the measures planned with the residents
- **45%** Communicating the measures implemented by the municipal authorities

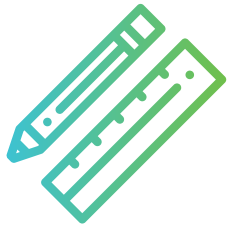
[4] A. Gendźwiłł, Zdecentralizowana adaptacja? Opinie władz lokalnych o zmianach klimatu i lokalnej polityce adaptacji do zmian klimatycznych (Decentralized adaptation. Opinions from the local authorities on climate change and the local adaptation policies), "Studia Regionalne i Lokalne" 2017, no. 2(68).

Implementation of Urban Adaptation Plans

Urban adaptation plans are strategic documents which reflect municipal policies aimed at a city's capacity to handle the natural hazards. The status of strategic documents should facilitate the implementation of the Urban Adaptation Plans (UAP) by the local authorities.

It is the local authorities which bear the responsibility for the implementation of the Urban Adaptation Plans, in cooperation with external stakeholders (both institutions and non-institutional). Effective implementation of an Urban Adaptation Plan will require designing or adapting already existing mechanisms and solutions to the requirements of the UAPs. During the implementation process, it is important to build a network of cooperation with both the city residents, and the entities participating in the development of the current urban policies in various areas (businesses, social organizational, employee self-government, sectoral structures). If external participants are engaged, the implementation of the UAPs will be a manifestation of building a civic society at micro level.

It should also be borne in mind that without implementing soft (educational or organizational) measures, there will be no effects of implementing technical measures. The cities must be prepared organizationally to implement adaptation plans, and the residents should be aware of the need to participate in implementation.



The success of the implementation effort will largely depend on determining implementation procedures. The proposed methodology for monitoring and evaluating the implementation of adaptation plans will contribute to better and faster achievement of the goals adopted.

ELEMENTS OF IMPLEMENTATION OF ADAPTATION PLANS

- Determining the team responsible for implementation
- Preparing a detailed implementation timetable
- Obtaining financing
- Linking implementation with the activities of other entities operating within the city area
- Engaging local communities
- Communication of the measures being implemented
- Monitoring the implementation of the measures
- Evaluating implementation results

Monitoring the progress of implementation of individual measures specified in the UAP will be the source of information on progress in implementing the strategic document. Oversight over implementation of the adaptation measures has been entrusted to mayors. It is recommended to conduct annual evaluations, based on information on the number of measures being implemented and their cost, divided by category (education and communication, organizational and technical measures).

Based on the data gathered, a report on the implementation of an Urban Adaptation Plan will be prepared, including:

- a summary of the organizational aspects relating to implementation (e.g. organizational changes, composition of the urban team appointed to implement the UAP, linking the city's adaptation policy to new municipal documents);
- information on adaptation measures planned, in progress and completed during the reporting period;
- recommendation for corrective actions;

An evaluation is intended to check if the measures undertaken have brought the expected products or results, and if they translated into achieving a general objective of the UAP. Therefore, the indicators proposed refer to the implementation of the adaptation measures, achievement of specific goals and of the general objective of the UAP.

Conclusions from the evaluation will form the basis for updating the UAP. The need for updating will be determined by mayors based on the monitoring reports and the evaluation.

The execution of the specific measures specified in the UAP will be monitored on an on-going basis and evaluated every two years. Based on the evaluation, the measure may be updated if and as necessary. The entire Urban Adaptation Plan will be updated every six years.

Challenges and opportunities to climate change

Implementing adaptation measures brings many environmental, social and economic opportunities. Adaptation to climate change may be treated as a tool for increasing the city attractiveness or creating safe and attractive urban spaces. Many cities in the world combine adaptation measures with the development of the Smart City, Green City and Compact City concepts and based on state-of-the-art pro-environmental and social solution creates high value urban life.

Financing of adaptation measures

Local authorities already have at their disposal various sources of financing adaptation. For example, the funds from the Operating Programme Infrastructure and the Environment 2014–2020 are addressed to cities which are planning to implement measures relating to rainwater management. Initiatives relating to the education of the general public may be financed from Regional Operating programmes. The National Fund for Environmental Protection and Water Management (NFOŚiGW) introduced an adaptation component in its financial offering: the programme "Preventing environmental hazards and elimination of their effects". A city's participation in the Life+ or Horizon 2020 programme may also be one of the sources of financing.

Sources of financing for adaptation measures:

National	• National Found for Environmental Protection and Water Management • Voivodship Found for Environmental Protection and Water Management	• State Budget
European Union	• Operational Programmes Infrastructure and Environment • Regional Operational Programmes	• Life+ • Horizon 2020
International, non-EU	• World Bank	• International Monetary Fund
Other	• Business • Banks	• Investment Funds • Foundations

	CHALLENGES	OPPORTUNITIES
Environmental area	• The existing urban space designed without addressing the needs for environmental protection	• Protection of biodiversity by creating habitats for animals and plants, enabling the migration of the species. • Ensuring the coherence and spatial durability of the urban ecological network resulting from measures aimed at increasing the protection or urban natural systems. • Ensuring the protection of natural resources (water, soil, surface of the earth) through rational management of such resources. • Decreasing a city's pressure on the environment by introducing a circular economy.
Social area	• Low social awareness of adaptation to climate changes. • No participation of the residents in adaptation activities. • Social problems of the cities.	• Improving the quality of urban life, manifested in the quality of housing conditions, i.e. living in a well-designed urban space close to large green areas. • Enhancing the residents' safety and the protection of health as a result of coordinated activities aimed at preparing the city for extreme events associated with climate change. • Increasing the awareness of climate change and the involvement of the residents by building communities of citizens who feel responsible for their city and initiate and engage in activities undertaken in their surroundings.
Economic area	• Obtaining financing for adaptation measures. • Low degree of technological advancement of the adaptation measures.	• Limiting financial losses and property losses resulting from catastrophes associated with climate changes by undertaking adaptation measures. • Developing Smart City solutions in connection with adaptation measures. • Creating an innovative image of the city which may help in attracting new investments, developing tourism, attracting new residents and increasing the quality of life of local communities. • Thoughtful adaptation measures creating favourable conditions for businesses. Awareness and prevention of hazards makes a city more attractive for investors.

The future of urban adaptation

The fact that climate change is not limited purely to environmental threats, while the adaptation process can bring quantifiable benefits in many areas of functioning of towns and cities, including socially and economically, is evidenced by the following statements of experts from various fields.

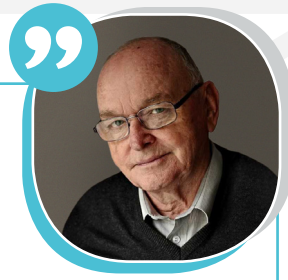
"Adaptation to climate changes contributes to environment protection and enables adjusting to climatic changes. To adapt to climate changes and the related phenomena such as droughts or heavy rains, cities must implement water-saving measures, enable storage of rainwater or increase the surface of biologically active areas. Climate change prevention also involves energy saving. Such integration of measures for adapting to climate changes, including protecting natural resources, must be undertaken at all levels of state and local governance. The need to adapt to climate changes is also an opportunity for transforming Polish economy towards low emission, innovation and towards an environment-friendly economy."

Paweł Sałek
Advisor to the President of the Republic of Poland for environmental protection and climate-related policies

"Local governments have planned adaptation measures, ensuring that they are both cost, environmentally and socially effective. The urban authorities that face the challenges arising from the implementation of these measures will not be alone, because the Ministry of the Environment is planning to allocate tangible funding to activities related to adaptation to climate change in the next EU financial perspective for the years 2021–2027, including those specified in urban adaptation plans. Towns and cities will continue to be supported with tools, such as the project being implemented by IOŚ-PIB (Institute of Environmental Protection – State Research Institute) named "Knowledge base on climate change and adaptation to its effects and channels of its dissemination in the context of increasing the resilience of the economy, environment and society to climate change, and counteracting and minimizing the effects of extraordinary threats", which can take the necessary knowledge on climate change and assess its impact to improve the efficiency and effectiveness of the adaptation measures."

Szymon Tumielewicz
Deputy Director of the Sustainable Development and International Cooperation Department

Ministry of the Environment



"Global climate change has an adverse effect on urban infrastructure in towns and cities, which worsens the climatic conditions as a result of constant development. Therefore, urban adaptation has a dual role to play: the reduction of the impact of global climate change and simultaneously the stoppage of the adverse impact of urban infrastructure on climatic conditions.

The expected increase in global greenhouse gas emissions gives the expectation of a further deterioration in climatic conditions, so it would be appropriate to be prepared for the need to update adaptation activities. A decision simultaneously needs to be made as to what time horizon for planning adaptation should be taken into account, bearing in mind that climatic conditions and the consequences of global changes will deteriorate, and as to what the admissible risk of threats is, given that cities have specific access to financial, human and technical resources."

Prof. Maciej Sadowski
Climatologist

Institute of Environmental Protection – National Research Institute

"When discussing the adaptation of cities of over 100,000 inhabitants to climate change, certain specifics of the aging population of these cities must be taken into account. The proportion of older people (65 years and over) will be larger than in the other population groups – almost 19% are currently in this age group (compared to 18% in cities and 16% in the whole country). The majority of older people will be women (currently 62% of older residents) who, more frequently than older men, constitute single-person households. Older women are also more often at risk of poverty. Furthermore, the longer life of women is related to a longer period of feeling health restrictions. Climate change can significantly impede the day-to-day functioning of older people, which requires both the development of support within social networks (family and neighbourhood), as well as formal social welfare. I attribute a special role to both local authorities and non-governmental organizations."

Prof. Irena Kotowska
Demography Unit of the Institute of Statistics and Demography, Warsaw School of Economics

"The business environment is still relatively unaware of the threats posed by climate change, as well as their costs and benefits. This suggests that, on the one hand, there is a need for education and, on the other, actions and guidelines that can help businesses better secure, prepare or adapt to the changes. Both the large and small ones which, being fully aware of the changing conditions, adapt the investments made, production cycles, cost models and distribution systems, will certainly be the winners in the new reality.

The Urban Adaptation Plan project gives numerous hints and inspirations, as well as warnings (in fact, for every industry), as to how, in the context of being present in the city, to take care of continuity of operation and social well-being. In cooperating with towns and cities, as well as the administration, business can and should play a key role in building public awareness about climate change and involving local communities in activities supporting adaptation."

Irena Pichola
partner, Sustainable Development Team Leader in Poland and Central Europe
Deloitte

"Large cities are already experiencing the effects of the changing climate. This obviously also applies to Warsaw. Therefore, it is even becoming necessary to assess which groups of residents and which sectors of the city are most exposed to these changes. Such a simplified diagnosis enables better decisions to be made as to the directions of activities or investment outlays that can prevent large material losses or even threats to the lives and health of the residents. Such activities should be performed with the maximum possible community involvement. This will not only allow for the better adjustment of activities to needs but also to the involvement of the residents in protective activities from the beginning, which will contribute to more rational and conscious behaviour in the event of threats or disasters and will therefore further increase the level of safety of our citizens."

Leszek Drogosz
Director
Infrastructure Office of the Capital City of Warsaw

"The formation of the green and blue infrastructure should be the fundamental strategy for adapting to climate change, because, outside historical centres, towns and cities are evolving and changing their infrastructure and architecture. On the one hand, this evolution should maintain the unique cultural heritage of the given town through the renovation of valuable objects, while introducing elements of greenery and water with good retention potential for restoring surface waters and groundwater in the reclaimed areas. As a result, trees and shrubs will intensively transpire, increasing air humidity, reducing air temperature and contributing to the dropping of suspended dust particles. Such solutions will create a network of oases in the city, enabling active life and recreation, while encouraging the use of zero-emission vehicles."

Prof. Maciej Zalewski
Director
European Regional Centre for Ecohydrology PAS, Department of Applied Ecology,
University of Łódź

"The inhabitants of every town or city constitute its integral part. The observed and forecast climate changes will affect them directly (affecting their health and well-being) and indirectly (affecting the infrastructure and the functioning of the towns and cities).

Therefore, climate change adaptation plans which are being prepared must be clearly targeted at humans. In searching for optimal solutions for residents, it will also be possible to positively influence various elements of urban infrastructure and the way they function in the changing climatic conditions. This will improve the broadly-understood well-being of the residents, which comprises the state of health and comfort of everyday life and, in critical situations, awareness that the appropriate municipal services will stand tall and will be able to quickly and effectively minimize the threats or their consequences."

prof. Krzysztof Błażejczyk
Bioclimatologist
Department of Geoecology and Climatology, Institute of Geography and Spatial Organization,
Polish Academy of Sciences

The future of urban adaptation

Regardless of whether or not the international community is able to stop the global increase in temperature, adaptation to the anticipated climate changes is a necessary development strategy. However, forecasting these changes is subject to a high degree of uncertainty. When planning to adapt to the threats related to climate change, it should be borne in mind that they may not appear or they may be threats of a different scale or extent than expected. Simultaneously, social problems, economic changes and spatial changes are superimposed in cities on the scale and extent of threats arising from climate change. Therefore, a great deal of flexibility needs to be maintained, particularly in cities, when planning adaptation activities. Adaptation plans enabling constant checks to be made as to which climate changes and changes in society, the economy and nature the towns and cities are to adapt to, regardless of the climatic conditions, and how the city reacts to the implemented adaptation activities, need to be monitored and updated. The Paris Agreement of 2015, which emphasized adaptation to climate change, mentioned that "monitoring and evaluating and learning from adaptation plans, policies, programmes and actions" is required in the adaptation planning process and the implementation of actions. In this context, adaptation means continuous learning.

Urban Adaptation Plans constitute a new documents that were prepared as a result of the work of multidisciplinary teams of experts and a broad group of local government partners representing 44 Polish towns and cities. They do not replace any urban strategic or planning documents, but constitute a significant supplement to them, enabling the implementation of a responsible and modern urban policy.

The complementary nature of Urban Adaptation Plans and other programmes and plans required account to be taken of many aspects of the functioning of the contemporary Polish city, both in the technical and organizational area, as well as emphasizing the needs and aspirations of its residents and other users. Towns and cities will receive a document of a strategic nature, based on a unified approach, which allows for a full view and systemic assessment of the state of resilience of Polish urban space to potential threats related to climate change. It is important to ensure that this document becomes an innovative tool for developing urban policy. Therefore, urban climate change adaptation plans should be adopted with resolutions of city councils, because only then will they constitute a fully effective and valuable instrument for implementing the intentions and development plans of every city.

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