Project co-financed by the European Union under the LIFE Program
and the National Fund for Environmental Protection and Water Management

NFOŚiGW

LIFE14 CCA/PL/000101

RadoKlima

LIFERADOMKLIMA-PL

BEST PRACTICE GUIDE

ADAPTATION OF CITIES TO CLIMATE CHANGE THROUGH THE USE OF BLUE-GREEN INFRASTRUCTURE LIFERADOMKLIMA-PL

radom siła w precyzji

wodociągi miejskie

UNIWERSYTET ŁÓDZKI

FPP ENVIRO

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INTRODUCTION

Poland is in a dynamic phase of development and implementation of many infrastructure investments, often supported by EU funds. The vast majority of these investments are understood as the expansion of grey infrastructure and the implementation of engineering solutions. Planners, policymakers and city dwellers still do not fully understand the need, or even the necessity, to invest in blue-green infrastructure (BGI) and nature-based solutions (NBS). Their potential for mitigation and adaptation to anthropogenic climate change is under-utilised by cities. Barriers to their implementation are the lack of knowledge and experience in planning and implementing these solutions, as well as the lack of appropriate legal instruments supporting the implementation of BGI and NBS.

LIFERADOMKLIMA-PL PROJECT

Radom was the first city in Poland to undertake comprehensive actions in the field of systematic development of blue-green infrastructure (BGI), in order to create a friendly, healthy space for its inhabitants to live and develop, and to mitigate the negative effects of extreme climatic phenomena. In order to achieve its goals, the City undertook to implement an innovative project..

LIFE14 CCA/PL/000101

„Adaptation to climate change through sustainable management of water of the urban area in Radom City"

www.life.radom.pl/pl

Project implementation period:
16/07/2015 – 31/12/2022

Funding:
The project co-financed by
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Total cost:
24 291 746 PLN

- co-financing from the EU LIFE Programme: : 12 207 760 PLN
- co-financing from the National Fund for Environmental Protection and Water Management:: 6 494 305 PLN

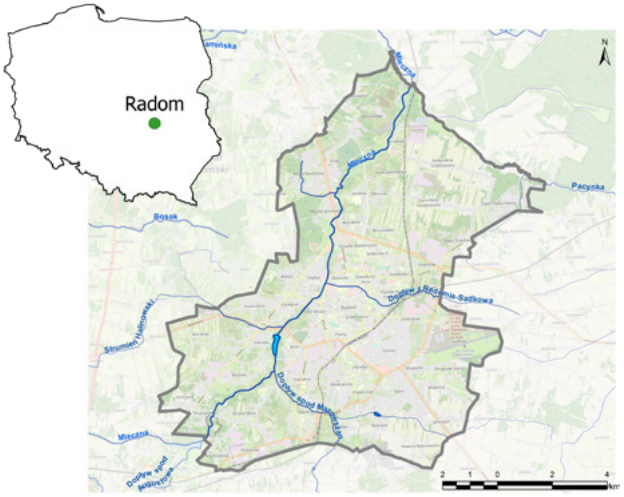
Applicant and Coordinating Beneficiary::

- Municipality of the City of Radom

Co-beneficiaries:

- Municipal Waterworks in Radom Ltd.
- University of Łódź
- FPP Enviro Ltd.

RADOM – DEMONSTRATION CITY



RADOM IN NUMBERS

Population: 213,715
City area: 11,180 ha
Green areas: 6.54%
Protected areas: 3.39%
Built-up area: 60%

MAIN WATERCOURSES

- The Mleczna
- The Pacynka
- The Cerekwianka
- The Kosówka
- The Potok Południowy
- The Potok Północny

MAIN RESERVOIR

- Borki Reservoir

WHAT IS RADOM KNOWN FOR?

- Radom Air Show
- International Gombrowicz Festival
- Radom Jazz Festival
- Famous people: Jacek Malczewski, Jan Kochanowski, Witold Gombrowicz, Leszek Kołakowski, Andrzej Wajda

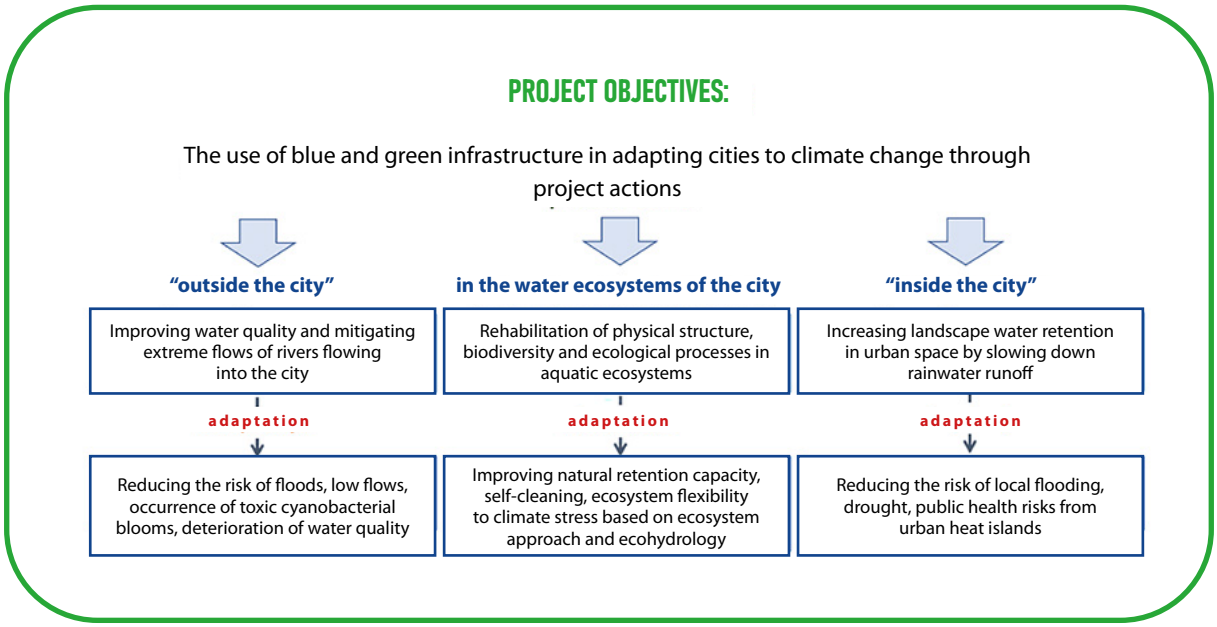
photo: www.radom.pl

Why Radom?

Radom, like every other city in Europe, is struggling with the effects of global warming. The city authorities early recognised the need to develop and consistently implement an adaptation policy to limit the losses caused by climate change and its effects. They also decided to look for new solutions, stimulate the innovation of the economy and improve the state of the environment and the quality of life of residents. It became important for the city to find a balance between grey and blue-green infrastructure and the changing climate, by carrying out its own tasks and supporting the initiatives of residents.

PROJECT OBJECTIVES

The main objective of the project was to create an urban space in Radom with increased resistance to anthropogenic climate change through the construction of a demonstrative blue-green infrastructure based on an ecosystem approach. Blue-green infrastructure is used to improve the ecological safety of residents in the face of global warming in a direct way (floods, droughts, low water quality, severe heat waves) and indirectly (destruction of grey infrastructure and weakening of the functioning of ecosystems and ecosystem services supplied by them).

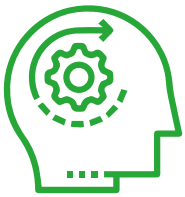


Detailed project objectives included:

- **Improving the quality of life** of residents by increasing **flood safety and improving the microclimate** in urban space thanks to the construction of BGI
- Preserving **biodiversity** through adaptation activities that **retain rainwater** and shape diverse habitats in the city
- Raising **public awareness** of the need to adapt to climate change in urban spaces and **sustainable water management** while protecting ecosystems
- **Exchange of experience and expert knowledge** with institutions and cities in Poland and abroad on the role of BGI in urban space and adaptation to climate change

PROJECT LOGIC

RadoKlima



STEP 1
awareness of the challenges related to the extreme weather conditions

STEP 2
establishment of an interdisciplinary team of experts

STEP 3
establishment of interdisciplinary working groups

STEP 4
assessment of the city's vulnerability to the effects of anthropogenic climate change

STEP 5
designation of BGI intervention areas depending on key challenges and the degree of urbanization

STEP 6
designation of BGI implementation areas and conceptual works

STEP 7
design and BGI implementation works

STEP 8
monitoring of adaptation activities

STEP 9
building social capacity for adaptation

STEP 10
replication and dissemination of knowledge, experience and BGI solutions

STEP 1

Awareness of the challenges in the city related to the intensifying extreme weather conditions

The starting point for taking action in the LIFERADOMKLIMA-PL project were the problems arising in the city related to the intensifying extreme weather conditions and their consequences for the functioning of the city. In Radom, these problems included:

- **flooding** of a several/dozen areas of the city by surface flowing rainwater
- repeated **floods** from rivers
- unsatisfactory **water quality** in the summer limiting its recreational use (cyanobacterial blooms in the Borki Reservoir – the most important recreational area in Radom)
- **urban drought**, heat and rising greenery maintenance cost

photo: the project file

STEP 2

Establishment of an interdisciplinary team of experts

In response to the growing problems, the **Radom Municipality and the Radom Municipal Waterworks established an interdisciplinary team** whose aim was to start work on scenarios for managing the identified challenges. The team consisted of:

- **city authorities** – Radom Municipality
- **representatives of the water and sewage industry** – Municipal Waterworks in Radom
- **representatives of biological sciences** – UNESCO Chair of Ecohydrology and Applied Ecology, Faculty of Biology and Environmental Protection, University of Łódź and
- **representatives of the private sector** related to the planning, design and implementation of blue-green infrastructure – the company FPP Enviro

During the work, the team detailed the challenges associated with the functioning of the city in climate extremes:

- **in periods of intense rainfall**: overloading of rainwater drainage and general sewage systems, flooding from the sewage system, floods from rivers, pollution of rivers and reservoirs, destruction of the biological structure of rivers and threat to biodiversity, suboptimal functioning of parts of water and sewage infrastructure, transport paralysis of the city, frequent crisis interventions of fire brigades related to flooding and related costs, losses in urban infrastructure, material losses for natural persons, psychological effects for residents, challenges for authorities and industry specialists, image losses for the city
- **during dry spells**: urban droughts, overheating of the city resulting from overlapping heat waves and the urban heat island, unfavourable microclimate increasing the likelihood of allergies and respiratory and cardiovascular diseases in the population, negative impact on the quality of life, increasing problems related to the maintenance of urban greenery and the functioning of the natural system, loss of flow in the rivers, low water level in the reservoir and cyanobacterial blooms, threat to biodiversity of terrestrial, aquatic and water-dependent ecosystems

The above challenges formed the basis for the formulation of an application to the LIFE Financial Instrument for funding adaptation measures, which was accepted.

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The triple helix model, i.e. a model of interaction and cooperation between elements of the innovative system: science – enterprises – administration (public authority), is very effective in developing diagnoses and solutions for complex adaptation projects. At the stage of formulating long-term activities in the project, it increases its innovativeness and the chance to develop effective solutions.

STEP 3

Establishment of interdisciplinary working groups

The interdisciplinarity and complexity of the issues undertaken in the LIFERADOMKLIMA-PL project meant that the first decision after its commencement was the establishment of the so-called Working Groups. They were intended to ensure that different perspectives were taken into account in project decision-making by incorporating the experience and knowledge of a wide range of stakeholders. They were also to ensure a more effective dissemination of knowledge about climate adaptation among the administration and entities cooperating with it. Ultimately, they allowed to focus on the broader context of the integration of aspects related to adaptation to climate change with the processes of urban development, planning, urban policy, as well as on decision-making taking into account climate aspects in many areas of the city's activity. The working groups were continuously involved in the consultation of the next steps of the project and activities related to its dissemination.

..... GOOD PRACTICE .....

Interdisciplinary Working Groups, composed of project stakeholders, meeting regularly in the course of the project implementation, improve its implementation and ensure that the project stays on course to achieve its objectives.

Two Working Groups have been established in Radom: Working Group No. 1 (GR1) operating at the City Hall on the integration of adaptation to climate change into local strategies and decision-making processes

Working Group No. 2 (GR2) for blue-green infrastructure and biodiversity, operating at the Municipal Waterworks in Radom.

Each group consisted of about 20 members representing various departments of the City Hall, municipal and regional institutions and non-governmental organisations. Other stakeholders have also been invited to the GR meetings on several occasions.

The participants of GR1 were representatives of the departments of the City Hall in Radom, the Municipal Waterworks in Radom, the Municipal Urban Planning Bureau in Radom, the City Council in Radom and co-beneficiaries of the project. The participants of GR2 were representatives of all co-beneficiaries, non-governmental organisations operating in the city, region and Poland, and – depending on the current tasks – Polish and international experts.

GR1's actions included:

- providing recommendations for the city on options for adaptation to climate change and possible next steps in the management of rainwater and other sensitive sectors
- providing recommendations for the city regarding the possibility of including adaptation activities in the city's development plans, with particular emphasis on rainwater
- disseminating knowledge on climate adaptation among the local administration in the region, the municipal administration in the city, cooperating businesses and residents
- identification of economically effective adaptation activities that can be replicated in the city by municipal services and every citizen

GR2's actions included:

- directing the project towards the best suited solutions in the field of BGI
- support in solving problems related to the implementation of BGI in the field of legislation and administrative paths
- initiating international and national cooperation in the field of exchange of experience in designing and implementing BGI solutions
- promotion of BGI solutions and their replication in the city and country

Meetings of working groups GR1 and GR2 (photo by Municipality of the City of Radom)

STEP 4

Conducting an assessment of the city's vulnerability to the effects of anthropogenic climate change

To assess the extent to which a city is not resilient to the effects of climate change, a so-called vulnerability assessment is carried out. It identifies economic sectors and areas of the city particularly vulnerable to adverse impacts. At a later stage, vulnerability assessment is the basis for effective planning of adaptation activities.

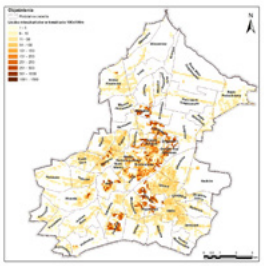
The results of the assessment carried out in the project point to increasing:

- climate warming – increase in average air temperatures in summer and winter, increase in extreme temperatures, increase in the number, length and frequency of heat waves
- changes in the distribution of precipitation – an increase in the amount of precipitation and a significant increase in heavy precipitation, especially in winter, and torrential downpours in summer
- drought risk – especially in summer
- frequency of snowless winters – reducing the number of days per year with snowfall and snow cover

Radom is one of 44 cities in Poland that participated in the project "Let's Feel the Climate" implemented by the Ministry of the Environment, in which cities with more than 100,000 inhabitants developed plans for adapting to climate change. The vulnerability assessment carried out as part of the LIFERADOMKLIMA-PL project was the basis for the development of the Municipal Adaptation Plan for Radom.

SECTORS PARTICULARLY VULNERABLE TO ANTHROPOGENIC CLIMATE CHANGE IN RADOM

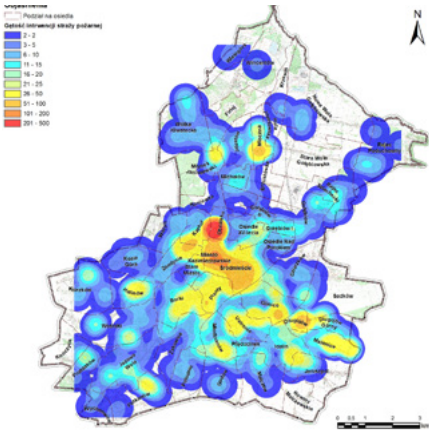
Public health



Transportation

Spatial planning

Water management



Interventions of the fire brigade in Radom

Collective map of floods caused by manholes in 2016 and 2050 (probability of rainfall 10%, 24h)

As part of the vulnerability assessment, the following activities and products were prepared in Radom, including, but not limited to:

- analysis of historical data related to the occurrence of climatic conditions in Radom and their effects – among others, the frequency of fire brigade intervention in flooding after the occurrence of precipitation of various intensity levels was analyzed
- analysis of climate models predicting climate change for two anthropogenic greenhouse gas emission scenarios – RCP 4.5 (moderately optimistic scenario) and RCP 8.5 (pessimistic scenario)
- a spatial database and maps of areas of Radom susceptible to extreme weather conditions and their effects – including high temperatures, flooding from the rainwater drainage system and flooding from rivers in the initial period (2016) and in the perspective of 2050
- a spatial database and maps of infrastructure facilities related to sectors particularly susceptible to extreme weather conditions
- identification of key areas of intervention and directions of action to increase the adaptation of urban space in Radom to climate impacts and extreme weather conditions

From the point of view of the functioning of Radom, sectors that were considered to be particularly sensitive to climate change in changing climatic conditions included public health, spatial management, water management and transport.

A brochure for residents summarising the results of the vulnerability assessment of the Radom urban space to climate change:

https://www.life.radom.pl/pl/o-projekcie/raporty

Simplified visualisation of the results of vulnerability assessment for residents of Radom in terms of hazard areas are available on the project website in the form of an interactive platform:

gis.umradom.pl/life_radom_mapy.html

..... GOOD PRACTICE .....

An assessment of vulnerability to climate change allows for:

- assessment of the severity and dynamics of changes in key climatic factors in the city

- determination of areas of the city most exposed to the negative impact of climate change

- identification of the sectors of the city's economy most exposed to the negative impact of climate change

- developing directions of action to mitigate the negative effects of climate change.

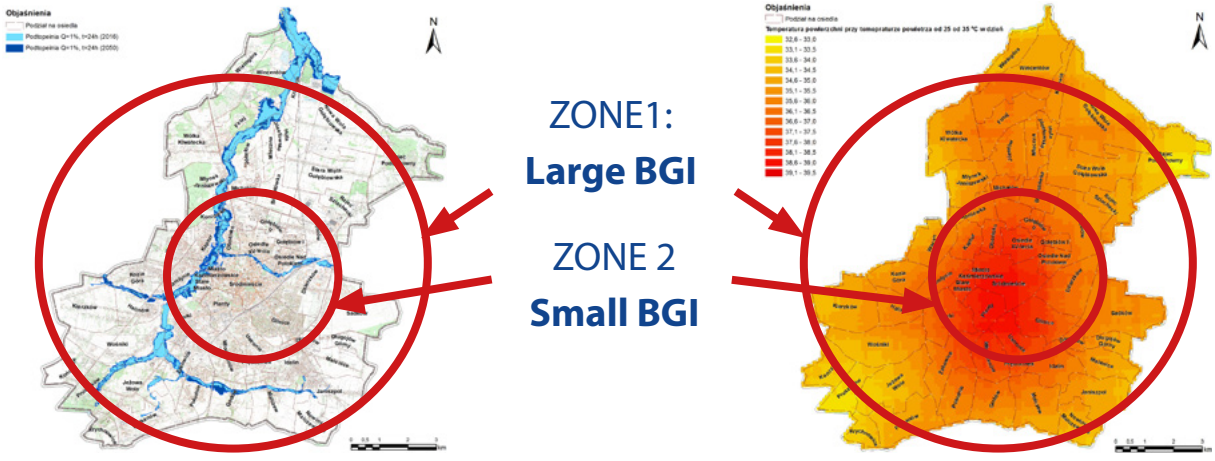
STEP 5

Designation of BGI intervention areas depending on key challenges and the degree of urbanisation

The results of the diagnosis carried out formed the basis for selecting the key areas of intervention. There are two zones of action in the city:

ZONE 1: The outskirts of the city – where actions aimed at increasing the retention capacity of river valleys are planned. Their **main goal is to** lower the high levels of rivers flowing into the city during the precipitation period and **reduce the risk of flooding**. At the same time, they were intended to contribute to the creation of new habitats, the improvement of biodiversity and the ability of ecosystems to provide ecosystem services. These measures have been given the working name of **"LARGE blue-green infrastructure" ("LARGE BGI").**

ZONE 2: Central areas of the city – where actions aimed at retaining rainwater at the place of precipitation are planned. Their **main goal** is to **relieve the rainwater drainage system and mitigate flooding** from rainwater in the city centre. Water retention in the landscape is also supposed to mitigate the effects of urban drought and support ecosystems and biodiversity in hot weather. These measures have been given the working name of **"SMALL blue-green infrastructure" ("SMALL BGI").**



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In urban areas, especially in the most heavily transformed areas, it is often necessary to use hybrid solutions, i.e. combining (hydro)technical solutions (grey infrastructure) with blue-green infrastructure. This approach pursues two objectives: it reduces strong pressures (e.g. reduction of pollutants flowing with rainwater to rivers using separators) and it increases the adaptive potential of the natural system and the city and the ecosystem services provided by the city. In addition, BGI improves biodiversity and increases the prevalence of protected species.

STEP 6

Designation of BGI implementation areas and conceptual works

THE MLECZNA RIVER

The Mleczna is the main watercourse of Radom and constitutes the **axis of activities in the area covered by the project**. Rainwater from individual districts of the city is discharged **by rainwater collectors** directly to the Mleczna and its tributaries. This causes the **risk of flooding, hydrological stress** for organisms living in the river resulting from extreme flows **and water pollution**. In the summer, the problem was the **drying up** of the river on some of its sections. This was influenced by the radical transformation of the river and its valley, including its **regulation** (a straightened channel, increased slope, unified shape and cross-sections, elimination of irregularities of the banks and bottom, destruction of ecotones, cutting off the valley's connection with the main channel) and **degradation of the valley** (buildings, tannery waste which is are the remains of tanneries located in the vicinity of the river).

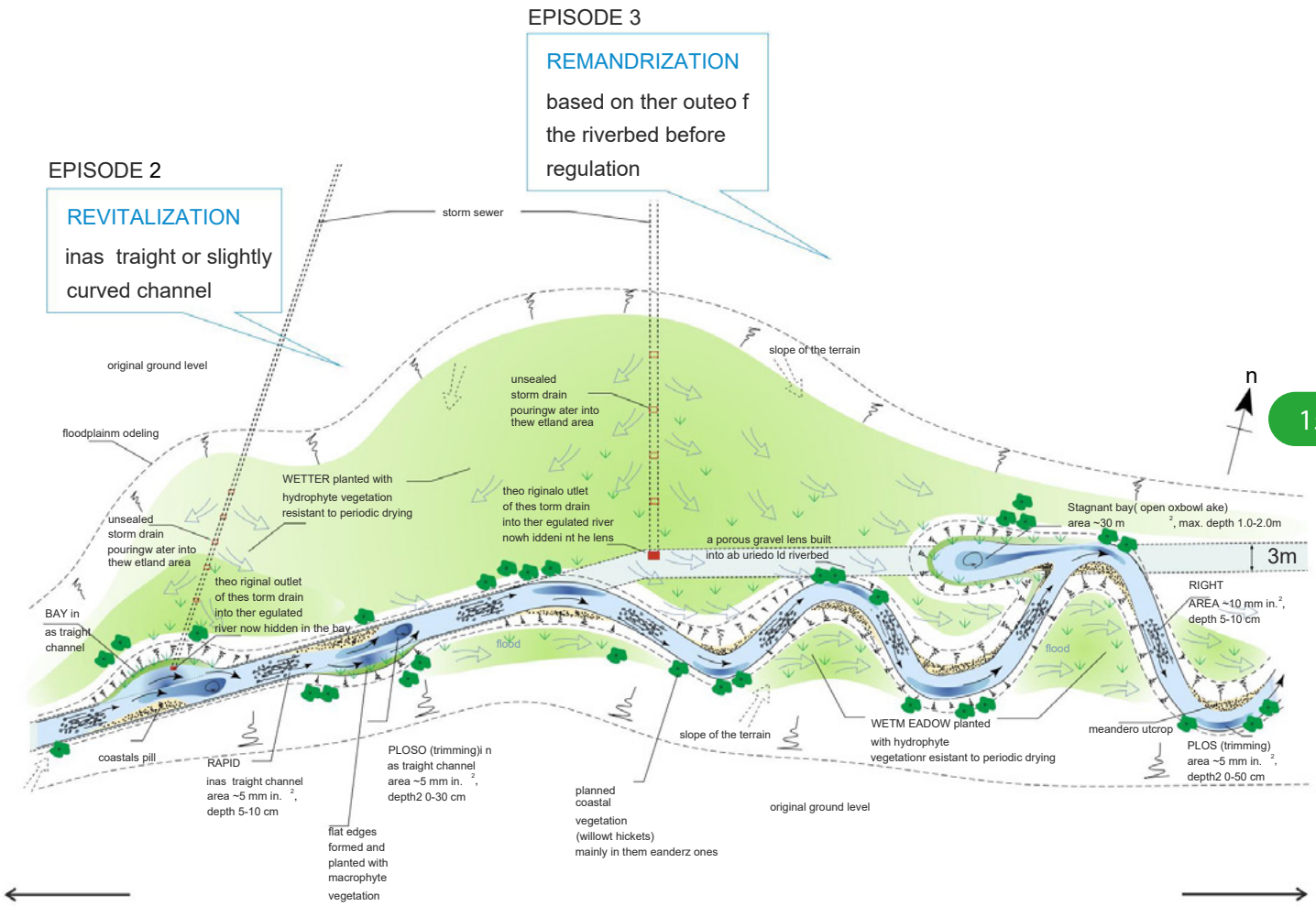
High water level in the regulated channel of the Mleczna river below the Borki reservoir (photo by Municipal Waterworks in Radom)

The regulation further exacerbated the **decline in biodiversity**, which posed a threat to the survival of many valuable plant and animal species.

Framework concept:

A number of restoration activities have been planned on the Mleczna along with **the meandering of the channel** and increasing its **hydromorphological diversity**. In places where meandering was not possible, other solutions were sought, enabling the differentiation of morphology and flow without violating the channel boundary. These measures were intended to improve **habitat conditions and self-cleaning of the river**. It was necessary to improve the river's connectivity with the floodplain, increasing **flood safety** and improving **the ecological condition of the river.**

THE MLECZNA RIVER



EPISODE 2

EPISODE 4(similars olutiona s for2)

The concept of renaturalisation of the Mleczna (University of Łódź)

BORKI RESERVOIR AND COLMATATION PONDS

The Borki Reservoir is a **place of recreation** for the inhabitants of Radom and the surrounding area. In the north-eastern part, there is a beach and a pier. The rest of the shoreline of the reservoir is covered with aquatic vegetation, mainly reed and rushes. The relatively large surface area of the reservoir means that numerous water and marsh bird species can be found here. However, the **cyanobacterial blooms** appearing in the summer period had a negative impact on the possibility of recreational use of the reservoir and its ecological condition. They were intensified by periodically **low water**

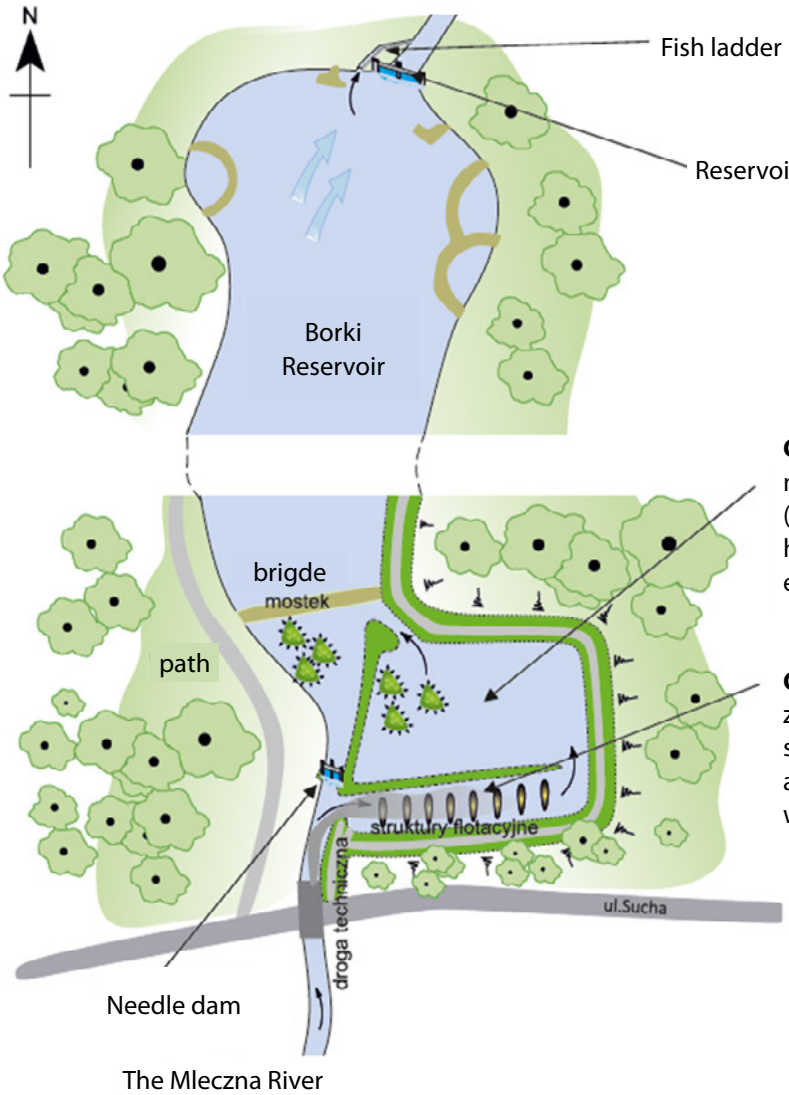
Cyanobacteria blooms in the recreational Borki Reservoir (photo by Municipal Waterworks in Radom)

levels and **high summer temperatures**, accelerating the growth of cyanobacteria and promoting the release of elements necessary for their growth from **bottom sediments**. During intense rainfall, the **flow of pollutants** from the reservoir catchment area with rainwater increased, forming a breeding ground for cyanobacteria. Sudden surges threatened the **safety of the hydrotechnical structure** and the areas below it in the city centre. The old structure of the dam did not allow the continuity of the river and **prevented the migration of fish**. The adaptation of the reservoir was therefore of great importance for both the **ecological safety of the inhabitants of Radom and the environment**.

Framework concept:

One of the tasks of the reservoir in the face of climate change was to buffer extreme water flows towards the city. So far, this has not been the case due to the low retention capacity, too small clearances of the movable closures on the damming structure and the inability to regulate the amount of water flowing into the water reservoir. It was necessary to **increase the retention capacity** of the reservoir, multi-stage **treatment of water flowing to it**, reconstruction of the dam enabling increasing its **flood capacity and animal migration** and mitigating the negative impact of **low flows** on the utility of the reservoir.

BORKI RESERVOIR AND COLMATATION PONDS



Colmatation reservoir 2
macrophytic vegetation zone (for river water pretreatment, habitat creation and biodiversity enhancement)

Colmatation reservoir 1
zone with a hardened bottom, flotation structures and a technical exit (for accumulation and easy removal of sludge deposited by flood waters)

The concept of adaptation of the Borki reservoir and colmatation ponds (University of Łódź)

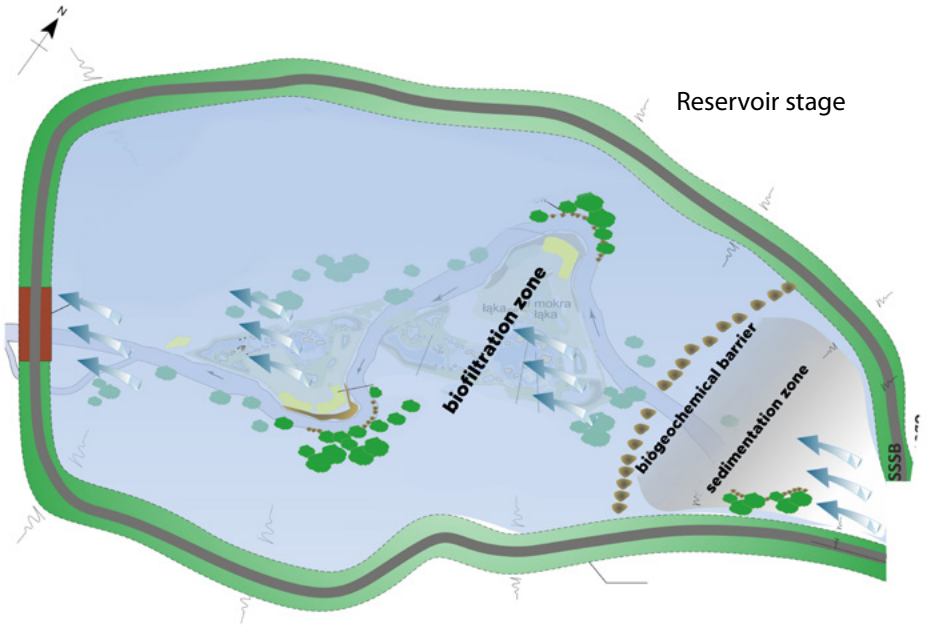
THE POTOK PÓŁNOCNY

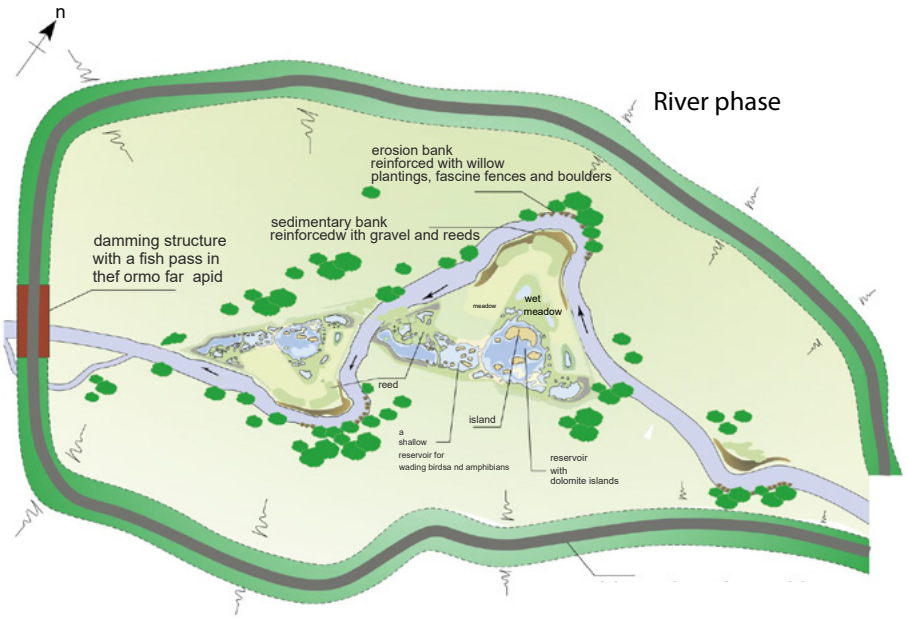
The Potok Północny is a **tributary of the Mleczna** flowing through the centre of Radom. In the upper section, rainwater from the airport in Sadków and a stream from allotments **are discharged to it**. The Potok Północny is characterised by relatively good water quality. However, the **planned expansion of the city** in the future may cause **an additional rainwater and pollution load** on it, which, especially with the expected increasing torrential rains, may be a problem for the surrounding settlements.

Framework concept:

In order to solve the challenges associated with the Potok Północny, it was initially planned to increase the retention capacity by building a retention reservoir. As a result of the analyses carried out in the project, it was proposed to replace the planned traditional engineering project by the so-called **"dry reservoir", which will fill up only during high flows**. Such a solution was to radically **increase the retention capacity** and prevent flooding, and additionally increase the biodiversity of the area.

View from the railway bridge in the eastern direction to the vast reeds and the Potok Północny stream (photo by Marek Miłkowski)





The concept of development of the Potok Północny valley area (University of Łódź)

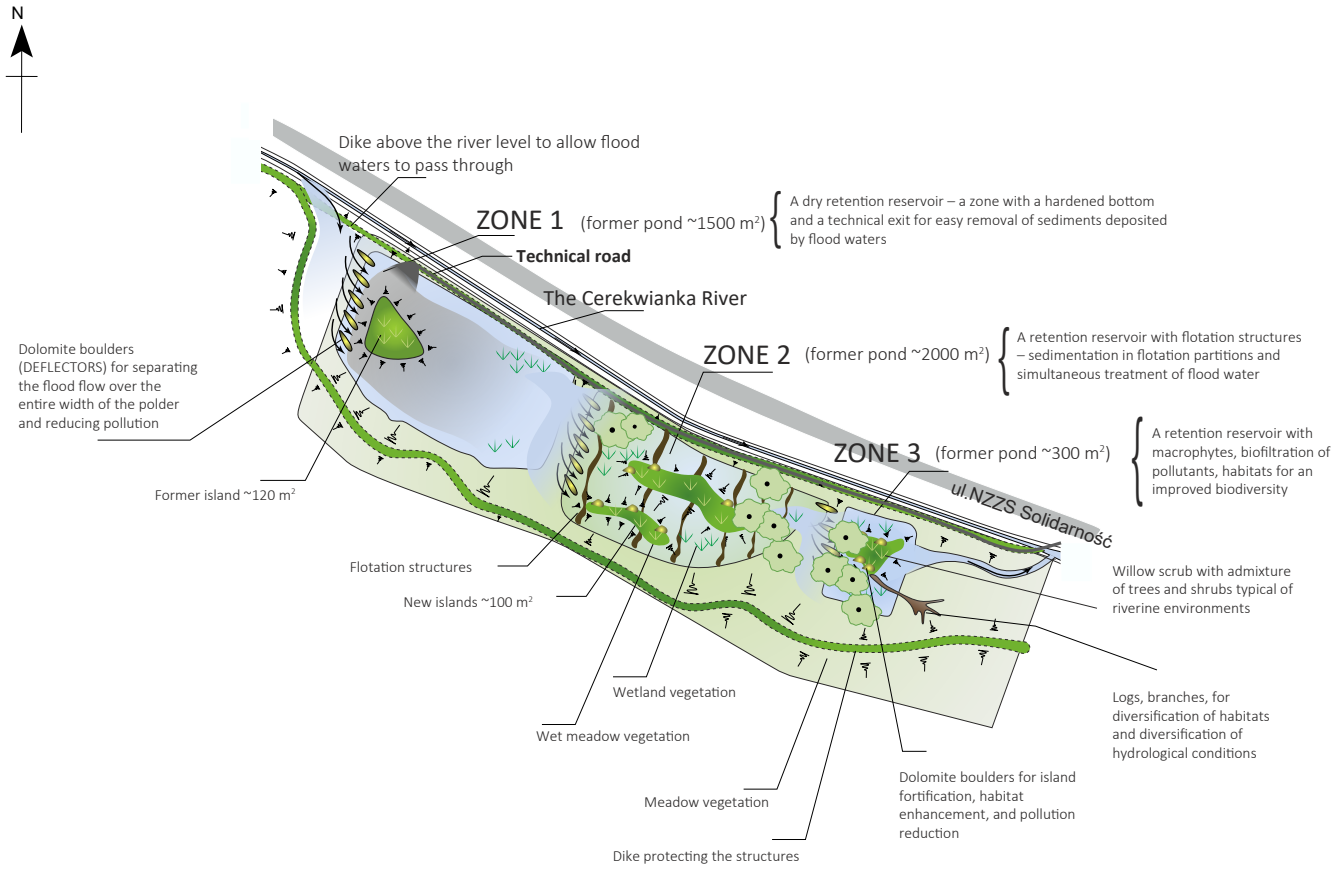
THE CEREKWIANKA

The Cerekwianka, also called Halinowski Stream, is a river flowing downstream of the Borki Reservoir into the Mleczna. It is a small watercourse, but an important ecological corridor, i.e. a route for the movement of animals as well as plant propagules. The Cerekwianka, **a tiny stream during dry spells**, has regularly caused local flooding and **flooded the nearby street** during the rainy season. Maratońska Street is one of the key access streets to the centre of Radom, which meant that after heavy rainfall, it was not possible to enter and exit the city centre.

Maratońska Street flooded by Cerekwianka (photo by Municipal Waterworks in Radom)

Framework concept:

Analysis of historical maps indicated that at the height of the observed floods, in the river valley, there were fish ponds. Their reconstruction and transformation into a **dry reservoir** was to become the basis for adaptation activities. **The new habitats** were to shelter many plants and animals and attract birds.



The concept of creating a floodplain polder on the Cerekwianka River (University of Łódź)

URBAN SPACE IN RADOM

In Radom, as in most cities in Poland, rainwater management was carried out on the basis of traditional management methods. **Over 90% of the city area is equipped with a rainwater drainage system** and it is the exclusive rainwater management tool. The rainwater drainage system drains rainwater from the city to the Mleczna, the Potok Północny and the Cerekwianka. Rainwater, before being introduced into the collectors, is pre-treated in sedimentation tanks of earth and reinforced concrete structure, and in lamella and coalescing separators. However, the **poor quality of river waters** and their **hydraulic overload** are a serious problem. In addition, the efficiency of the rainwater drainage system in changing climatic conditions decreases. Increasing rainfall causes its temporary overload resulting in flooding of the city.

Radom flooded after rainfall (photo by Municipality of the City of Radom)

Framework concept:

In the project, it was decided to look for a solution "at the source", i.e. through the **management of rainwater at the place of precipitation** (source control). Such a method allows to limit surface runoff and the amount of water flowing in a short time to the rainwater drainage system, which prevents it from **overloading and flooding**. It also reduces flooding from rivers by **reducing the hydraulic load** on the river from rainwater discharged into it. In addition, the water retained in the landscape **mitigates the effects of urban drought** during dry spells.

Danish solutions for water collection rainfall and support for biodiversity in the built-up spaces of the city, they were an inspiration for BZI solutions developed as part of the project (Photo by Amphi Consult)

STEP 7

Design and BGI implementation works

The need to ensure that adaptation measures are in line with the regulations in force in Poland for the implementation of investments.

The project implemented in Radom concerned adaptation to climate change through sustainable water management in urban space. The contract concluded with the European Commission and the National Fund for Environmental Protection and Water Management included tasks in the field of "adaptation measures", "renaturalisation", implementation of "blue-green infrastructure", concerning "increasing the retention capacity of river valleys" and mitigating extreme flows, while creating habitats to support biodiversity. The tasks included, but were not limited to: adaptation of the Borki Reservoir, adaptation of colmatation ponds, adaptation of the A0 channel, adaptation of the floodplain on the Potok Północny, adaptation of the area by the Cerekwianka into a floodplain polder, renaturalisation of the Mleczna, and construction of small BGI facilities in the urban space of Radom.

During the implementation of the Project, however, the adaptation of the scope and naming of the tasks agreed with the European Commission to the laws in force in Poland proved to be a major challenge. These regulations include:

- Act of 3 October 2008 on the provision of information on the environment and its protection, public participation in environmental protection and environmental impact assessments (environmental decision)
- Act of 20 July 2017 Water Law (Water Law permit)
- Act of 7 July 1994 Construction Law (construction permit)
- The Special Purpose Flood Act – Act of 8 July 2010 on special principles of preparation for the implementation of investments in flood control structures (permit for implementation

There is a different nomenclature in each of these laws, and the authorities processing the applications are very scrupulous in ensuring that the nomenclature used in the application is in accordance with the particular law. Terms such as "adaptation", "modernisation", "renaturalisation", "blue-green infrastructure" do not appear in any of them. Nevertheless, the activities so named in the LIFE project require administrative decisions based on the current Polish regulations.

..... GOOD PRACTICE .....

The need to adapt the nomenclature of adaptation measures to the current Polish regulations for the implementation of investments can be a challenge when obtaining administrative decisions. This may affect the long preparation time of the investment, which should be taken into account when planning its timing and costs.

The provisions of the aforementioned laws are as follows:

- Article 3(1)(13) of the Act of 3 October 2008 on the provision of information on the environment and its protection, public participation in environmental protection and environmental impact assessments defines "project" as follows: "it means a construction target or **other interference in the environment consisting in a transformation or change of the use of the land**, including the extraction of minerals; technologically related projects are qualified as one project, even if they are carried out by different entities." In the case of an application for an environmental decision, we can define a project as "adaptation, modernisation, renaturalisation."
- The next step after the environmental decision is to obtain a decision on the location of the public-purpose investment under the provisions of the Planning and Spatial Development Act. In general, the investments implemented as part of the Project should be qualified as public-purpose investments, as defined in the Real Estate Management Act (Article 6(4) of the aforementioned Act: construction and maintenance of facilities and equipment for environmental protection, reservoirs and other water facilities for water supply, flow regulation and flood protection, as well as regulation and maintenance of waters and water melioration facilities owned by the State Treasury or local government units). There is no requirement to obtain a decision when an investment is carried out under the Special Purpose Flood Act.
- Undoubtedly, all activities related to interference in the river channel require the application of the provisions of the Water Law Act, as Article 1 of this Act states that „the Act regulates the management of water in accordance with the principle of sustainable development, in particular the shaping and protection of water resources, the use of water and the management of water resources". Renaturalisation measures are part of the definition of river regulation set out in Article 236(2) „Regulation of waters consists in undertakings concerning the shaping of the longitudinal and transverse cross-section and the horizontal layout of the channel of a natural watercourse. Water regulation consists in particular of activities which do not constitute water maintenance activities" The provisions of Article 236 apply accordingly to the development of mountain streams, the shaping of new channels of natural watercourses. Thus, when applying for a Water Law permit, it is necessary to define the planned activities, in accordance with the provisions of the Act, as the construction of water facilities, because according to Article 16(65), water facilities are understood as devices or structures for shaping water resources or using these resources, including, inter alia, regulating structures. The construction of regulating structures requires a Water Law permit (Article 389(6) – construction of water facilities). In addition, other provisions of the Water Law Act apply, i.e. for instance, Article 389(8), according to which a change in the shape of the land on the grounds adjacent to the waters, affecting the water flow conditions, also requires a Water Law permit. Attention should also be drawn to the provisions of Article 220(13) and (14) of the Water Law, according to which, if the establishment of the shoreline is necessary in connection with the construction of water facilities or the shaping of new channels of natural watercourses, the proceedings on the establishment of the shoreline shall be carried out jointly with the proceedings on the Water Law permit, and the decision on the establishment of the shoreline shall cover the section and banks of the natural watercourse included in the inland water regulation project. In the event that the authority deems it advisable to apply the above provision, it should be borne in mind that the shoreline determination procedure is very lengthy. In such a case, in addition to the Water Law survey, it will be necessary to draw up specialised geodetic documentation – a project for the separation of land covered by water from adjacent land. An additional contradiction is the fact that one of the basic objectives in renaturalisation is to allow the river to meander freely and to allow lateral erosion associated with the movement of the riverbed, which contradicts the geodetic delimitation of its permanent course. Perhaps a good solution would be to geodetically delimit the extent of the valley instead of the channel, which in turn may be difficult in already built-up areas of the valley.
- The next step in preparing the tasks is to obtain a building permit under the provisions of the Building Law Act or a decision authorising the implementation of an investment in the field of flood control structures under the provisions of the Special Purpose Flood Act. If there is no need to acquire land for the intended measures and the investor has the right to dispose of the real estate for construction purposes, it is possible to apply for a building permit under the provisions of the Building Law.

..... GOOD PRACTICE .....

When defining the name of the measure in a project and then drafting the documents necessary to obtain administrative decisions, the applicable terminology in the acts should be taken into account. In the project schedule, it is necessary to indicate a sufficiently long time to obtain all decisions.

Environmental decisions

In our experience, it takes the longest to obtain a decision on environmental conditions for the implementation of the project, which is the first decision required under the administrative procedure. This is the case even if the project is not classified as a project that may always have a significant impact on the environment or a project that may potentially have a significant impact on the environment and is not implemented in a Natura 2000 area. Although in such cases no environmental impact assessment procedure is carried out and no report but only a Project Information Sheet is drawn up, the examination of the application by the authority, due to the need to carry out an environmental impact analysis, is lengthy and the application often needs to be supplemented.

..... GOOD PRACTICE .....

- *It is necessary to take into account the timing of decisions in the planned projects.*
- *The aim should be to ensure that investments do not have a significant negative impact on the environment, which should be the rule for adaptation measures.*
- *Adaptation activities are easier in more degraded areas (less environmentally valuable – which probably require the most adaptation activities).*
- *Taking into account that the Project implementation often takes place in environmentally valuable areas, it is advisable to monitor all environmental elements from the beginning of the Project implementation in order to be prepared to submit a comprehensive documentation with the application, without the need to supplement it, which may shorten the period for obtaining a decision.*

Acquisition of land and implementation of tasks under the Special Purpose Flood Act.

A major challenge when implementing tasks involving adaptation or renaturalisation is the issue of land ownership. It is advisable for the project to include funds for land purchase or compensation for land takeover in cases where the entity implementing the project does not own the land. In addition, when implementing tasks within flowing waters, the need to have the right to dispose of real estate owned by the State Treasury (land covered by water) should be taken into account. Certainly the concept of renaturalisation should be agreed with the relevant units of Wody Polskie (State Water Holding) exercising ownership rights to the waters and land covered by water, so that it does not turn out that in the area where the activities are planned, other plans of this body are foreseen. After obtaining a Water Law permit (from the competent Catchment Area Board if it is not an investment in the scope of flood control structures or from the Regional Water Management Board if you apply the Special Purpose Flood Act), it is necessary to conclude an agreement with the competent Director of the Regional Water Management Board on the use of land covered by water.

Where the implementation of a project requires the acquisition of land, a very common problem is that it is not possible to purchase the land in the form of a civil-law agreement due to the common problem of the lack of regulation of ownership issues. In such a case, a proven way (in the case of our project) is to carry out the investment on the basis of the provisions of the Act of 8 July 2010 on special principles of preparation for the implementation of investments in the field of flood control structures, the so-called Special Purpose Flood Act. They provide the possibility to take over land for compensation (also land with an unregulated legal status) and shorten the period for obtaining a decision, as a decision on the location of a public purpose investment and a decision permitting the felling of trees (if necessary for the implementation of the investment) are not required. Our project experience also shows that landowners are keen to dispose of their land, as it is located in the immediate vicinity of rivers, often in their valleys, and is frequently flooded, having no construction or market value. However, this implies the need to specify the intended adaptation measures, by definition understood as 'soft' BGI solutions, as specific flood control structures. In turn, it is necessary to identify specific flood control structures in the construction project, in accordance with the scope specified in the aforementioned Special Purpose Flood Act (Article 2(1)) and the Water Law (Article 16(1)). Most often this will be the construction of a floodplain polder, a flood control reservoir or the construction/implementation of regulating structures, i.e. structures shaping the longitudinal and transverse cross-section and the horizontal layout of a watercourse channel. Applicable regulations (technical conditions to be met by hydraulic engineering structures and their location, industry standards, etc.) cause designers to present very technical solutions that are not compatible and coherent with the objectives of the LIFE Project.

..... GOOD PRACTICE .....

Taking into account the legal considerations outlined above, it is advisable to select locations (river sections) where the land availability problem will be most limited. Of course, it would be best if the entity carrying out the renaturalisation or adaptation is the owner of the land on which it intends to carry it out. In order to ensure that the design solutions are as close to nature and as environmentally-friendly as possible, it is necessary for the designers to cooperate continuously with the project beneficiaries, naturalists and ecologists at each stage of the successive studies.

CO-DESIGN AND INTERDISCIPLINARY APPROACH

The project's offer was addressed to all residents of Radom as well as tourists choosing the city as their place of recreation. In terms of the implementation of climate change adaptation, the project was addressed to specific stakeholder groups, whose thinking and approach was to change by moving away from strictly technical solutions and recognising adaptation measures as a remedy to the existing and anticipated negative effects of extreme weather events. The target stakeholder groups here are: politicians, institutions planning and managing infrastructure (water, roads, housing), planners, developers, water engineers and other engineers developing technical projects, teachers educating the next generation in a spirit of respect for the environment and climate and with knowledge of the changes taking place. The involvement of the above groups is key to integrating climate change adaptation into decision-making processes, attitudes, investment plans and thinking among decision-makers and contractors as well as recipients of adaptation projects. Another key issue was the co-design of BGI solutions, which very often proved to be a challenging process, requiring the search for a common language between engineers and ecologists, designers and city representatives, as well as city representatives and residents. New methods of communication had to be developed, often compromises had to be made and, ultimately, the prepared implementation materials had to be adapted and processed in an inflexible legal order that does not take adaptation issues into account. In such complex projects, inter-sectoral cooperation from the very beginning of the project process is crucial to achieve satisfactory results and optimise task completion times.

..... GOOD PRACTICE .....

In complex projects concerning the adaptation of urban space to climate change, close inter-sectoral cooperation from the very beginning of the project process is crucial. It should include such stakeholder groups as: decision-makers, officials, ecologists and ecohydrologists, designers and engineers, institutions planning and managing urban infrastructure, institutions supervising and providing opinions on the investment process and environmental protection, as well as planners and landowners – developers, residents, housing associations. Such cooperation from an early, conceptual stage allows major conflicts to be avoided, compromises or new solutions to be worked out and project intentions to be achieved in a timely and satisfactory manner.

The LIFERADOMKLIMA-PL project placed great emphasis on including diverse stakeholder groups in the project. The project offered diverse activities aimed at specific groups and developed a wide range of ways to reach them. We estimate that several thousand people were covered by activities such as:

- regular cooperation in project development (NGOs and Working Groups)
- communications to citizens through the media (press, radio, television, website)
- workshops on climate change and its negative effects on stakeholders
- art competitions for Radom schools
- the Concert with the Climate performed by the Radom Chamber Orchestra
- opening of the first Climate Kindergarten in Radom and a Family Picnic
- public consultations connected with the implementation of BGI
- promotion of the project during each summer holiday weekend as part of the "Feel the Holiday Climate" sports events
- Family Picnic at the Borki Reservoir for climate protection enthusiasts (and not only)
- planting several hundred trees and shrubs in the city and placing them in the tree database on the Radom Tree website (drzewa.radom.pl).
- cooperation with the Mazovian District Chamber of Civil Engineers in Radom

IMPLEMENTATION OF ADAPTATION MEASURES

ZONE 1:
BLUE-GREEN INFRASTRUCTURE IN THE CITY'S CENTRAL AREAS

CLIMAPOND

What is CLIMAPOND?

Climapond is a small biological reservoir for rainwater, imitating a rural pond in urban conditions and specially adapted to them. Its design allows it to repeatedly receive large volumes of rainwater from paved surfaces, while maintaining the reservoir's natural values and improving water conditions in the surrounding area. The water flowing into the reservoir during the precipitation period gradually soaks into the ground during rain-free weather. Part of the water does not infiltrate and is retained in the reservoir, allowing aquatic species to survive during dry periods and providing water for the surrounding animals during high temperatures.

Innovation

- a solution that enables self-regulation of the intensity of incoming rainwater flow to the reservoir to protect its ecosystem from hydraulic stress during rainfall and preserve its habitat character
- maintaining a minimum water level in the reservoir during dry spells to protect the reservoir-dwelling species from water stress
- self-regulating retention volume

The innovation is protected by copyright – Patent No. PAT.233854 (System for the drainage, retention and infiltration of rainwater, as well as the drainage device and distribution gutter included in the system).

CLIMAPOND - PUBLIC KINDERGARTEN NO. 16

Adaptation challenges

- retention of water from the roof of the kindergarten at the place of precipitation
- creation of a biodiversity enclave to combat drought and high temperatures
- reduction of fees for rainwater drainage
- creation of an attractive space for climate education and relaxation for children

Adaptation solutions

The project involved the construction of a Climapond reservoir, landscaping facilities (a water pump and water playground) and a rain garden equipped with an emergency overflow to the rain water drainage system. The entire system captures rainwater from part of the roof of the kindergarten building, from an area of approx. 210 m^2. Water from the roof is discharged by means of roof drains, and then is led to the reservoir through an underground drainage system.

The reservoir has been designed in such a way that during precipitation it accumulates incoming water and gradually infiltrates it during the following days. After the water is released, the reservoir is ready to accept another portion of rain. Part of the reservoir is always filled with water, supporting plants and animals during drought. Excess water from the reservoir is discharged to the water playground and then to the basin with an emergency drain to the rainwater drainage system.

Native species of aquatic, swamp and meadow vegetation were planted on the slopes and steps of the reservoir, including: the fringed pink (Dianthus superbus), needle spikerush (Eleocharis acicularis), meadow geranium (Geranium pratense), mare's-tail (Hippuris vulgaris), yellow iris (Iris pseudacorus), common rush (Juncus effusus), sticky catchfly (Viscaria vulgaris), water mint (Mentha aquatica), water forget-me-not (Myosotis scorpioides), broadleaf arrowhead (Sagittaria latifolia), common water-plantain (Alisma plantago aquatica), greater pond sedge (Carex riparia) and others.

Effects of projects

- creation of an additional landscape retention site with a retention volume of approx. 4 m^3
- management of all water from the connected part of the roof (210 m^2) on the premises of the kindergarten (confirmed by monitoring results)
- creation of a new habitat (several species of aquatic plants and animals, watering place for birds, insects and small mammals, including hedgehogs) – confirmed by monitoring results. You can find here, among others, interesting beetles associated with dead wood, among others, the longhorn beetle(Leptura quadrifasciata), Uloma culinaris and Cerylon hysteroides. This is also where Spilomyia diophthalma was found, a hover fly listed on the Red List of Threatened and Declining Animals (category NT)
- the area around the reservoir is equipped with landscaping, making the pond more pleasant and providing climate education, and is partly developed by the children (e.g. wooden herb pots, wooden benches, animals made by the children out of painted stones)

Public Kindergarten No. 16, Grenadierów 3 St., Radom

Coordinates: 51,385882 N; 21,15051 E

Completed works:

- Climapond
- water playground
- infiltration basin with emergency connection to the drainage system

Before implementation

After implementation

CLIMAPOND - PUBLIC PRIMARY SCHOOL NR 11

Adaptation challenges

- retention of water from the roof of the school at the place of precipitation
- creation of an attractive leisure area for children, young people and school staff
- reduction of fees for rainwater drainage
- demonstration of adaptation solutions for climate education in school

Adaptation actions

The project involved the construction of the Climapond equipped with an emergency overflow to the rainwater drainage system connected to a landscaping facility – a wooden bench.

Two functional zones were separated in the reservoir: a shallower zone with rainwater infiltration with a depth of approx. 35 cm and a zone without rainwater infiltration with a depth of approx. 65 cm. The surface of the evaporation and filtration reservoir is approx. 29 m^2.

On the slopes and steps of the reservoir, native vegetation was planted, adapted to different humidity conditions and with different depths of immersion, including: common water-plantain (Alisma plantago aquatica), greater pond sedge (Carex riparia), needle spikerush (Eleocharis acicularis), fringed pink (Dianthus superbus) and others.

The area around the pond is secured by a fence.

Effects of projects

- management of all rainwater from the surface of approx. 290 m^2 of the roof (confirmed by monitoring results)
- additional water retention volume in the amount of approx. 11 m^3
- creation of a new habitat for vegetation with different moisture requirements
- colonisation of the reservoir by several insect species, including 6 species of dragonfly, e.g. the common winter damselfly (Sympecma fusca) and azure damselfly (Coenagrion puella) and a butterfly – the small china-mark (Cataclysta lemnata), whose larvae probably developed on the duckweed growing in the pond
- a watering place for 8 species of birds and small mammals
- recreation area for young people and school staff

Adam Jerzy Czartoryski Public Primary School No. 11

Gagarina 19 St., Radom

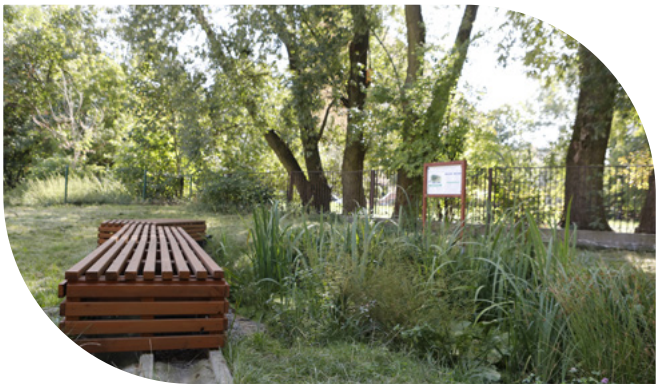
Coordinates: 51,383468 N; 21,155029 E

Completed works:

- Climapond
- landscaping – a bench connected to a water supply and emergency overflow system

Before implementation

After implementation



CLIMAPOND - PUBLIC KINDERGARTEN NO. 11

Adaptation challenges

- retention of water from the roof of the kindergarten at the place of precipitation, relief of the rainwater drainage system in the adjacent street and prevention of flooding
- rainwater retention on steep slopes
- creation of an educational space for children and building environmental awareness
- reduction of fees for rainwater drainage

Adaptation actions

The project involved the construction of a Climapond with a modified design, adapted to the steep slope of the terrain. The Climapond here took the form of a cascading rain garden. It is equipped with an emergency overflow that discharges any excess rainwater directly into the rainwater drainage system located in the adjacent street.

The system captures rainwater from the roof of the kindergarten building with an area of approx. 162 m^2 and the pavement area (approx. 33 m^2). The water from the roof is collected by means of gutters and then, via an open linear drainage system, discharged along the pavement into the rain garden.

The garden is divided into 3 sections and two functional zones:

- a marshy zone with a periodic water table of up to 6 cm (a zone without rainwater infiltration),
- a wet zone with a periodic water table of up to 32 cm (zone with rainwater infiltration),
- a rain garden with an area of 18.5 m^2.

The area around the cascade garden is secured by a fence.

Effects of projects

- management of all rainwater from the surface of approx. 195 m^2 of the roof (confirmed by monitoring results)
- creation of a habitat with plant species such as: the cyperus sedge (Carex pseudocyperus), water forget-me-not (Myosotis scorpioides), common water-plantain (Alisma plantago-aquatica), yellow iris (Iris pseudacorus), marsh cranesbill (Geranium palustre), broadleaf arrowhead (Sagittaria latifolia), mare's-tail (Hippuris vulgaris), creeping bentgrass (Agrostis stolonifera) and many others.
- colonisation of the rain garden by several species of animals, including 7 species of beetles
- climate education area for children from kindergarten

Public Kindergarten No. 11
Kościuszki 10 St., Radom

Coordinates: 51,395166 N; 21,150607 E

Completed works:

- Climapond with a rain garden in the form of a cascade
- emergency overflow to the drainage system

Before implementation

After implementation

CLIMABOX

What is CLIMABOX?

Climabox is a kind of rain garden in hydrophytic vegetation placed in a modular above-ground container. Unlike most rain gardens, Climabox containers use mostly typical aquatic plants. Thanks to this, the water capacity is larger than a typical rain garden and the collected water can be used for many purposes on the plot.

The Climabox is tight, so it can be placed directly against the wall of a building and can be made of a variety of materials. Therefore, it is an ideal solution where there are no conditions for other solutions, e.g. a Climapond. The Climabox offers retention of rainwater from roof surfaces, gives the opportunity to irrigate vegetation on the property during drought, is a place of rest for users of facilities and forms a local mini-ecosystem. Excess rainwater is discharged through the system into infiltration basins with vegetation or into emergency drains.

Innovation

- higher capacity compared to a traditional rain garden
- the possibility of using the collected water for technical works and irrigation of greenery around Climaboxes
- possibility to integrate with other BGI solutions

CLIMABOX – ABOVE-GROUND RAIN GARDEN IN A CONCRETE CONTAINER

Adaptation challenges

- retention of rainwater in a very tightly sealed area, with a dense underground infrastructure and located significantly below the surrounding green areas
- providing water for irrigation of the greenery of the facility and reducing the related costs
- creation of a friendly space for a social group particularly sensitive to climate change – children under 5 years of age

Adaptation solutions

The project involved the construction of a Climabox that also functions as a bench at a public kindergarten. The reservoir captures rainfall from part of the roof of the kindergarten building with an area of approximately 83 m^2. The water from the roof is collected by means of gutters and then discharged directly into the rain garden by means of a roof drain.

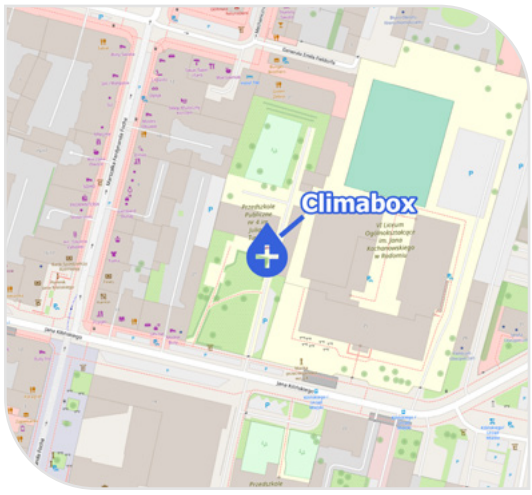
The garden is divided into 3 parts:

- a rectangular reservoir with substrate and plantings of meadow plants and wetland ecosystems
- a rectangular reservoir filled only with water, with plantings of hydrophilic plants
- an L-shaped reservoir, partially closed, with the function of a bench and a wing pump

Some of the plantings for the reservoir include: the purple loosestrife (Lythrum salicaria), yellow iris (Iris pseudacorus), flowering rush (Butomus umbellatus), and lesser bulrush (Typha angustifolia)

Effects of projects

- creation of a retention capacity with a total volume of 1.6 m^3
- management of most or all of the rainwater from the drained facility, assuming its regular use in dry periods for watering the greenery
- a watering place for birds and a habitat of more than 10 insect species
- improving the aesthetics of the place
- climate education area for children



Julian Tuwim Public Kindergarten No. 4
Kilińskiego 23 St., Radom

Coordinates: 51,402567 N; 21,155408 E

Completed works:

- Climabox
- emergency overflow to the drainage system
- landscaping – a bench and a pump

Before implementation

After implementation

CLIMABOX – ABOVE-GROUND RAIN GARDEN IN A METAL AND WOOD CONTAINER

Adaptation challenges

- limiting the amount of water discharged into the rainwater drainage system
- providing water for irrigation of the greenery of the facility
- creation of a friendly space for a social group particularly sensitive to climate change – people over 65 years of age
- creating an educational space for high school youth

Adaptation solutions

In each of the two locations, two Climabox reservoirs with water vegetation were made in a steel and wooden structure. The water from the roofs is collected by means of gutters and then brought to the first module of the reservoir by means of a roof drain. The water from the first module is cascaded to subsequent modules where aquatic plants are planted. Excess rainwater is discharged in two ways – in the case of location 1, to the rainwater drainage system, and in the case of location 2, to the adjacent green area.

Pots in a steel and wooden structure have been divided into functional zones with a decreasing height of the structure. The first collects water for its later use, the second is covered with high water vegetation planted in the substrate layer, and the third one with floating vegetation islands.

Effects of projects

- management of all rainwater from the drained facility in the green area
- creation of a mini-habitat for aquatic plants in the city centre – the vegetation used includes, among others: the lakeshore bulrush (Scirpus lacustris), yellow iris (Iris pseudacorus), flowering rush (Butomus umbellatus), four-leaf clover (Marsilea quadrifolia), bogbean (Menyanthes trifoliata) and others
- watering place for birds and insects
- improving the aesthetics
- area of climate education for young people and a place of rest for the elderly

Stanisław Staszic Secondary School No. XI with Integrated Classes
11 Listopada 27 St., Radom

Coordinates: 51,415293 N; 21,157794 E

Completed works:

- two metal and wood Climabox reservoirs with infiltration basins

Before implementation

After implementation

Nad Potokiem Residential Care Home
of Bohdana "Danuta" Kijewska
Struga 88 St., Radom

Coordinates: 51,409781 N; 21,181162 E

Completed works:

- two metal and wood Climabox reservoirs with infiltration basin

Before implementation

After implementation

CLIMABOX – ABOVE-GROUND RAIN GARDEN IN A BRICK CONTAINER

Adaptation challenges

- increasing the retention potential of a large area of greenery and its irrigation
- creation of a friendly space for a social group particularly sensitive to climate change – people over 65 years of age
- watering place for birds and insects
- limiting the amount of water discharged into the rainwater drainage system

Adaptation solutions

The project involved the construction of a brick Climabox with aquatic vegetation of various habitats. The pots have a total area of about 5 m^2. They were divided into three functional zones with a decreasing height of the structure. The first and third zones allow for the maintenance of floating islands, and the second, intermediate one, for the maintenance of high aquatic vegetation growing in the substrate layer. The excess water is discharged back into the drain pipe.

Effects of projects

- management of all rainwater from the drained facility in the green area,
- creation of a mini-habitat for aquatic plants in the city centre: the water mint (Mentha aquatica), water forget-me-not (Mosotis palustris), water violet (Hottonia palustris), yellow iris (Iris pseudacorus) and others
- improving the aesthetics of the place

"Weterana Walki i Pracy" Nursing Home
Wyścigowa 16 St., Radom

Coordinates: 51,376003 N; 21,159374 E

Completed works:

- two brick Climabox reservoirs with infiltration basins

Before implementation

After implementation

TREE TRENCH

What is a TREE TRENCH?

A tree trench is a tree-covered infiltration basin equipped with an innovative subsurface water distribution and tree irrigation system, enabling trees to grow in low-infiltration areas. The tree basin is a solution that works well in built-up areas or with low-permeable soils, where trees can take up and evaporate water directly from adapted underground retention systems. In each of these cases, the tree lane is connected by a coherent underground retention, infiltration or retention-infiltration system, allowing stored water to flow between the plants. In the event of heavy rainfall, excess rainwater can be captured by the drainage system.

Innovation

- improved tree growth in areas with low water infiltration
- solution made using almost exclusively natural elements (minimal use of synthetic materials)

NIECKA DRZEWNA - PUBLIC PRIMARY SCHOOL NO. 33

Public Primary School No. 33 of Kawalerowie Orderu Uśmiechu, Kolberga 5 St., Radom

Coordinates: 51,400833 N; 21,171862 E

Completed works:

- tree basin
- dry streams
- landscaping

Before implementation

After implementation

Adaptation challenges

- improving the microclimate in the inner courtyard of the primary school – high temperatures and sunshine prevent students from using the green area at the school on hot days
- increasing infiltration in impermeable terrain – trees wither due to water conditions (impermeable soil) or grow very slowly
- limiting the amount of water discharged into the rainwater drainage system
- creating a friendly educational space for youth

Adaptation actions

In the inner courtyard of the school, an infiltration basin was made along with an innovative irrigation system for the lane of 5 trees, collecting rainwater from the roof of the gymnasium and the school. The water from the roof is fed to the basin by roof drains and further by dry streams. A lane of five trees of native species was planted in the basin of ca. 40 m^2, which can receive nearly 8 m^3 of water at one time. The remaining surface of the slopes is occupied by densely planted additional vegetation. Among the plants planted here are: the sticky catchfly (Viscaria vulgaris), spiked speedwell (Veronica Spicata), bugle (Ajuga reptans) wavy hair-grass (Deschampsia flexuos), lesser periwinkle (Vinca minor) and others. The challenge was to adapt the appropriate vegetation, which was subjected to desiccation most of the time.

The land depression has been fitted with an emergency overflow with discharge to the rainwater drainage system. Nine benches were installed near the basin in a way enabling conducting outdoor classes on climate change.

Effects of projects

- management of all rainwater from the surface of 290 m^2 of the school roof
- effective irrigation of trees on terrain unsuitable for tree growth
- improving the microclimate in the school yard
- habitat of several animal species, including 10 species of insects
- creating an educational space in the open air and improving the aesthetics of the place

BLUE-GREEN BUS STOPS AND CYCLE SHELTERS

What is a BLUE-GREEN STOP?

A blue-green bus stop is an innovative and multifunctional piece of urban architecture. In addition to its traditional function of providing shelter for passengers, it retains rainwater and provides additional green space for people and nature. Rainfall is retained in several ways: by a vegetated green roof with a retention layer, in a retention-infiltration box with climbing plants that collects excess water from the roof and (optionally) from surrounding sealed surfaces, and by directing excess water from the retention-infiltration box to a nearby green area, a tree basin, other BGI elements or a rainwater drainage system. The green stop supports biodiversity, being a shelter for insects and birds. Its design reduces collisions between animals and glass compared to traditional designs.

Innovation

- innovative design of the stop, adapted to the increased load and compliant with EU standards
- green roof, including drainage layers, adapted to the sloping shape of the roof and the construction requirements of the shelter
- walls covered with evergreen or flowering vines, growing in a retention-infiltration box, providing vegetation with access to water and protection against frost

Adaptacja do zmian klimatu poprzez zrównoważoną gospodarkę wodą w przestrzeni miejskiej Radomia

RadoKlima (LIFE 14CCA/PL/000101)

projekt współfinansowany przez Unię Europejską w ramach Instrumentu Finansowego LIFE
oraz Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej w Warszawie

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ZATRZYMUJĄCY WODĘ OPADOWĄ

- Pierwszy zielony przystanek zatrzymujący wodę opadową w Polsce
- Zieleń na dachu i ścianie odporna na zmieniający się klimat miejski
- Innowacyjny produkt zgodny z wytycznymi adaptacji miast do zmian klimatu

INNOWACYJNA KONSTRUKCJA
zgodna z normami EU

- oryginalny, innowacyjny projekt (przechwytywanie i przepływ wody opadowej pomiędzy elementami wiaty)
- wzmocnienia podpór dachowych (pozwalają na bezpieczną instalację dociążonej zieleni)

10m² ROŚLINNEGO DACHU
z rozchodników i ziół

- zatrzymuje jednorazowo do 180 l deszczu (zapobiega miejscowym podtopieniom)
- odparowuje 99% opadu w ciągu roku (poprawia wilgotność i jakość powietrza, korzystny dla osób z chorobami układu oddechowego, osób starszych i dzieci)
- obniża temperaturę dachu nawet o 7°C w upalny dzień (zmniejsza narażenie na skutki upałów latem)
- tworzy miejsce przyjazne pożytecznym owadom i ptakom (poprawia bioróżnorodność)
- zmniejsza ilość pyłów zawieszonych i innych zanieczyszczeń (wpływa pozytywnie na zdrowie)
- 1 m² dachu produkuje nawet 1 kg czystego tlenu na rok

9m² ROŚLINNEJ ŚCIANY
z zimozielonych pnączy

- zatrzymuje 70 l wody spływającej z chodników (zapobiega miejscowym podtopieniom)
- odparowuje zatrzymaną wodę opadową (poprawia wilgotność i jakość powietrza)
- zacienia przystanek w upalne dni i obniża temperaturę dzięki parowaniu roślin (łagodzi mikroklimat, poprawia samopoczucie, korzystny dla osób z chorobami układu krążenia, osób starszych i dzieci)
- bezpieczniejszy dla ptaków (rozdzielone elementy ograniczają liczbę kolizji ze szklaną ścianą)

SYSTEM NAWADNIANIA DRZEW
wodą opadową

- zatrzymuje 470 l wody opadowej z przystanku i z uszczelnionych powierzchni (zapobiega miejscowym podtopieniom)
- odparowuje wodę opadową zebraną z 40m² przyległych chodników (poprawia wilgotność i jakość powietrza)
- zapewnia wodę niezbędną dla prawidłowego rozwoju drzewa nawet do 2 tygodni (poprawia kondycję drzewa i zmniejsza koszty utrzymania)

KORZYŚCI Z ZIELONEGO DACHU RETENCYJNEGO: niebieski - Zatrzymywanie wody opadowej | pomarańczowy - Łagodzenie wysokich temperatur | zielony - Więcej zieleni i poprawa bioróżnorodności | szary - Poprawa jakości powietrza

PARTNERZY PROJEKTU: Radom siła w precyzji; wodociągi miejskie; Uniwersytet Łódzki; FPP ENVIRO

WSPÓŁPRACA: mzdik Miejski Zarząd Dróg i Komunikacji

BLUE-GREEN BUS STOPS - JAGIELLONIAN SQUARE

Jagiellonian Square (opposite Galeria Słoneczna), Radom

Coordinates: 51,404762 N; 21,154475 E

Completed BGI

- blue-green bus stop shelter with a rain garden
- blue-green bus stop shelter with a tree basin

Green bus stop shelter with a tree trench

Green bus stop shelter with a rain garden

Adaptation challenges

- improved comfort for waiting passengers
- capturing rainwater in a tightly built-up road lane
- creation of a micro-habitat in a terrain with a high degree of urbanisation
- ecological education and raising climate awareness among residents using interchanges in the most frequented transport hub of Radom

Adaptation project

Two blue-green bus stops were placed at Jagiellonian Square in Radom The most attractive part of the stop is the green roof equipped with a rainwater retention system. In total, it introduces into the road lane space about 10 m^2 of greenery – a mixture of stonecrops (Sedum sp.). The roof structure has been designed to retain up to 90% of the rainwater falling on it annually. It irrigates the roof and vegetation planted around the shelter structure.

Behind the shelter, an underground retention-infiltration box was made, enabling planting of green wall plants (vines) and accompanying plants. A system of drainage of the pot behind the shelter was provided in the form of an emergency overflow to the adjacent green area and to the tree basin. The shelters are equipped with standard elements of a bus stop shelter, such as: a wooden bench, a backlit display case for timetables and an information sign. An important element is the placement in the display case of an information poster explaining how the blue-green stops work.

Effects of projects

- introduction of greenery in road lanes and public transport waiting areas – over 10 m^2 of the plant roof and 9 m^2 of the plant wall made of vines
- reducing the temperature of the roof in high sunlight by up to 7°C
- retained approx. 90% of the precipitation from the roof surface and part of the precipitation from the adjacent sealed areas
- creation of a habitat for insects (flowering vegetation of roofs attracts pollinators) and birds (nesting of blackbirds in the ivy of one of the shelters has been found),
- reducing the risk of bird-window collisions (green wall)
- ecological education and strengthening knowledge about adaptation among the inhabitants of Radom


RESERVED


ZIELONY PRZYSTANEK
ZATRZYMUJĄCY WODĘ OPADOWĄ


RESERVED


vue
ZARA
COSTA
COFFEE

BLUE-GREEN CYCLE SHELTER – RADOM SPORTS CENTRE (RCS)

RCS (Radom Sports Centre)
Struga 63 St., Radom

Coordinates: 51,408593 N; 21,172324 E

Completed BGI

- blue-green cycle shelter
- pots with the possibility of planting climbing and low vegetation

Before implementation

After implementation

Adaptation challenges and implementation outcomes

- capturing part of the rainwater in the tightly built-up area of a new investment
- creation of a micro-habitat for insects in a terrain with a high degree of urbanisation
- ecological education and raising climate awareness among numerous residents visiting the Radom Sports Centre

BLUE-GREEN CYCLE SHELTER – PRIMARY SCHOOL NO. 33

Public Primary School No. 33 of Kawalerowie Orderu Uśmiechu
Kolberga 5 St., Radom

Coordinates: 51,400833 N; 21,171862 E

Completed BGI

- green cycle shelter with pots for low and climbing plants

Adaptation challenges and implementation outcomes

- capturing part of the rainwater in a concreted space on the school premises
- ecological education and raising climate awareness among students
- creation of a micro-habitat in a heavily built-up area
- interesting architectural element

REVITALISATION OF PUBLIC SPACE - BEMA SQUARE

Square between Bema, Jasińskiego and Sowińskiego streets, Radom

Coordinates: 51,411606 N; 21,163705 E

Completed BGI

- infiltration basin with three retention areas

Before implementation

After implementation

Adaptation challenges

- management of rainwater from the paths of the newly created playground

Adaptation actions

The infiltration basin was constructed within a larger project to develop the space between the blocks of flats by building a leisure square. The infiltration basin takes the form of three ground depressions capturing excess water during periods of high precipitation. The zones were separated by an installation of gabions filled with hydrotechnical stones.

Implementation outcomes

- capturing part of the rainwater in the area of 5,137 m^2 of the newly created playground area
- retention volume of more than 37 m^3 of rainwater
- home to dozens of animal species, including more than 20 insect species; an attractive site for bumblebees, for which the area's habitat attractiveness has been increased through the construction of 'insect hotels'
- landscape element attractive to children and young people
- ecological education and raising climate awareness among site visitors

IMPLEMENTATION OF ADAPTATION MEASURES

ZONE 2

BLUE-GREEN INFRASTRUCTURE IN URBAN RIVER VALLEYS ON THE OUTSKIRTS OF THE CITY

MLECZNA RIVER - RESTORATION

**Radom, the Mleczna River,
along the boulevards and Garbarska Street**

Coordinates: 51,399094 N; 21,124761 E

Before implementation

After implementation

Adaptation challenges

- low retention capacity resulting from cutting off the valley from the river
- too fast drainage of rainwater through the channel of the Mleczna which has been regulated (straightened) on this section, leading to flooding in the areas downstream
- risk of flooding from the river as a result of narrowing the channel and partitioning of limited water capacity by numerous structures
- low ecological status resulting from the degradation of the nature of the channel

Scope of implementation

In order to improve protection from flooding caused by the waters of the Mleczna, the channel and valley retention resulting from the regulation of the watercourse has been increased. On an 800 m section, deflectors slowing down the flow of water were made. Ramps and stone and gravel backfills were made to raise the bottom of the river bed and increase channel and landscape retention. The system of meanders connected to the ponds and the high-water channel was restored. The ponds were supposed to imitate oxbows, which became a refugium for fish during a period of high water flows. In addition, they also slowed down the outflow of water, increased its retention and infiltration.

The investment involved:

- formation of 4 water-logging and retention bays connected to the riverbed
- restoring the course of the river to a more natural state by making 7 meanders and backfilling straight sections
- the formation of a high-water channel between water-logging and retention bays and the riverbed with a length of 205 m
- strengthening fragments (bends) of the new river bed with a rip-rap in fascines in the slope foot, in places exposed to increased speeds at high flows
- execution of 11 rapids – deflectors, causing intra-corridor meandering, in the form of a loose stone rip-rap and individual boulders and tree stumps embedded in it
- construction of a wooden observation deck for educational and promotional purposes and operational inspections
- reconstruction of the outlet section of the rainwater drainage system discharging water into the Mleczna by changing the outlet from the one discharging directly to the river to an indirect outlet distributing water before it enters the river for shallowing on an area of 75 m^2

Benefits

- the meandering of the river and its connection to the valley has resulted in a slowing down of the flow in the channel of the Mleczna in the renaturalised section and in an increase in the level of the water table at medium and low flows, which means an increase in channel and valley retention and a reduction in the risk of uncontrolled flooding of waters on built-up areas
- the chemical parameters determining the water quality have been improved. Average concentrations of total suspended solids, ammoniacal nitrogen and total phosphorus at the site upstream of the renaturalised river section were lower in the period 2021/2022, which may be a result of the implementation of effective solutions in the upper part of the catchment, i.e. at the Borki Reservoir, colmatation ponds and the Cerekwianka River. The introduction of solutions slowing down the water flow and forcing a change in the character of the flow from straight to winding, resulted in a noticeable decrease in the amount of transported suspended solids in water by about 15% and in the concentration of total nitrogen by about 30% during rainy periods
- there was a restoration of degraded natural and semi-natural hydrogenic habitats, including degraded riparian communities, wet meadows and reeds in an area of approx. 1 ha

The most valuable species of the analysed area – weatherfish (Misgurnus fossilis) – was found in the water-logging bays (photo by Marek Miłkowski)

Gravel piles raise the level of water in the channel, slowing its outflow and improving the quality (photo by Project Archive)

- habitat quality was improved for bird species, amphibians, invertebrates and other groups, including species from Annex I of the Bird Directive occurring in the urban Mleczna River valley: western marsh harrier (Circus aeruginosus) and corn crake (Crex crex)
- thanks to the restoration of meanders and the creation of areas of stagnant water, conditions for the existence of several species of dragonflies have been created, including those not previously found in this site: red-eyed damselfly (Erythromma najas), common winter damselfly (Sympecma fusca) and scarce blue-tailed damselfly (Ischnura pumilio) – a dragonfly not yet found in the Radom reservoirs
- the revitalisation carried out with the use of deflectors in the form of transverse barriers resembling natural barriers has influenced the diversity of habitats and the abundance of fish inhabiting the revitalised section of the watercourse covered by the project. In the section with deflectors, three specimens of the rarest ide (Leuciscus idus) were recorded, while the other species were not only present in numbers of at least a few specimens, but were also caught more than once. On the control section of this river, where no solutions were implemented, not a single individual of the pike (Esox lucius) or the common bream (Abramis brama) was found and the number of chubs (Squalius cephalus) accounted for only about 30% of the individuals caught in the section with deflectors
- on the other hand, in the ponds, despite the relatively small numbers of fish, a larger number of species were found, including the most valuable species of the analysed area – the weatherfish (Misgurnus fossilis). It is the only site of some lymnophilic species, such as the common rudd (Scardinius erythrophthalmus). The largest specimens of the pike (Esox lucius) were found in the water-logging bays, which also indicates that this type of habitat enhanced the "habitat offer" within the revitalised section of the river and the changes resulting from the project can be seen as definitely positive
- a hydrological model of the Mleczna catchment was developed, which was used to develop concepts and projects related to the adaptation of existing infrastructure, and after their implementation, to assess the effectiveness of the actions taken. A database on the quality of the river environment and a report on monitoring the physico-chemical properties of water and assessing the effectiveness of completed tasks were also developed.

BORKI RESERVOIR, A0 CANAL, COLMATATION PONDS

Radom, Borki District

(1) Canal A0

Coordinates:
51,384552 N; 21,117332 E

(2) Colmatation ponds

Coordinates:
51,386794 N; 21,116786 E

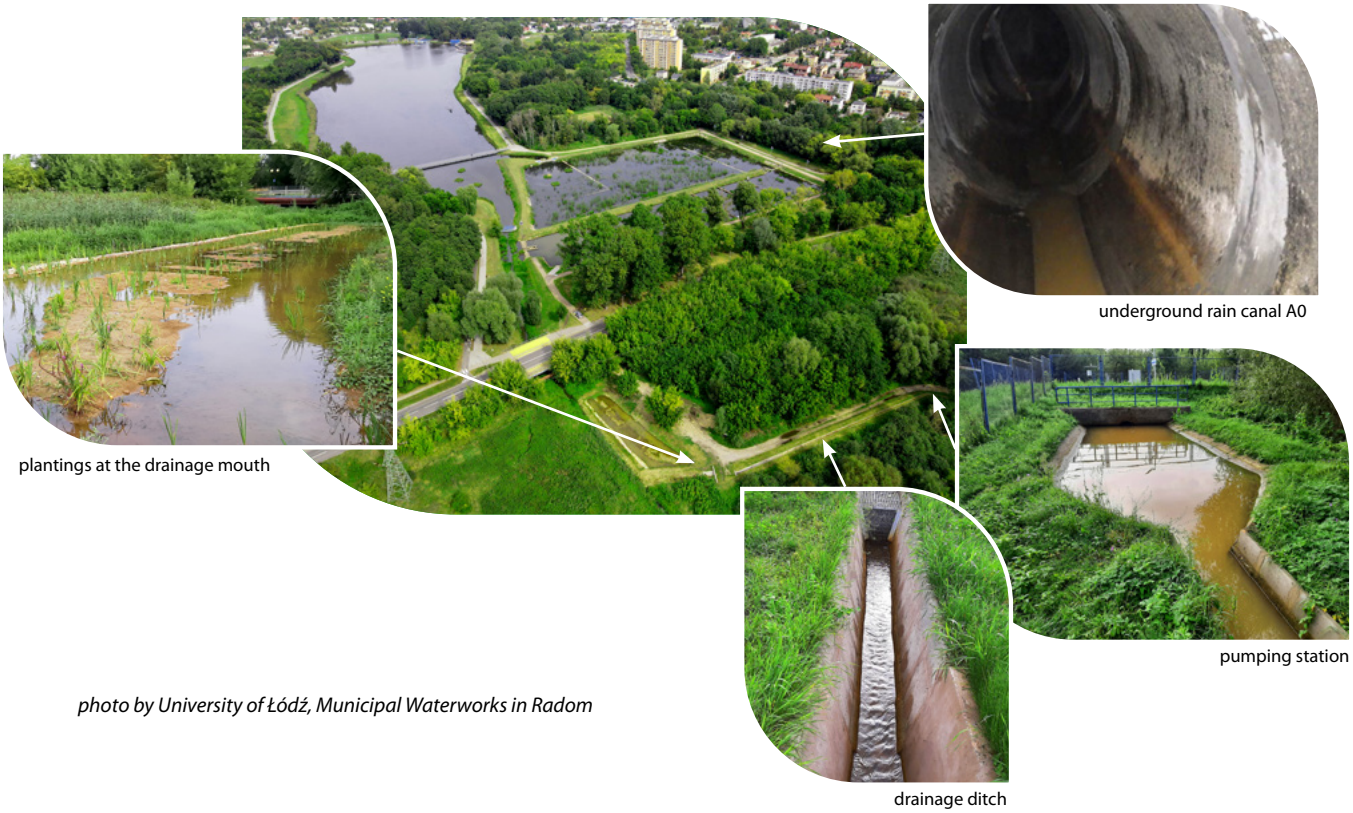
((3) Borki Reservoir:

Coordinates:
51,390959 N; 21,115463 E

The implementation of measures related to the Borki Reservoir was the most complex undertaking of the LIFERADOMKLIMA-PL project. It consisted of three major project tasks:

ADAPTATION MEASURES ON THE BORKI RESERVOIR

CANAL A0	(1) COLMATATION PONDS	BORKI RESERVOIR
improvement of the quality of water suppling the reservoir and water supply during drought	improvement of the quality of water flowing into the reservoir via the Mleczna river during rainfall	improvement of the capacity and flood protection efficiency of the Borki reservoir



underground rain canal A0

plantings at the drainage mouth

pumping station

drainage ditch

photo by University of Łódź, Municipal Waterworks in Radom

CANAL A0 – IMPROVING THE QUALITY OF WATER SUPPLY TO THE BORKI RESERVOIR AND REPLENISHMENT DURING THE DROUGHT

Adaptation challenge

- reduction of water flow in the A0 canal in the dry season and improvement of its quality
- improvement of the quality of water entering the Borki Reservoir to reduce cyanobacterial blooms and improve the ecological safety of people using the Borki Reservoir
- mitigation of low water levels in the Borki Reservoir

Scope of implementation

Sealing the A0 underground collector – a system that transports rainwater to the Mleczna – was crucial to prevent groundwater contaminated with iron compounds from entering the collector. The high concentration of iron causes brown colouration of water and soil unfavorable after the introduction of rainwater from the canal into surface waters. Originally located along the reservoir, the A0 canal discharged water into the river below the Borki Reservoir, which additionally burdened it and increased the flood risk. As part of the project, the existing system was adopted to capture rainwater from the A0 underground collector and, after its pre-treatment, discharge it into the Mleczna upstream of the reservoir, as an adaptive measure to mitigate the effects of low water levels. This ensured the replenishment of the water in the reservoir, especially in periods when the water loss in the reservoir (evaporation, infiltration, runoff) exceeded its supply.

Water is discharged from the A0 canal with a drainage ditch to the Mleczna upstream of the Borki Reservoir. For its pre-treatment, a hybrid system consisting of underground and above-ground parts was made. The underground part includes the water intake system from the A0 underground canal together with a centrifugal sedimentation tank and a pumping station. The above-ground part is the Sequential Sedimentation-Biofiltration System (SSSB), starting with a sedimentation tank located at the point of water outlet to the surface, of the system with three permeable reactive barriers (PRB) made of dolomite, limestone (stone rip-rap), the **BioKer** preparation and the vegetation zone on the outflow acting as a biofilter. The PRB system was placed in an existing concrete bed with a length of 112 m, which was previously a water drainage ditch from the rainwater canal. The last element is a biofilter built on a sandy substrate with a vegetation zone with an area of approx. 600 m^2. The discharge to the Mleczna takes place on the surface through the entire length of the side slope of the biofilter, lined with dolomite stones.

BIOKER is a lightweight ceramic aggregate coated with a multilayer biopolymer, a sorbent placed in mesh baskets on the water outflow. Thanks to the properties of the biopolymer, it is possible to coat the light ceramic core with materials with high sorption efficiency. This allows you to obtain a lightweight product with the ability to remove impurities from water. The research carried out at the UNESCO Chair of Ecohydrology and Applied Ecology of the University of Łódź confirmed the high effectiveness of BIOKER against phosphate ions, which are among the main causes of eutrophication of inland waters. In addition, the possibility of using a biocarbon-modified preparation to remove pesticide contaminants was tested, also with a positive outcome. The wide range of possibilities associated with the use of this preparation for water purification contributed to its commercialisation. Since 2018, cooperation has been established with APRS sp. z o. o., which offers BIOKER on the market in Poland. The preparation is covered by patent protection, patent No. Pat.238640 (Jarosiewicz and Zalewski, 2021).

The investment involved:

- sealing of the underground A0 canal along a section of approx. 700 m, allowing for capturing rainwater transported by the A0 collector and replenishing water resources in the Borki Reservoir during dry periods
- adaptation of the pumping station and rainwater supply system of the Mleczna waters upstream of the Borki Reservoir, originating from the A0 underground rainwater collector
- changing the function of the existing rainwater drainage ditch from the A0 canal pumping station to a filtration system constituting a sequential sedimentation and biofiltration system, enabling water purification using an innovative system of permeable reactive barriers (PRB) for the pre-treatment of water obtained from the A0 canal, which are used to increase the flow in the Mleczna on the section feeding the Borki Reservoir

- the construction of a plant biofiltration zone (the use of phytoremediation processes in improving water quality) with an area of approx. 300 m^2, built on a sandy substrate and located on the final fragment of the drainage ditch, together with the surface overflow of water into the river along the entire length of the side slope of the biofilter, additionally lined with dolomite stones.

Benefits:

- reduction of water flow in the A0 canal during the dry period by 50%
- improvement of the quality of water entering the Borki Reservoir by a sequential sedimentation and biofiltration system constructed on the drainage ditch from the A0 canal in the range from 28% for nitrates to 85% for ammonium ions, including phosphates by 64%
- in 2016, the average concentration of iron between the site located at the beginning and end of the then planned A0 canal section to be sealed doubled (from 2.8 mg/L to 5.6 mg/L). Sealing the canal at a distance of about 700 meters and limiting the infiltration of groundwater rich in iron compounds caused that, after the adaptation, this increase was only 11% (from 3.1 mg/L to 3.4 mg/L)
- the PRB system used reduces about 1/3 of the load of phosphates transported from the A0 canal. Along with the biofiltration part, the system removes in total almost 70% of phosphates. The achieved efficiency of the system in reducing nitrate ions and ammonium ions was 11% and 33%, respectively, and should increase further with the development of the biofiltration zone and biofilm inside the barriers

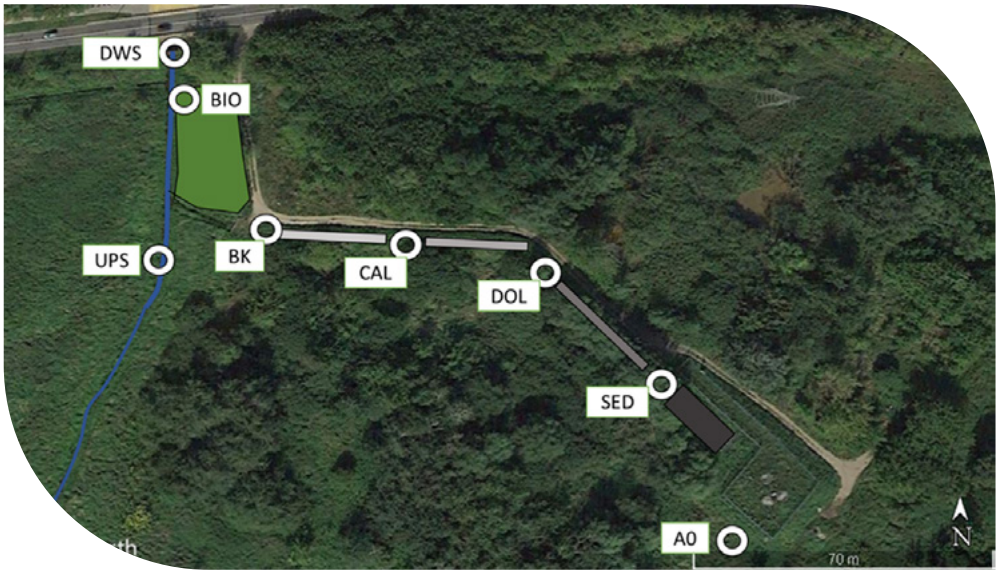


Diagram *of the system for purification of water from the A0 collector before their introduction into the Mleczna and further into the Borki Reservoir; abbreviations: SED – sedimentation part of the system, DOL – dolomite filling of the drainage ditch, CAL – limestone filling of the drainage ditch, BK – Bioker filling of the drainage ditch, BIO – vegetation zone (biofilter), UPS – river station above the water outlet from the pre-treatment system, DWS – station below the water outlet from the pre-treatment system.*

After sealing the A0 underground canal, much less contaminated water enters it (photo on the left – before, photo on the right after modernisation) (photo by Municipal Waterworks in Radom).

COLMATATION PONDS – IMPROVING THE QUALITY OF WATER FLOWING INTO THE RESERVOIR FROM THE MLECZNA DURING RAINFALL

Adaptation challenge

- reduction of nitrogen and phosphorus loads causing the formation of cyanobacteria in the Borki Reservoir
- reduction of flood risk
- preservation of habitats for organisms living in the colmatation ponds

Scope of implementation

The reconstruction of the colmatation ponds located just above the Borki Reservoir on the tributary of the Mleczna was intended to mitigate the river high-water stages and the purification of water introduced from the river into the reservoir at high flows. For this purpose, nature-based solutions were used, which include: sedimentation of the suspension transported by the river thanks to the construction of a special settlement zone at the point of inflow of the Mleczna waters to the reservoir and extension of the water flow path in the upper colmatation pond; strengthening of filtration and adsorption processes through the use of dolomite structures; improvement of the physical and chemical properties of water as a result of their aeration and assimilation of biogenic substances through planting of reed vegetation and in the form of islands floating in the lower colmatation pond. The combination of many nature-based processes and their enhancement through the use of ecohydrology was aimed at increasing the efficiency of removing phosphorus and other pollutants from the water to prevent the appearance of cyanobacteria in the Borki Reservoir, which has a recreational function.

Investment details and benefits:

- increasing the retention capacity of the colmatation ponds by 4,500 m^3
- limiting the internal supply, i.e. the penetration of impurities, mainly phosphorus compounds, into the water from bottom sediments in the summer as a result of the removal of sediments
- improving the quality of water discharged from the Mleczna into the colmatation ponds and the Borki Reservoir by creating a sequential system involving the slurry sedimentation zone, dolomite structures removing phosphorus compounds, and water vegetation zones (phytoremediation)
- aeration and mixing of water (a system of bottom diffusers) improving water physical properties, limiting the penetration of phosphorus from the sediment into the water and installation of renewable energy devices (wind turbines, photovoltaics) to power the above solutions
- increasing the pre-treatment capacity of the colmatation ponds in terms of reducing the amount of total suspended solids (approx. 39% in the entire period 2021/2022), total nitrogen (approx. 34%), nitrate nitrogen (approx. 24%) and ammonium nitrogen (approx. 17%). The efficiency of total phosphorus removal in colmatation ponds increased from approx. 1% in 2016 to approx. 12% in 2021/2022 and iron from 18% to 29%
- achieving the possibility of regulating the inflow of water to the Borki Reservoir by reconstructing the needle dam that diverts flood waters directly to the colmatation ponds and reconstructing the weir that dams up excess rainwater in the colmatation ponds,
- creating the right conditions for valuable plant species (the white waterlily (Nymphaea alba) has appeared, which is subject to partial protection)) and animals
- lush vegetation, shallow water and numerous safe places have made this place attractive for birds, including the most endangered species (listed in the Annex to the Habitats Directive), among others the little bittern (Ixobrychus minutus) and marsh tern (Chlidonias hybrida) as well as insects – the hairy-footed flower bee (Anthophora plumipes) covered by partial species protection, inhabiting the slopes of the reservoir
- water at the outflow from the colmatation ponds to the Borki Reservoir met the standards for good water potential for all analysed indicators, except for phosphate phosphorus
- de-silted and rebuilt colmatation ponds introduced much smaller amounts of slurry into the Borki Reservoir than in 2016, and thus significantly lower concentrations of total forms of nitrogen and phosphorus. In 2021, there was a 15% reduction in total phosphorus in the Borki Reservoir, compared to a 60% increase in the concentration of this parameter in 2016

Colmatation ponds and inflow of the Mleczna River to the Borki Reservoir (photo by photo by Municipal Waterworks in Radom, Radomski Dron)

Colmatation ponds (photo by project archive)

Weir directing the waters of the Mleczna River to colmatation ponds (photo by project archive).

Floating islands for birds on colmatation ponds (photo by photo by Municipal Waterworks in Radom)

BORKI RESERVOIR – IMPROVING THE CAPACITY AND FLOOD EFFICIENCY OF THE BORKI RESERVOIR

Adaptation challenge

- increasing the retention volume of the Borki Reservoir and a flexible flood management system
- providing an ecological corridor for migration of aquatic organisms
- improvement of water quality and reduction of cyanobacterial blooms

Scope of implementation

In the Borki Reservoir, a reconstruction of the main weir was carried out to obtain additional retention capacity of flood waters in the reservoir bowl. An important activity was to construct a fish ladder for two-way migration of fish and other aquatic organisms. This action restored the continuity of the river's ecological corridor. In addition, during the investment works, the silt accumulated at the bottom of the reservoir was removed, increasing its capacity and limiting the internal supply of the reservoir with biogens. Water aeration and mixing devices (fountains) were installed to improve the physical properties of the water and reduce the possibility of algal and cyanobacteria blooms forming in the water. Devices using renewable energy (wind turbines, photovoltaics) were also installed to power the above solutions.

Investment details and benefits:

- adaptation of the Borki reservoir by removing 12,000 m^3 of sediments from approx. 70% of the bottom of the reservoir, which increased its retention capacity
- reconstruction of the main weir, which provided additional 20 cm of rainwater retention in the reservoir bowl, increased by 17% (24,000 m^3) the retention capacity of the rainwater reservoir - reducing the amount of water flowing from the reservoir to the Mleczna River during heavy rainfall protects the lower-lying areas of the city from flooding
- the retention capacity of the entire system, taking into account the retention capacity of the colmatation ponds, increased by 28,500 m^3, which means that for the flow in the Mleczna amounting to 11 m^3/s (100-year water) after an intense rainfall, within 45 minutes, this water will be completely retained in the reservoir. For a flow half as long, the retention period of these waters will be doubled
- the construction of the fish ladder enables two-way migration of fish and other aquatic organisms and the opening of the ecological corridor between the Mleczna River and the Borki Reservoir. During the monitoring of the weir, 244 individuals of 6 fish species were found. The species most frequently found in the fish ladder was the perch, and the intensity of migration between individual controls ranged from 8.3 to 59.3 individuals per hour of trap operation.
- the Borki reservoir is characterised by the greatest diversity of avifauna species among the analyzed Large BGI facilities (a total of 113 species – 111 shown in the monitoring, 2 – unpublished data), of which as many as 13 have been listed in Annex I to the Birds Directive, including: the common kingfisher (Alcedo atthis), whiskered tern (Chlidonias hybrida), black tern (Chlidonias niger), and the western marsh harrier (Circus aeruginosus)

Reduction of cyanobacteria blooms in the Borki Reservoir

The fish ladder (left) at the weir (right) on the Borki Reservoir (photo Z. Kaczkowski).

The Borki Reservoir (photo by Municipal Waterworks in Radom, Radomski Dron)

THE CEREKWIANKA – FLOOD POLDER PROTECTING AGAINST FLOODING

Radom, the Cerekwianka River (Strumień Halinowski), along Ceramiczna Street

Coordinates: 51.39732436255424N, 21.102400474421092E

Before implementation

After implementation

Adaptation challenge

- heavily regulated and built-up with hydrotechnical infrastructure, the watercourse in the city centre is not able to take over rainwater transported by the river and discharged from storm collectors
- excess water becomes a problem in the places of narrowing the channel (road culverts) and in the place of inflow to the Mleczna, creating flooding on the access road to the city

Scope of implementation

One of the climate change adaptation solutions was to construct a floodplain polder near the Cerekwianka River in the place of fish ponds existing many years ago. The polder is able to completely take over rainwater carried by the river to the city centre (for flow Q1% of 6 m^3/s, the polder will fill in 45 minutes) without causing an increased flow and flooding downstream. In the dry season, the reservoir automatically lowers the water level by draining it into the watercourse and preparing to take over the next rainfall wave. Natural processes were used in the design of the reservoir for water pre-treatment by creating a sedimentation zone at the inlet to the polder to retain mainly the slurry, geochemical zones to capture phosphates and biofiltration zones to reduce nitrogen compounds.

Investment details and benefits:

- creating a floodplain polder with an area of 1.7 hectares and an average depth of 1.2 m, by adapting the existing depression of the area on the former fish ponds on the right bank of the Cerekwianka River. The system can take over 17,800 m^3 of rainwater without flooding the surrounding roads
- the construction of a sequential water pre-treatment system consisting of a sedimentation part and two biofiltration parts with natural aquatic vegetation removes biogenic substances – the reduction for ammonium nitrogen was about 16%, for ammonium nitrogen about 2% and for phosphate phosphorus about 83%
- use of natural succession processes to develop a plant structure that improves water quality and enhances the biodiversity of the area by creating a mosaic of water and marsh habitats

- introduction to the bottom of the reservoir of several thousand cuttings of reed vegetation – the bulrush (Typha L.), yellow iris (Iris pseudacorus), great manna grass (Glyceria maxima), acute sedge Carex acuta) – to initiate and accelerate succession processes
- post-adaptation monitoring showed the appearance of a plant community previously unrecorded here – the common stonewort (Charetum vulgaris), representing a Natura 2000 protected habitat (code 3140)
- there was an increase in the number of dragonfly species to 21 (with 6 species in 2016), including, for example, the scarlet dragonfly (Crocothemis erythraea) and the white-tailed skimmer (Orthetrum albistylum), indicating favourable environmental changes
- reproductive habitats were created for many species of amphibians, e.g. the common water frog (Pelophylax kl. esculentus), pool frog (Pelophylax lessonae), grass frog (Rana temporaria), common toad (Bufo bufo) and European green toad (Bufotes viridis)
- 51 species of birds were found, including migrating (feeding and resting) birds from Annex I of the Birds Directive: black stork (Alcedo atthis)
- the ecological corridor for the migration of aquatic organisms, spawning sites for fish and habitats allowing for the achievement of good water quality of the Cerekwianka River have been maintained

The Cerekwianka River at the height of the floodplain polder. Photo on the left – the riverbed with rusty colour of water above the outlet from the polder. Photo on the right – no rusty colour of water on the river section at the outflow from the polder (photo by Sebastian Szklarek).

Cerekwianka Polder. Photo on the left – in the dry period before filling with water. Photo on the right – after the period of precipitation and filling the polder (photo by Sebastian Szklarek).

THE POTOK PÓŁNOCNY

Radom, Nad Potokiem District, near Olsztyńska Street

Coordinates: 51,405608 N; 21,183094 E

Before implementation

After implementation

Adaptation challenge

- adaptation of a floodplain area on the Potok Północny into a multifuctional area to improve the quality of water, increase biodiversity, and create social and educational functions,
- mitigation of extreme water flows to the city centre
- creating a habitat for animals, including various species of Amphibia and birds
- improvement in the inhabitants quality of life

Scope of implementation

In order to achieve the project objectives, a multifunctional area of 2 ha was constructed within the riverbed and valley of the Potok Północny.

The investment involved:

- adaptation of the floodplain into a multifunctional area functioning during the period of flood flows with an area of approx. 2 ha with the formation of floodplain zones
- shaping a new section of the Potok Północny riverbed between the railway tracks and the street, sectionally reinforced with fascines with a stone rip-rap
- meandering of the Potok Północny riverbed in the bowl of the multifunctional system
- the construction of sedimentation-flotation and biofiltration zones along the route of the newly formed section of the Potok Północny channel, including the catchment area;
- execution of protection in the form of a dike with adjustment of the crest to the function of a service road (legal requirement)
- execution of an outlet structure enabling water level regulation
- as a result of a collision with the implemented investment, it was necessary to relocate the gas, electricity and sewage network

Benefits:

- slowing down the highest flows of water flowing into the city in the Potok Północny by approx. 10-20% (it is not possible to verify the design assumptions due to the completion of the investment just before the end of the project)
- creating the possibility of rainwater retention in the amount of more than 10,000 m^3, which means that for the flow in the river amounting to 9 m^3/s (100-year water) after an intense rainfall, within 20 minutes, this water will be completely retained in the system. For a flow half as long, this time will be doubled. As a result, the works carried out improved the flood safety of the areas of the city centre located directly in the catchment area of the Potok Północny and indirectly in the catchment area of the Mleczna
- creation of aquatic and wetland habitats that will improve the biodiversity of the area
- expected improvement in water quality (assessment of the effectiveness of this solution in improving water quality was not possible due to the completion of the investment in September 2022)
- creating a multifunctional space for residents of a nearby housing estate

The multifunctional reservoir on the Potok Północny with high water level. A photo taken shortly after the adaptation works were completed, before the vegetation is established (photo by Municipal Waterworks in Radom)

Construction of a polder on the Potok Północny (photo by Municipal Waterworks in Radom, Radomski Dron)

STEP 8

Monitoring of adaptation measures

The completed adaptation tasks are subject to constant monitoring in the scope of:

- monitoring of climatic conditions
- monitoring of the physico-chemical properties of waters
- hydrological monitoring
- monitoring of biodiversity using the traditional method and the eDNA method
- monitoring the effects of the project – improving the quality of life of the inhabitants of Radom (surveys)

Full reports on the monitoring carried out in the LIFE RadomKlima project can be found on the project website: https://life.radom.pl/pl/o-projekcie/raporty

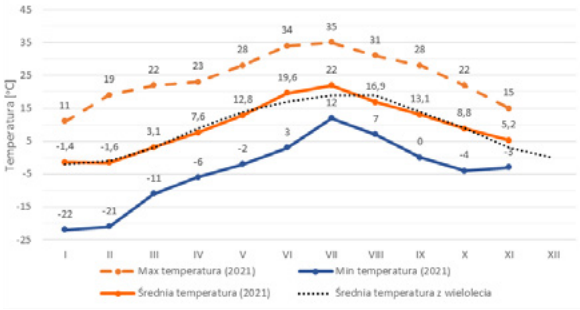
Monitoring of climatic conditions

As part of the monitoring of climatic conditions, meteorological stations were installed in three different locations in Radom. The stations have been operating continuously since 2018 and allow monitoring of current climatic conditions and continuing analysis of long-term historical trends made in the vulnerability assessment. The stations purchased by the Municipal Waterworks in Radom conduct real-time measurements of wind speed, pressure, precipitation, temperature and humidity.

..... GOOD PRACTICE .....

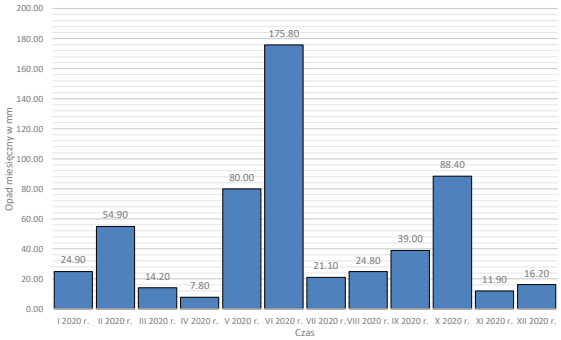
In the absence of installed meteorological stations, analyses of general data can be performed on the basis of data obtained from external entities. In Radom, these were, among others, data from the Institute of Meteorology and Water Management, Radom Airport, Radom Military Airport, and private meteorological stations.

The most interesting from the point of view of current adaptation works were real-time measurements of temperature and precipitation. Monitoring reports **confirmed the upward trend in air temperatures**. In the graph presented here, you can see the average, minimum and maximum temperature recorded at the ST1 station in 2022 in relation to the average temperature from the multi-year period for the city of Radom.



Average, minimum and maximum temperature recorded at the "Sławno" station in 2022 in relation to the average temperature from the multi-year period for the city of Radom

Analysis of the distribution of monthly precipitation totals in the same station showed that the **highest monthly precipitation** during the project occurred in June 2020 and amounted to 175.8 mm. The results of all stations and from all years **also confirm the presence of long-term dry spells**, especially in spring, during the summer holiday months, in November and December.



Monthly precipitation registered at the "Sławno" station in 2020

Measuring station LIFERADOMKLIMA-PL – ST3 (photo by University of Łódź)

The work carried out as part of the monitoring allowed, among others, **to prepare material for the calibration of the numerical model of the hydrological network** in Radom and to forecast changes for future temperature and precipitation conditions. In combination with data from conducted measurement campaigns (monitoring of water levels, temperatures and flows in selected computational sections), they allowed to determine the actual retention of the analysed catchment area and the "response of the catchment area to precipitation". The collected and analysed precipitation data has been fed to the **numerical catchment model**.

The results of the monitoring **also confirmed the conclusions of the vulnerability assessment** that the most vulnerable sector is the water sector, including rainwater management and sectors exposed to the effects of its maladjustment. Unrenovated elements of grey infrastructure and insufficient reservoir retention will further exacerbate the city's problem and expose it to more frequent flooding.

Monitoring of the physico-chemical properties of waters and hydrological monitoring

An important element of the project is the monitoring of the effectiveness of the adaptation measures taken. Monitoring of the physico-chemical parameters of water was carried out before the introduction of adaptation measures, in 2016, and then after the end of adaptation measures, in 2021 and 2022. The monitoring was carried out on 12 basic stations. After the completion of the project, it also covered 14 additional stations, assessing the effectiveness of the newly created solutions – a small BGI.

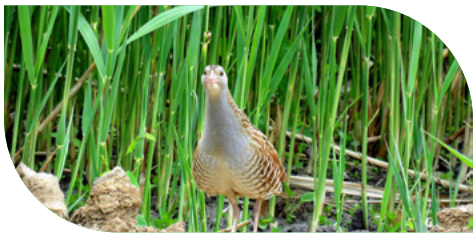
The hydrological monitoring involved conducting a measurement campaign in the hydrological catchment area of the Mleczna, in the area of ongoing adaptation activities. Devices were installed to monitor the level of the water table in the Borki Reservoir and in the polder on the Cerekwianka. Measurements of water flow velocity in selected measurement sections and related measurements of water flow rate in the hydrological network were carried out using radar and ultrasonic devices. The measurements were used to carry out the process of calibrating the mathematical model of the hydrological network and performing dedicated analyses to assess the effectiveness of the implemented adaptation actions. Ecohydrological solutions based on nature implemented in Radom contributed to retain more than 60,000 m^3 of rainwater in the city area, reducing the risk of flooding from 378.9 ha flooded urban areas in 2017 to 319.8 ha in 2022.

Monitoring of biodiversity

Improving humidity conditions and creating even the smallest water reservoirs, especially in the conditions of "urban concrete deserts" always has a positive effect on increasing biodiversity, i.e. the variety of life forms. Water is essential for the development of urban greenery, with it comes wetland and aquatic vegetation and animals associated with the aquatic environment – invertebrates, amphibians, birds and mammals. All these groups were monitored as part of the LIFERADOMKLIMA-PL project.

The pool frog (Pelophylax lessonae), male (photo by Oskar Gross, FPP Enviro)

After carrying out adaptation measures in the river valleys, 9 species of amphibians were found, including 5 species endangered on the European Union scale (listed in Annex IV of the Habitats Directive): the moor frog (Rana arvalis), pool frog (Pelophylax lessonae), European green toad (Bufotes viridis), common spadefoot (Pelobates fuscus) and the rarest of them – northern crested newt (Triturus cristatus), occurring in the Potok Północny area. The latter species was detected thanks to an innovative method of DNA testing from water samples – the so-called environmental DNA (EDNA).



The corn crake (Crex crex), male (photo by Robert Tęcza)

During the observations, 124 bird species were found in the studied area, including 15 species listed in Annex I to the Birds Directive. As many as 13 of them were found in the vicinity of adaptation measures carried out in the area of the Borki reservoir, including: the common kingfisher (Alcedo atthis), black stork (Alcedo atthis), corn crake (Crex crex), syrian woodpecker (Dendrocopos syriacus), peregrine falcon (Falco peregrinus) and even a visitor from the far north – the black-throated loon (Gavia arctica).

Dozens of valuable species of insects have been found. The most interesting include the beetle from the species of Cucujus cinnaberinus and the large copper butterfly (Lycaena dispar). They are protected under national and European laws. In addition, 23 species of dragonflies were found at the monitored sites. For the first time, the scarce blue-tailed damselfly (Ischnura pumilio) was observed – a dragonfly not yet found in Radom.

The large copper (Lycaena dispar), male – the Potok Północny (photo by Marek Miłkowski)

Compared to the period before the start of the LIFE project, the number of fish species increased by 8. In total, 26 species of fish were found, including two species also listed in Annex II of the Habitats Directive: the asp (Leuciscus aspius) and the weatherfish (Misgurnus fossilis).

The weatherfish (Misgurnus fossilis) – the most valuable fish species found in Radom (photo by Roman Kujawa)

The mare's-tail (Hippuris vulgaris) in the Climapond in a climatic kindergarten in Radom (photo by Michał Maniakowski)

Small BGI facilities play a very important role, among which the newly created ponds (Climaponds) were characterised by the greatest biodiversity. Aquatic plants were introduced in them, among others: the European water-plantain (Alisma plantago-aquatica L.), arrowhead (Sagittaria sagittifolia), and mare's-tail (Hippuris vulgaris). In an urban environment, where access to water is very limited, water reservoirs are used by birds to drink water and take a bath in the summer. In the ivy of one of the green bus shelters, common blackbirds (Turdus merula) have nested. Mammals have also taken advantage – a hedgehog (Erinaceus roumanicus) settled in the vicinity of the Climapond at Public Kindergarten No. 16.

Monitoring the effects of the project – improving the quality of life of the inhabitants of Radom (surveys).

Social and institutional awareness of adaptation to climate change has been built through educational activities. To assess their impact, a survey was conducted on a sample of about 500 adult residents of Radom at the beginning and at the end of the project.

The results of surveys carried out at the beginning of the project showed that almost half of the residents are worried about the state of the natural environment in the city. These concerns are most often related to poor air quality and the effects of prolonged heat (including drought, water shortages), temperature spikes and the formation of an urban heat island, as well as pollution of rivers and water reservoirs. In the opinion of the respondents, local flooding was a lesser threat. However, the survey indicated that an important problem – according to the residents – was too little green infrastructure within the city limits and places where people could shelter from the effects of long-term heat.

After the implementation of the LIFE project, the vast majority of Radom residents consider climate change to be a serious problem that should become the basis of the city's policy. The percentage of Radom inhabitants declaring the above-mentioned concerns has definitely increased, which may result directly from the increase in the level of ecological awareness of the local community. Residents felt an improvement in the quality of life in the city in terms of rainwater management. Currently, the percentage of residents fearing the effects of increased rainfall, storms and flooding is lower than in 2016. People living in areas directly exposed to climate change are significantly less likely than other respondents to fear that they may experience local flooding (e.g. flooding of basements) in the future. There was also an improvement in the aspects of turning streets and sidewalks into torrents during heavy rainfall, overflowing sewage manholes, or contaminated/obstructed drainage inlets. In recent years, the proportion of residents not experiencing these phenomena has increased. 80% of residents also appreciated the usefulness of increasing the capacity of the Borki urban reservoir and building a new reservoir on the Potok Północny.

Illustration from Educational Materials

Educational boards at Kindergarten No. 11 (photo by project archive)

STEP 9

Building social capacity for adaptation

The project placed great emphasis on conducting information and promotion activities. These included but were not limited to: maintenance of the project website and Facebook profile; installation of information boards at project sites; networking with other projects and organisations; organisation of the project launch and closing conferences; cooperation with other LIFE projects dealing with aspects of climate change adaptation; study trips to Denmark, Germany and the Netherlands; organisation of promotional events, production and distribution of promotional and information materials; thematic competitions for schools; workshops in educational institutions; development, production and distribution of audiovisual materials about the project; development of an action plan to continue the achievements and outcomes of the project.

A field visit of the Masovian District Chamber of Civil Engineers (Photo by Municipality of the City of Radom)

Collaboration with professional groups

Thanks to the LIFERADOMKLIMA-PL project, adaptation measures to climate change were integrated into the mainstream of urban spatial planning and knowledge about informed decision-making at the local level was increased through, among others, working groups. Meetings for groups of professionals and technical trips for Polish and foreign students were also organised.

Meeting of Working Groups and designers with NGOs (Photo by Municipality of the City of Radom)

Cooperation with NGOs

The project cooperated with eight non-governmental organisations with different intensity and at different times: Bractwo Rowerowe, Towarzystwo Ziemi Radomskiej, Klub Przyrodników Ziemi Radomskiej, Fundacja Sendzimira, Stowarzyszenie Zielona Akcja Reaktywacja, Stowarzyszenie Orzeł i Reszka, Liga Ochrony Przyrody, Stowarzyszenie Radomianie dla Demokracji.

Meetings with children from Radom schools as part of educational activities (Photo by Municipality of the City of Radom

Cooperation with schools

During the implementation of the project, 5 editions of an art competition were held among students of grades 4-6 in primary schools, in lower secondary schools and secondary schools of public educational institutions of the city of Radom. A total of 396 students took part in it. The premises of schools are excellent places for in-depth ecological education. Therefore, part of the adaptation activities in the field of the small BGI were implemented in secondary schools, primary schools and kindergartens. Educational materials were prepared for conducting classes for preschoolers, which were used at the opening of the "Climate Kindergarten No. 16 in Radom" and made available to teachers.

Event "Feel the Climate" (photo by Municipality of Radom)

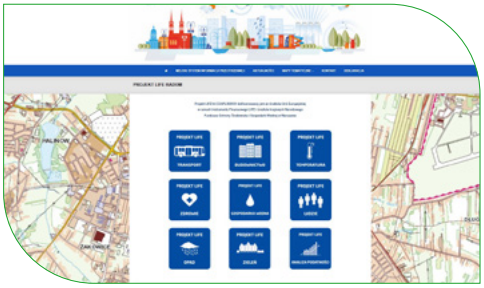
Awareness-raising among the public

Many thematic events were organised for the residents of Radom, including "Feel the Climate" 2019, "Family Picnic" 2019, "Concert with the Climate" 2018, art competitions, e.g.: "ECO-CITY" in 2020 and "Impacts of Climate Change" in 2019.

life.radom.pl

Educational game

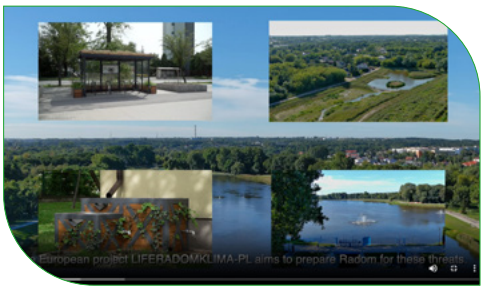
The educational game can be used by both schools and all interested persons. It is available on the project website and allows you to design your own climate-resilient city.



gis.umradom.pl/life_radom_mapy.html

Interactive platform

The interactive platform on the project website disseminates the results and plays an educational role. The platform provides residents with maps of Radom showing areas sensitive to climate change. It operates based on the vulnerability assessment methodology developed as part of the project and the adaptability of urban space to climate change.



Kadr z filmu o projekcie (life.radom.pl)

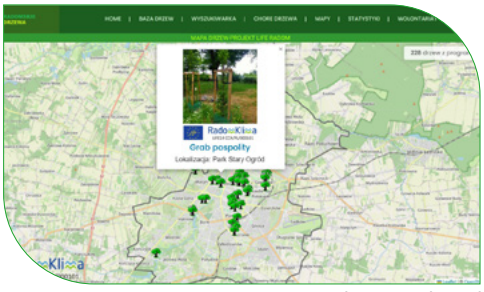
Films

12 short films about the project and the small and large BGI in Radom were made. All films are available on the project website: www.life.radom.pl. In addition, more than 50 announcements have been published in local and national newspapers and trade journals – some of which are also available on the project website and in online resources.

ECOCITY conference (photo by Municipality of Radom)

Conferences

As part of the project, two international conferences were organised – the first in April 2016, on the occasion of the launch, and the second in November 2022, on the occasion of the completion of the project. The results of the project were presented at 52 national and international conferences, including in Belgium, the Czech Republic, France, Spain, Germany, Portugal, Poland, the United Kingdom and many other countries. During national and international meetings, more than 9,000 printed materials about project activities were distributed.



drzewa.radom.pl

Radom Trees

The LIFERADOMKLIMA-PL project financed the purchase of seedlings 513 trees and 191 shrubs that were planted or distributed on the occasion of various information and promotional events. Planted trees were digitized as part of the Radom Trees campaign by Green Action Association Zielona Akcja Radom and placed in the tree database on the website drzewa.radom.pl.

STEP 10

Replication and dissemination of BGI knowledge, experience and solutions

Project solutions have great potential in terms of their replication. Products such as the climate change vulnerability assessment, a comprehensive approach to multi-level territorial rainwater management, the GIS tools on the interactive platform, the interactive educational game and demonstration blue-green infrastructure are available to all interested parties. The knowledge and experience gained in the project have already become the basis for the implementation of further adaptation projects under the LIFE financial mechanism.

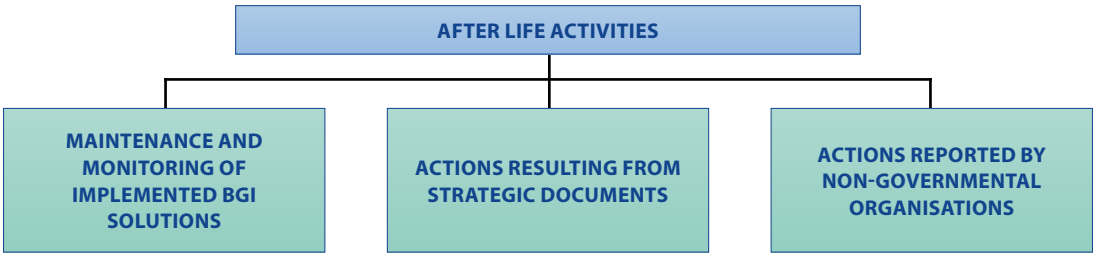
CURRENTLY, TWO LIFE PROJECTS ARE BEING IMPLEMENTED THAT DRAW ON THE EXPERIENCE OF LIFE RADOMKLIMA PL:

(1) IP LIFE PL PILICA BASIN CTRL: IMPLEMENTATION OF RIVER BASIN MANAGEMENT PLAN IN THE VISTULA BASIN ON THE EXAMPLE OF PILICA RIVER CATCHMENT (IMPLEMENTED IN THE PILICA CATCHMENT IN POLAND)

(2) LIFECOOLCITY (LIFE21-CCA-PL, PROJECT 101074553): USE OF REMOTE SENSING FOR MANAGEMENT OF BLUE-GREEN INFRASTRUCTURE IN THE PROCESS OF CITY ADAPTATION TO CLIMATE CHANGE (IMPLEMENTED IN THE CITY OF WROCŁAW AND REPLICATED TO 10 000 OTHER CITIES IN EUROPE)

After LIFE activities

Adaptation measures in Radom did not end with the completion of the project. They are and will be continued as part of the "After LIFE" plan and will cover three main groups of actions.



Maintenance and monitoring of implemented BGI solutions

Part of the activities results from the need to maintain the implemented solutions, including demonstration BGI solutions and to ensure their proper functioning after the completion of implementation. This group of activities is directly related to the implementations performed in the project. It is also planned to continue monitoring the effects of the project and disseminate the developed solutions through a number of educational, promotional and scientific projects in Poland and abroad. For all activities, the period assumed in the After LIFE plan is 5 years after the end of the project. The activities will be financed from the beneficiaries' own resources as well as, if possible, with the use of external funds, especially when replicating design solutions in the field of large and small BGI in order to manage rainwater in the city.

Actions resulting from strategic documents

Part of the project experience will be implemented in other areas of the city than those covered by demonstration activities as part of the LIFERADOMKLIMA-PL project. These activities result from the current and upcoming strategic documents of the City of Radom:

- The Concept of the Radom Greenery Development Program (PRTZ) and
- Climate Change Adaptation Plan for the City of Radom until 2030 (MPA).

They take into account, inter alia, adaptation activities in sensitive areas identified by the Radom climate change vulnerability assessment and include the further implementation of a small BGI in the central part of the city and a large BGI on its peripheral parts. The implementation of these strategies will require the involvement of many actors: City Hall departments, municipal units, companies, associations, organisations, and residents. The Department of Environmental Protection and Agriculture of the City Hall will be responsible for monitoring and implementing them. Due to the extensive scope of tasks planned for implementation, labour intensity and complexity, and the need to secure (obtain) significant financial resources, the implementation provides for a timeframe of 2023-2034. The primary source of financing will be the municipal budget. In the case of securing the funds necessary as „own contribution", it will be possible to apply for funds from the European Union, as well as national and regional instruments..

Action needs reported by NGOs

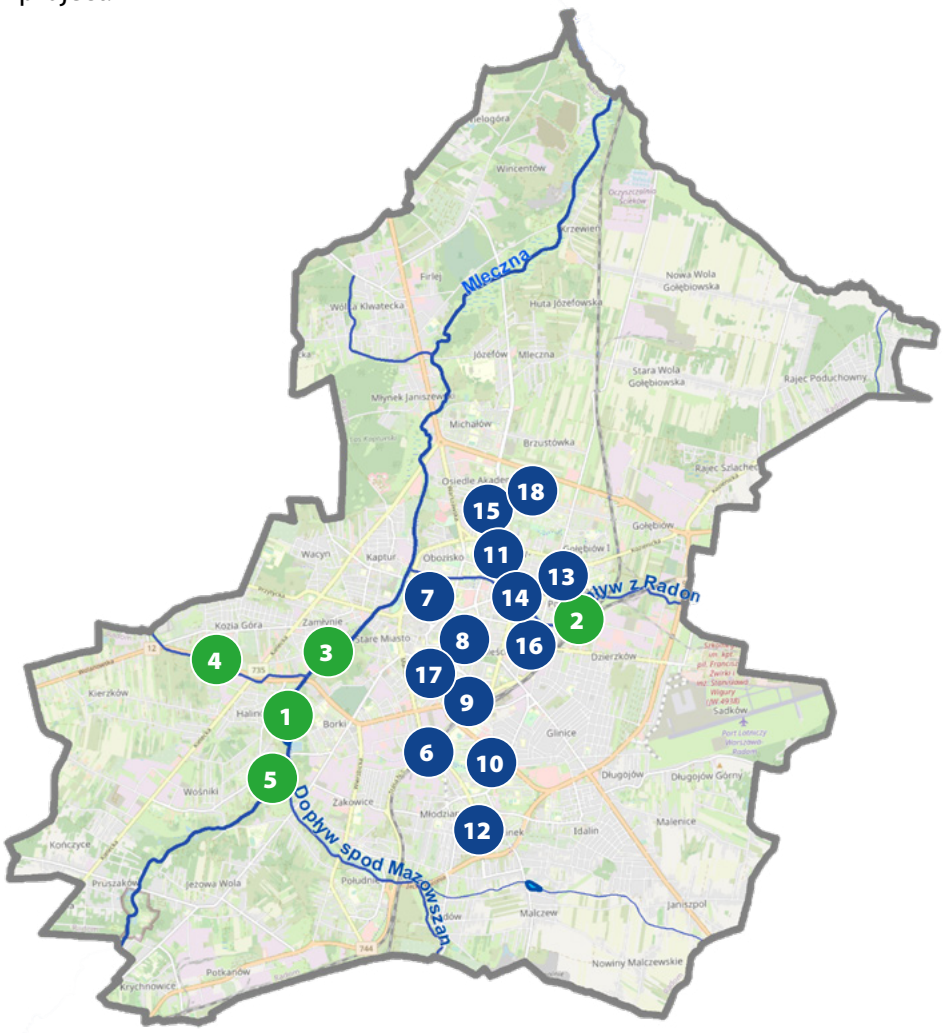
During project meetings with non-governmental organizations and representatives of residents, a number of needs have been reported - needs that are part of the continuation of activities carried out under the LIFERADOMKLIMA-PL project. They have aimed primarily at strengthening the natural capital of the city and its biodiversity and activating it residents. The After Life plan also takes into account these needs, especially those reported by NGOs.

In December 2022, due to the effects of the LIFERADOMKLIMA-PL project, the city of Radom was recognised at the international level. It has been included in the Global Network of Ecohydrology Demonstration Sites under the UNESCO Intergovernmental Hydrological Programme (UNESCO-IHP).

PROJEKT LIFERADOMKLIMA-PL

As the first city in Poland, Radom has been implementing a project on adapting the city to anthropogenic climate change since 2015. The project called „Adaptation to climate change through sustainable management of water of the urban area in Radom City" (LIFERADOMKLIMA-PL, LIFE14 CCA/PL/000101) is co-financed by the European Union under the LIFE Program and the National Fund for Environmental Protection and Water Management.

Adaptation activities undertaken in the LIFERADOMKLIMA-PL project:



Map source: OpenStreetMap.org

Large BGI (blue-green infrastructure):

1. Adaptation of the Borki reservoir and colmatation ponds
2. Construction of a multifunctional reservoir on the Potok

Północny river with a sequential sedimentation and biofiltration system (SSSB) (between Olsztyńska St and railway tracks)

3. Remeandering of the Mleczna river (at the boulevards over Mleczna)
4. Floodplain polders on the Cerekwianka river (at NSSZ Solidarności St. - behind Jana Łaskiego Roundabout)
5. Canal A0 and SSSB on the Mleczna river above the Borki reservoir (at Sucha St)

Small BGI (blue-green infrastructure):

6. Climapond Public Kindergarten No. 16 (3 Grenadierów St)
7. Green bus shelters (Struga St opposite Galeria Słoneczna)
8. Rain garden – Public Kindergarten No. 4 (23 Jana Kilińskiego St)
9. Rain Garden and Climapond - Public Kindergarten No. 11 (10 Kościuszki St)
10. Climapond – Public Primary School No. 11 (19 Gagarina St)
11. Absorptive basins (Square Bema St/ Jasińskiego St)
12. Rain gardens - Nursing Home (16 Wyścigowa St)
13. Rain gardens - Nursing Home (88 Struga St)
14. Green bicycle shelter - RCS at (63 Struga St)
15. Rain Gardens and Climapond - XI LO (27 11 Listopada St)
16. Tree trench and Green bicycle shelter - Public Primary School No. 33 (5 Kolberga St)
17. Climapond and Green bicycle shelter - III LO (44 Traugutta St)
18. Climabox - Municipal Cultural Centre Amphitheatre (5 Daszyńskiego St)

The project is implemented by:

with partners:

More about the project: **www.life.radom.pl**