RETENTION

KEEP THE WATER!

Water scarcity prevention program

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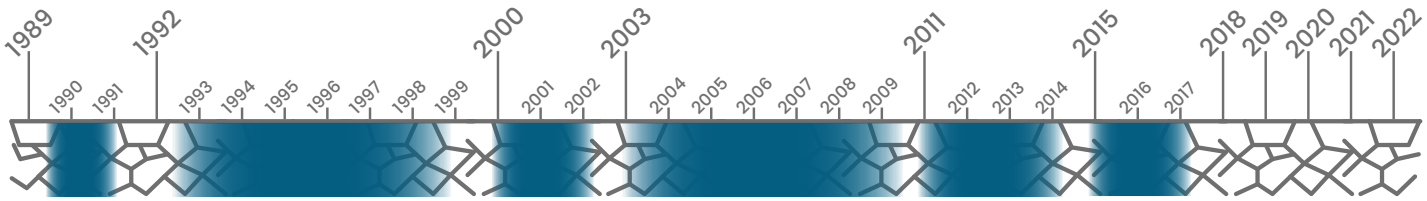
1. Purpose and scope of the Water scarcity prevention program

Poland has one of the smallest water resources per inhabitant in Europe. According to the statistics for the year 2019, there were less than 1,100 m^3 of water per inhabitant in Poland, while in Europe, on average, this amount was over 2,5 times more.[1] Drought occurrences are on the rise. From 1989 to 2000, droughts occurred every 5 years, but in the last few years, their frequency has increased to every 2.5 years.



drought

Furthermore, climate change projections indicate that temperature will increase, which will lead to greater evaporation. This will increase the speed of water circulation, thus increasing the length of the non-rainy periods and, at the same time, the frequency of torrential rainfall.

The scarcity of water has a significant impact on the society, environment and economy. Insufficient water resources affects the ability of municipal governments to provide water for the population on the affordable prices; it also has a negative effect on aquatic or water dependent organisms - animals and plants, such as fish or reeds; it impact many branches of economy, particularly agriculture and food processing, the paper industry, and the energetic sector. Likewise tourism depends directly and indirectly on the availability of water; last but not least, water quantity is also related to its quality: the less water in the watercourse, the more pollutants are concentrated in it.

The situation implies that measures are needed to improve water availability for citizens and the environment as well as for all branches of the economy. This task will be achieved by the implementation of the Water scarcity prevention program for the years 2021-2027 with a perspective until 2030.

The main objective of this program is to increase water retention to 15% of the average annual outflow.

The main objective of WSPP is to be supported by 3 specific objectives:

1. Indication and implementation of measures within the scope of building an integrated system of natural and artificial water retention;
2. Creating conditions for the sustainable use of water resources;
3. Raising public awareness of the need to retain and save water.

The measures introduced in the Program are designed to ensure the achievement of the stated goals by increasing all types of retention in Poland, as well as extensive information and education activities.

[1] Gutry-Korycka, M. Zasoby wodne Polski [Poland's water resources]. Warsaw: IMGW-PIB, 2014.

2. Water resources in Poland

2.1. Surface waters

The term surface water resources refers to part of waters of the rivers and lakes that can be used to meet the needs of the population and the economy. Their quantity and quality are equally important when it comes to their condition for water abstraction and use. The concept of water resources refers exclusively to that part of water that is renewed each year. The volume of river outflow from a given area is assumed to be water resources.

The data collected by the Institute of Meteorology and Water Management - State- Research Institute on river flows can be used to estimate the surface water resources and areas where water is scarce.

For this purpose, a number of indicators characterising water resources are used, such as the environmental flow, characteristic flows: the lowest flow from the low, the medium-low flow, the average annual flow, and a number of others . The above indicators are determined for water balanced catchments.

The areas that are at risk of insufficient water resources (deficit areas) were identified by the analysis of the calculated values of indicators for the water balance catchment.

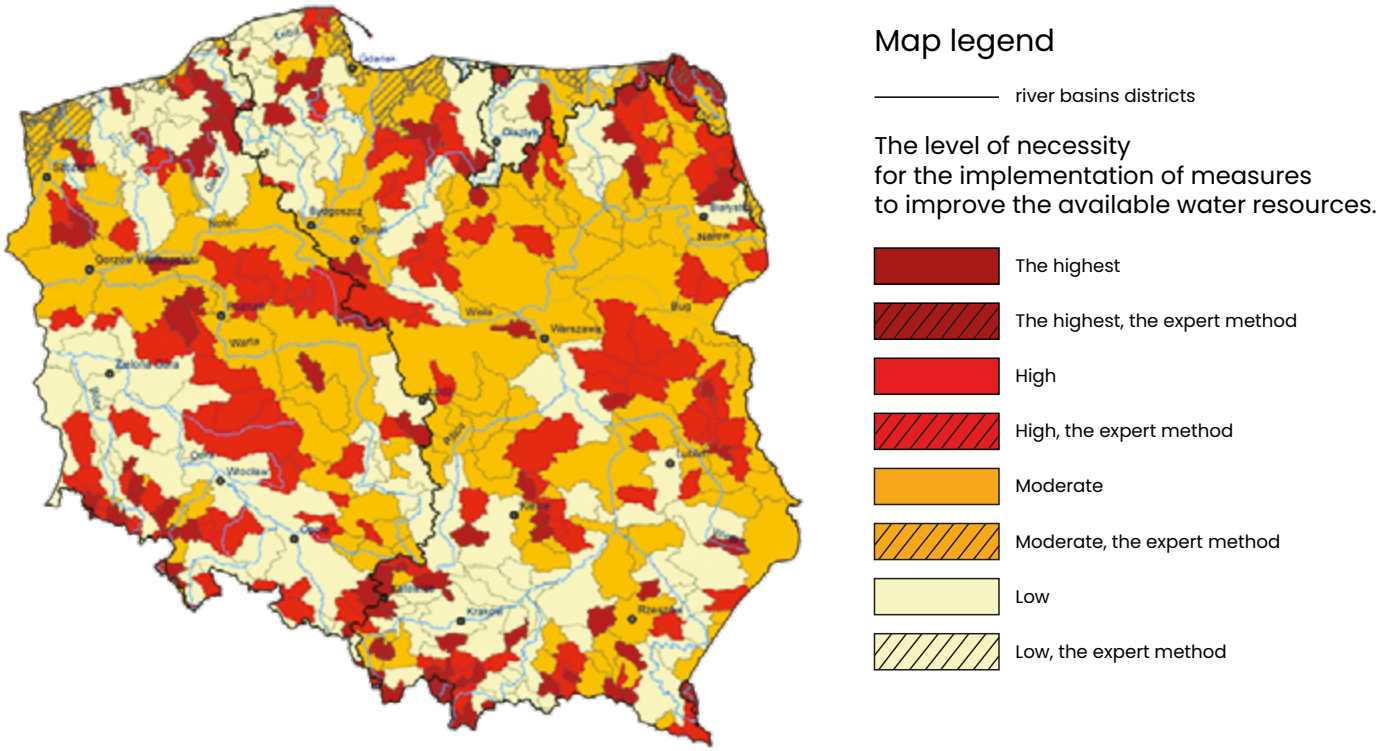
The division into four classes was adopted, corresponding to the following priorities:

- the highest,
- high,
- moderate,
- low.

Nationally, the high priority of increasing retention applies to 28% of catchment areas, and the highest – to over 25%. This means that over 50% of Poland is in danger of suffering from a surface water shortage. Nationally, the risk of water deficit varies spatially, but it affects each of the voivodships, as only 23% of the catchment areas do not require a priority implementation of measures.

Another important factor affecting the water deficit is climate change. In annual terms, based on the results of the CHASE and KLIMADA2 climate change models, an increase in precipitation and outflow of water by rivers is forecast until 2050. This means that in the short term, climate change will not cause an increase in water deficit in Poland on an annual basis. However, there will be an extension of the rain-free periods in the summer.

Figure 1. Deficit areas in Poland



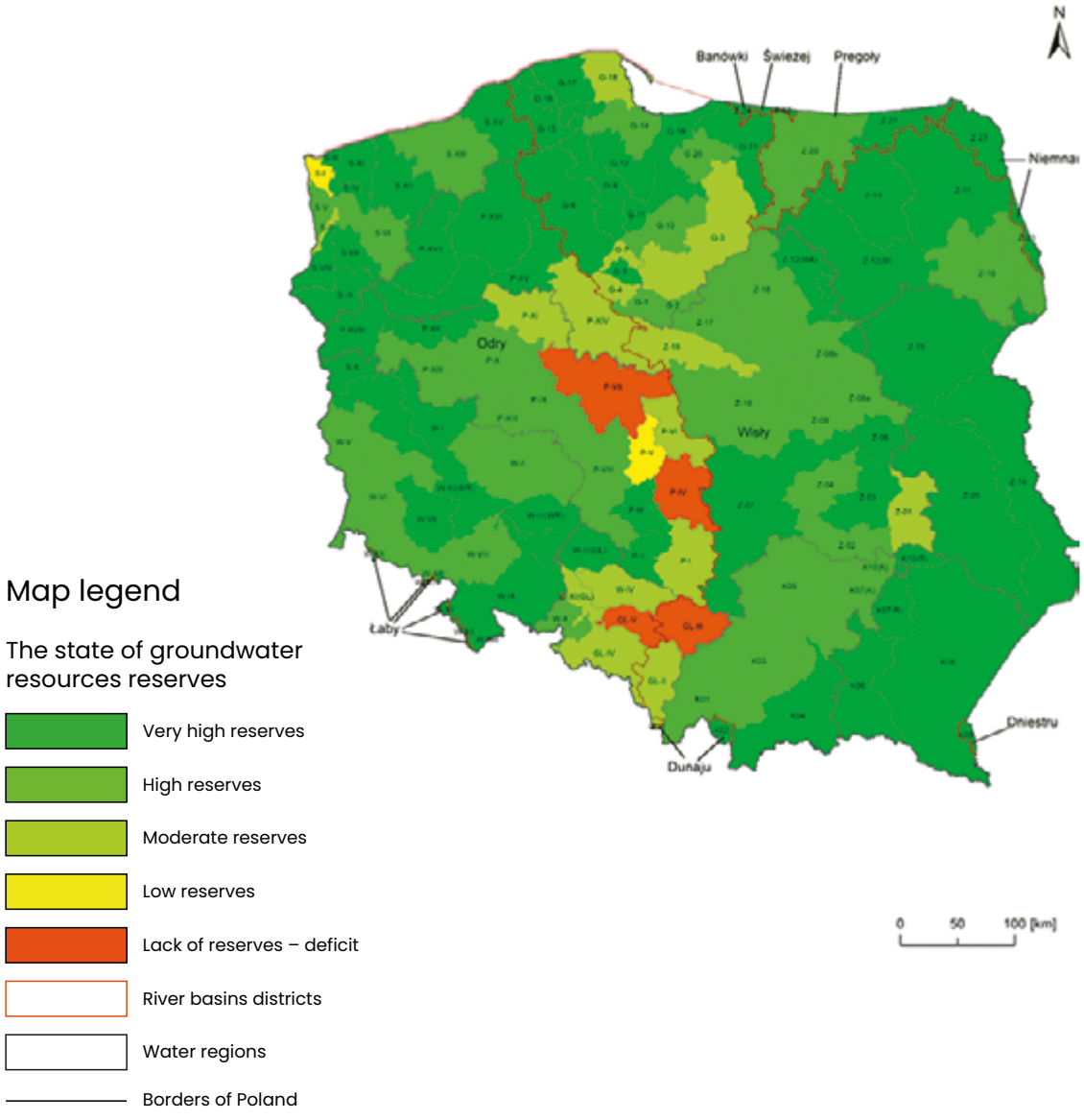
2.2. Groundwater

It is possible to estimate the amount of available groundwater for a country, while maintaining the limitations related to the requirements of environmental protection.

The main institution providing information on groundwater is the Polish Geological Institute – National Research Institute. Based on the data from hydrogeological and geological-engineering documentation developed by this institution, it is possible to determine the availability of groundwater. The resources are evaluated on the scale of selected areas with similar conditions, known as balance areas.

The way of use of groundwater influences their level. Higher consumption reduces reserves. Therefore, if more than 100% of the available water is absorbed, it likely to leads to the water deficit. For now the deficit of groundwater occurs only in four balance areas, and is directly connected with the activities of the mines.

Figure 2. Groundwater deficit areas



There is currently no risk of groundwater scarcity in most areas of Poland. Only 3,3% of Polish territory is at risk of a deficit, and the low reserves cover two balance areas, which account for 0. 5% of Poland's land area.

Based on the assessment of the predicted climate changes for the years 2030 and 2050 it is assumed that natural factors should not lead to a further deterioration of the state of available groundwater resources. These resources should maintain at the current level or even increase.

3. Water retention in Poland

One of the effective ways to improve the availability of water resources is retention, i.e. its storage in the environment.

The term water retention refers to the ability to temporarily hold water in a catchment. Through the retention the water circulation slows down, and the water balance improves. Surface runoff is replaced by slow ground runoff, which leads to the increasement of water resources. In the surrounding areas, the level of the groundwater is rising.

Surface runoff can be significantly reduced by water retention, which often occurs as a result of high amounts of water being absorbed into the ground. Water flowing along a river or stream can cause a speed reduction. This causes a slower circulation of water in the environment. The slower water drains, the more it will be stored in the environment.

The most common division of the retention types distinguish natural retention and artificial retention.

Due on the volume of stored water, artificial retention can be divided into two groups:

- Reservoirs with a capacity greater than 5 million m^3 are classified as large-scale retention reservoirs;
- Reservoirs with a capacity of less than 5 million m^3 are classified as small-scale retention reservoirs.

Another category is microretention (reservoirs with a capacity of less than 0.1 million m^3 and an area of up to 1 ha), which performs similar tasks as small retention.

Depending on the way how the water is stored in the environment, we can distinguish the following types of the retention:

- landscape retention,
- soil retention,
- retention of groundwater,
- retention of surface waters.

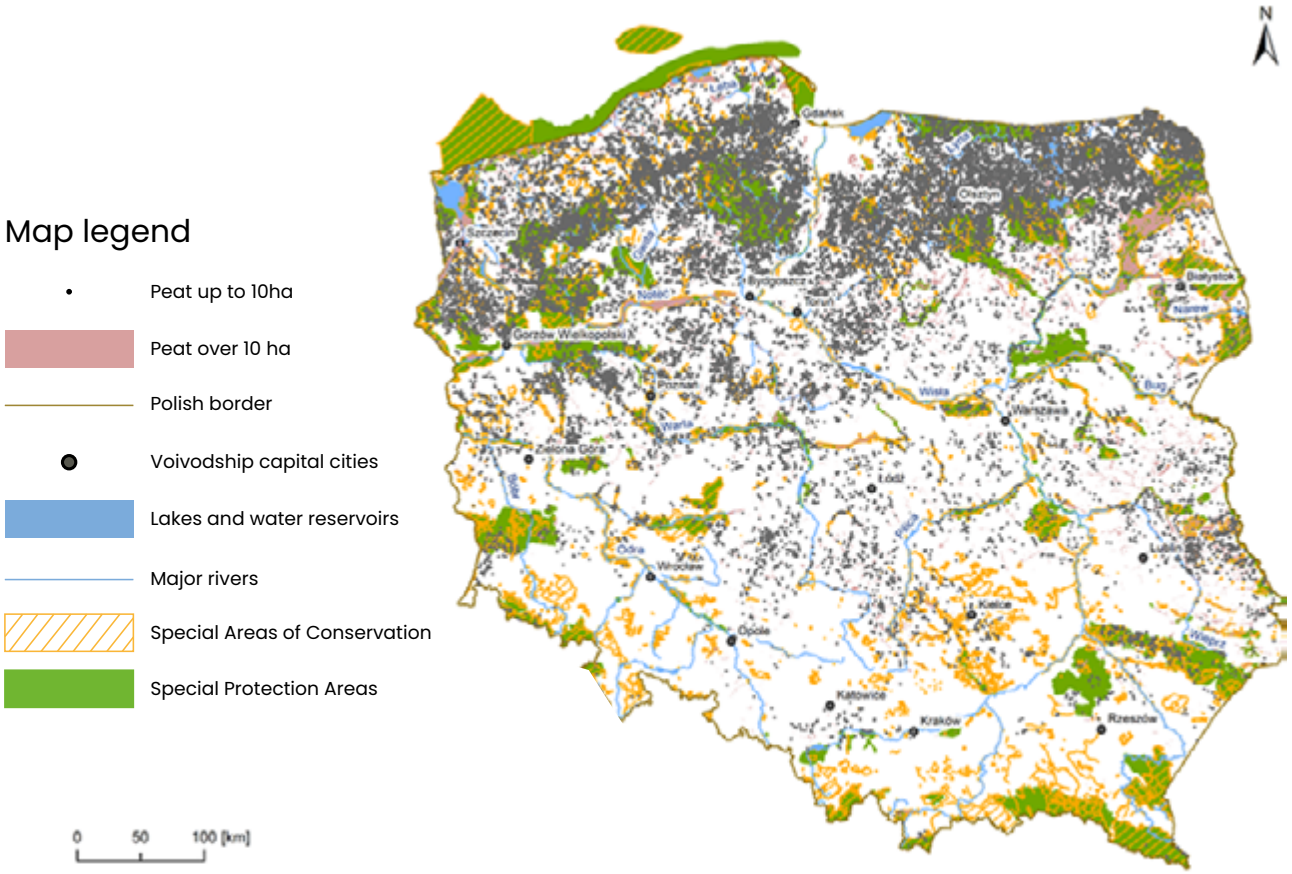
* Due to its specific nature, we also distinguish urban retention.

The lakes are an evident reservoir of water. About 16.5 million m^3 is retained in the country's largest lakes. In Poland, the following lakes are characterized by the largest total resources.:

- Śniardwy,
- Łebsko,
- Gopło,
- Miedwie,
- Bukowo,
- Jamno.

Wetlands, especially peat, are important for water storage. It is estimated that they retain 14 billion m^3.

Figure 3. The location of peat in Poland in relation to protected areas.



Source: Prepared on the basis of the GIS Wetlands database and the data of the General Directorate for Environmental Protection.

Water can also be temporarily retained by forests. Forests with older generations of trees and greater diversity retain more water. Deciduous forests can retain more water than coniferous forests. In Poland, nearly 30% of the area is covered with forests. It allows for the retention of up to 23 billion m^3 of water.

Figure 4. Forests in water regions

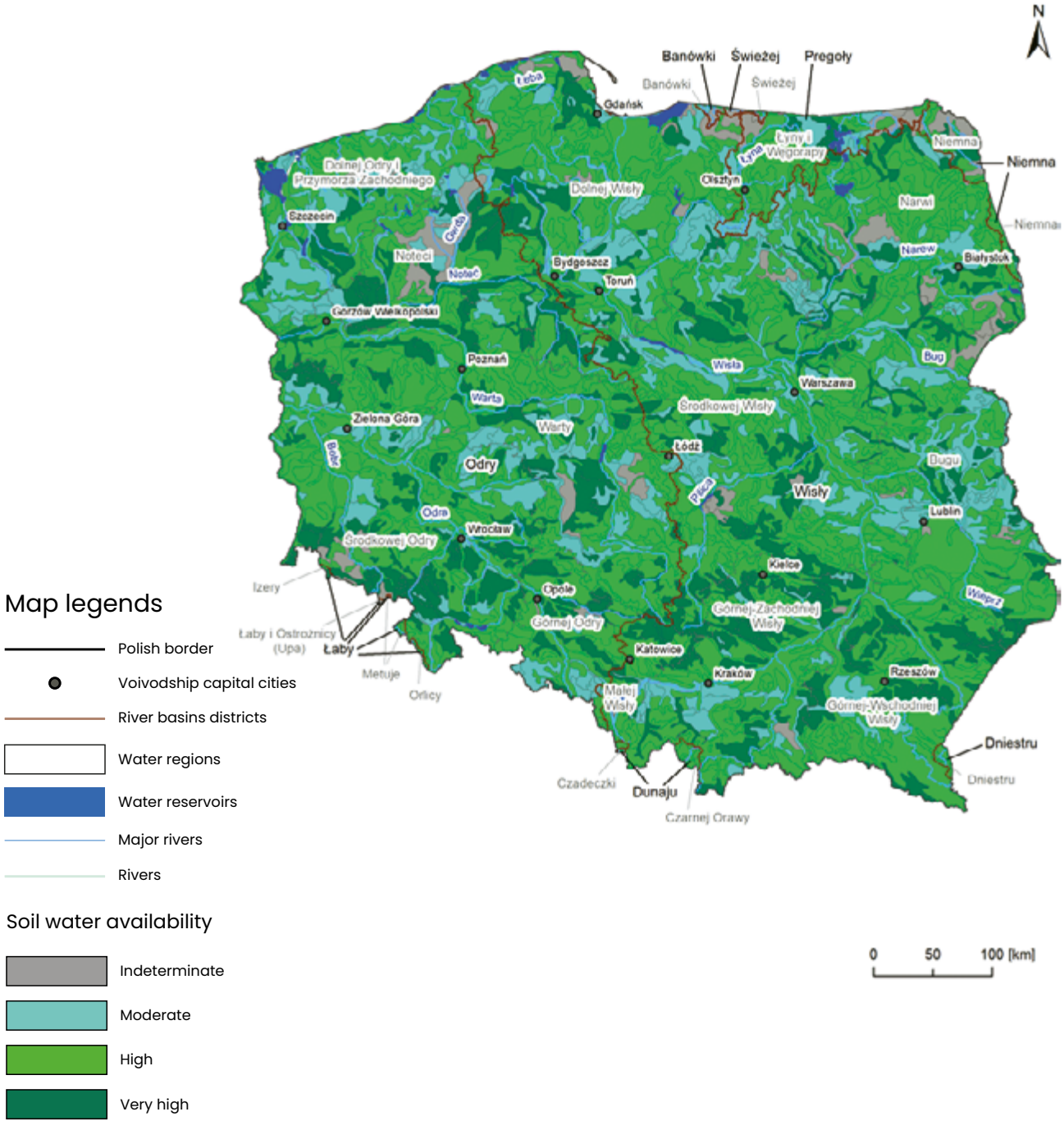
Map legends

- Water reservoirs
- Major rivers
- Rivers
- Deciduous forests
- Coniferous forests
- Mixed forests
- Water regions
- River basins districts
- Polish border
- Voivodship capital cities

Source: Prepared on the basis of CLC 2018

Water can also be retained in the soil. A parameter that characterizes soil retention is water capacity, which means the water content in soil. Water capacity depends on type of soil. River muds and clay soils retain the largest amount of water. The smallest amount of water is retained by gravel and sandy soils– even three times less than river muds Poland is dominated by soils with a high total water capacity, representing over 62% of the countries area. Soils with a very high water capacity are located in the southern part of Poland, especially in the Kłodzko Valley and the Kraków-Sandomierz Upland.

Figure 5. The classes of total water capacity of soils in Poland



Source: European Soil Data Centre (ESDAC)

Aside from natural retention, water can also be stored in retention reservoirs. This is the type of retention that allows to control the amount of collected water.

As part of the artificial retention, around 4.5 billion m^3 of water is stored in over 9 thousand reservoirs in Poland, which is about 7.5% of the average annual outflow from the country's territory.

Another important element of retention is microretention in urban areas, especially solutions such as::

- green roofs and facades,
- rain gardens and microretention objects,
- wildflower meadows,
- swales and channels,
- permeable surfaces of communication routes and squares,
- containers for self-collection of rainwater.

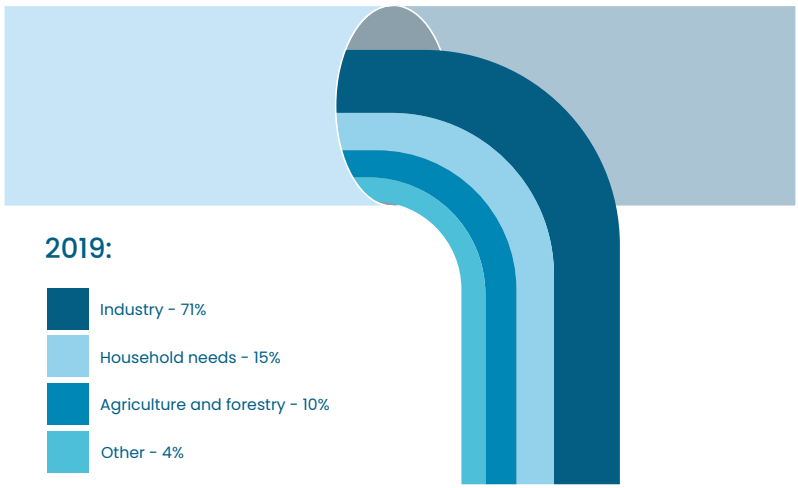
Although the volume of water stored in this way is not particularly spectacular, it plays a significant role for cities. All these measures, on the one hand, protect urban areas against floods caused by heavy rainfall, and on the other hand, provide water for the functioning of cities in periods without rainfall. It is also a way of adapting to climate change.

4. Water demand

The growing demand for water also increases water scarcity. Water is a key element for human life and activities. The total absorption of water to cover the needs of the national economy and population in 2019 amounted to 8.8 billion m^3, of which 74.5% was surface water consumption and 25.5% was groundwater consumption. Water consumption varies from 23 m^3 of water per capita in the Danube basin district to over 200 m^3 in the Vistula and Odra river basins districts.

According to the statistics for 2019, the largest water consumption in Poland is by industry, which consumes 6. 3 billion m^3 of water per year, which is 71% of total water consumption. Surface water is the main source of this demand (95%).

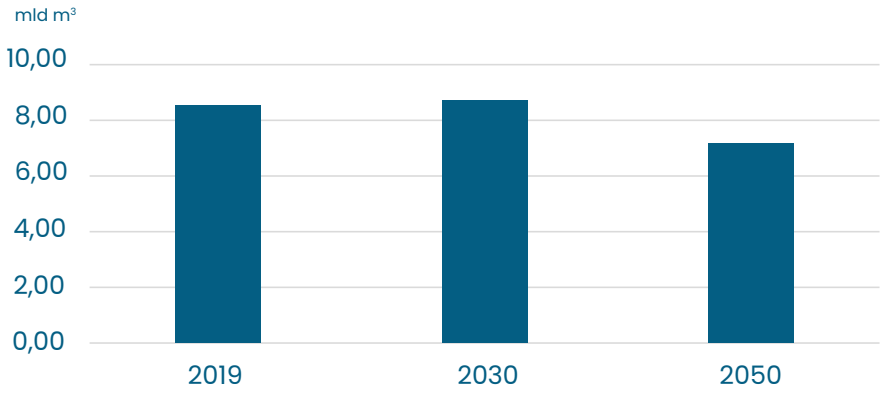
Figure 7. Water consumption in 2019, broken down by sectors of the economy



Household water consumption totals about 1.3 billion m^3 per year, the majority of which (71.8%) came from groundwater intakes. Consumption in the agriculture and forestry (aquaculture) sector is about 0.8 billion m^3 per year, and it is covered by surface water.

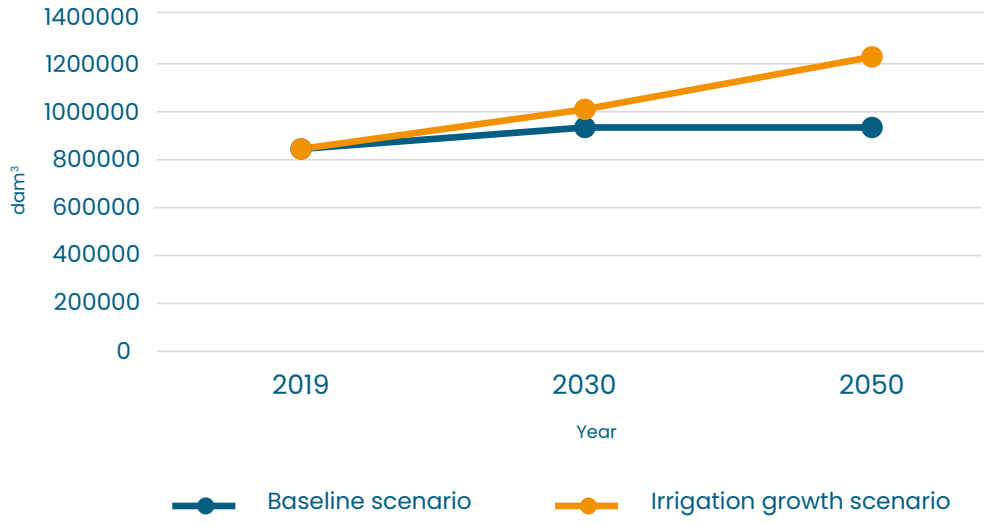
Consumption of water is not constant over time. Water demand forecasts indicate that consumption will increase by 2030 and decrease by 2050.

Figure 8. Forecast of changes in water demand in Poland



The demand for water in agriculture will increase due to the increasing importance of irrigation. In comparison with the year 2019 it will increase by 111% in 2030 and 2050.

Figure 9. Forecast of changes in water demand in Poland



Source: Prepared on the basis of data from Statistics Poland/Local Data Bank.

Household water demand will increase as well, due to the developing wealth of the society. Growing efficiency of water use and the decline in the number of inhabitants will slow down the dynamic of growing water use, but will not outweigh it. According to estimates, the consumption of water for household needs comparing to the year 2019 will be higher by 105.5% in 2030 and by 108.9% in 2050.

A decrease in water use for industrial purposes is expected. It is possible due to the technological development, and changes in the structure of the energy market. Gradual shift of energy sources, allowing to lower the use of coal-based power plants, which consume large amounts of water, will reduce global demand for water. As a result, it is estimated that water consumption for industrial purposes compares to the level from 2019 will amount 97.1% in 2030 and 83.8% in 2050. Industrial water consumption accounts a significant share of the total water consumption in the country (71.4%) and, consequently, significantly affects the amount of total water demand.

5. Measures to improve retention

The Water scarcity prevention program introduces 14 types of measures to improve retention:

- 3 types of measures related to the hydrotechnical investments;
- 5 types of measures aimed at improving retention in agricultural areas;
- 2 types of measures aimed at increasing forest retention;
- 2 types in the field of restoration measures;
- 1 type for urban areas;
- 1 type dedicated to post-mining areas.

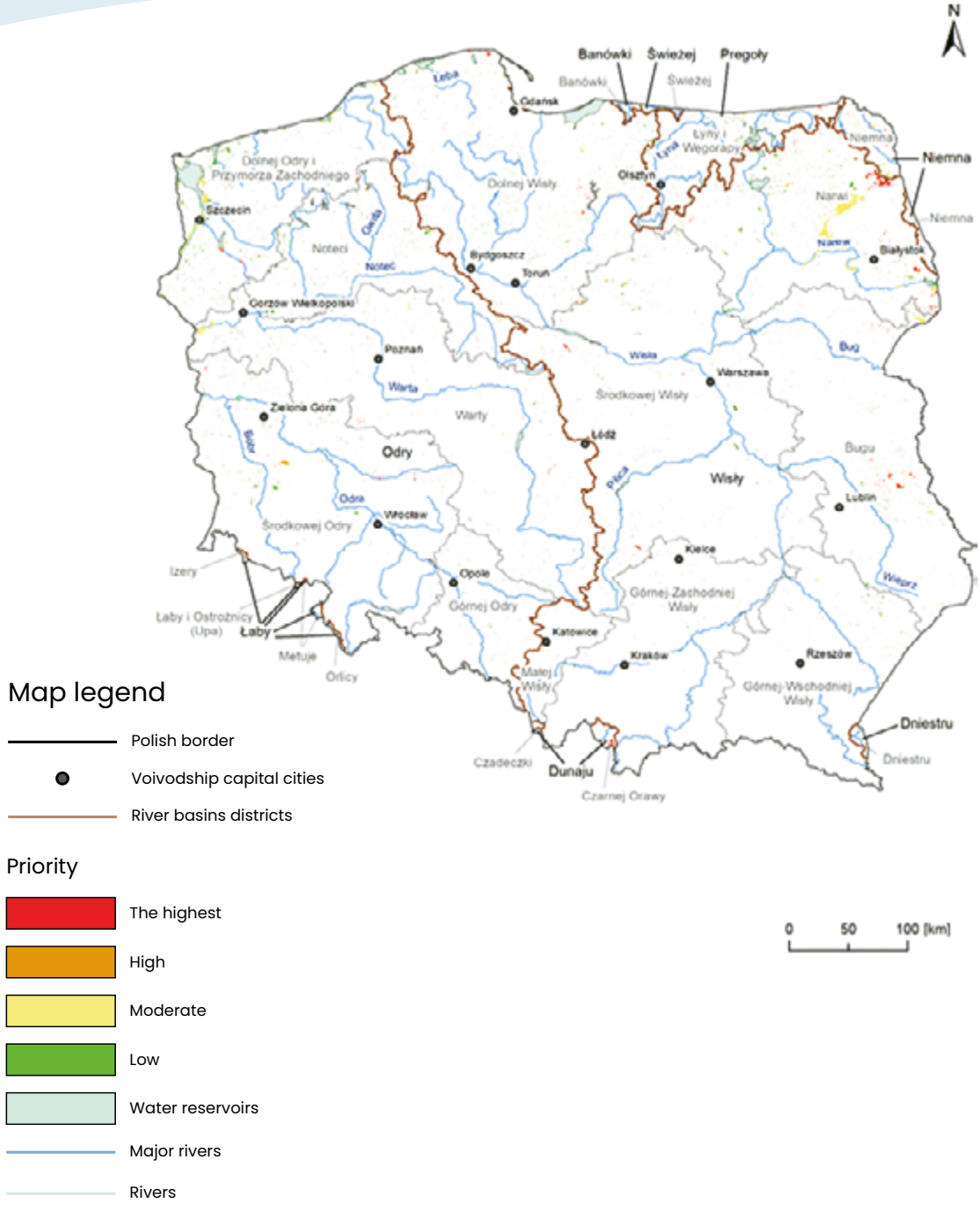
Type no 1 – Wetlands restoration

Water constitutes 75-90% of the wetlands volume. Therefore, they are very effective natural water magazines. Wetlands reduce the runoff of rainwater, thus increasing the retention of water in the catchment area. This accumulation of water contains large amounts of organic carbon that would otherwise be lost to the atmosphere. By excluding carbon from the atmosphere, wetlands help reduce the greenhouse effect. They are also a natural treatment method for reducing pollution in surface waters and precipitation. Increasing retention in wetlands - by limiting runoff - will contribute to raising the groundwater level and reduce the effects of drought. Restoration of wetland ecosystems also contributes to increasing biodiversity.

Many wetlands were drained by a network of drainage ditches. The planned measures depends on restoring natural conditions in the wetlands that are currently drained, and are located in areas threatened with a deficit of surface water. Wetlands located in protected areas have also received high priority when it comes to implementation of measures.

Measures should always be adjusted to the local situation. Restoration efforts include blocking the outflow of water in drainage ditches with gates, restoring the natural character of supply watercourses, and initiating the spontaneous disappearance of the drainage role of ditches by construction of dams made of peat material or insertion wood rubble into drainage ditches in order to initiate gradual decline of the drainage, and changing the forms and techniques of wetland use (in the case of agricultural use). .

Figure 10. Wetlands to be restored



Map legend

- Polish border
- Voivodship capital cities
- River basins districts

Priority

- The highest
- High
- Moderate
- Low
- Water reservoirs
- Major rivers
- Rivers

Based on the assumptions concerning water retention per 1 hectare, and the area of wetlands proposed in the highest and high priority restoration measures, the estimated retention in the entire territory of Poland may reach the value of approximately 170.5 million m³.

Assuming the average cost of wetland restoration will amount to PLN 40,744.8 per hectare, the estimated cost of restoration with the highest priority would amount approximately PLN 1.30 billion.[2]

[2] Costs calculated based on Biedroń I., 2020, Water restoration. Handbook of good practice in surface water restoration, State Water Holding Polish Waters, Krakow

Type no 2: Renaturation of rivers

The speed of water flow is reduced when rivers are restored to their natural state, due to the presence of aquatic and above-water vegetation, as well as a diversified course of the river bed.

In case of less extensively transformed watercourses, restoration may rely on appropriate modifications to maintenance works to enable the restoration of natural processes of riverbed structure restoration. In case of strongly transformed watercourses it may be necessary to remove water-control devices (bank reinforcements, bands, spurs, thresholds) or introduce natural obstacles into the bed in the form of stone rip-raps, tree trunks, or other obstacles slowing down the flow of water in the river. In extreme cases, it may be necessary to shape new, more natural river beds in place of the current, strongly distorted ones.

The necessity for the restoration of rivers in Poland are considerable. Therefore, National Program for Restoration of Surface Waters[3] includes over 3 thousand of rivers and their fragments, which account for over 85% of the entire river network. It is proposed to begin restoring the natural character of rivers at first for the 11 sections of the highest priority rivers: the Rudawa, Mienia and fragments of the Wisłoka, Łęg, Ślina, Narewka, Krzna, Wda, Płociczna and Ina.

High priority was given to: Bobrek, Rów Mokry, Biała Tarnowska and fragments of Dunajec, Reda, Stobrawa and Ślęza.

The volume of retention obtained as a result of the renaturation of the highest priority rivers will amount to 1,149.2 million m³. The estimated cost of the suggested measures is about PLN 3.5 billion.

Type no 3: Realization and restoration of small retention and microretention objects in forest areas.

Retention in forests is developed by the State Forests National Forest Holding under two projects:

- Comprehensive adaptation of forests and forestry to climate change small retention and protection against water erosion in lowland areas;
- Comprehensive project for the adaptation of forests and forestry to climate change – small retention and protection against water erosion in mountain areas.

We can distinguish two subtypes of retention measures implemented by the State Forests:

[3] The national program of surface water renaturation – a document developed by the State Water Holding Polish Waters collecting recommendations for restoring the natural character of surface waters.

Subtype of measure No. 3.1: Construction of small retention reservoirs in forests

The measure intends to build 428 reservoirs with a retention of 2.8 million m^3.

Subtype of action No. 3.2: Construction of other hydrotechnical objects in forests, excluding small retention reservoirs.

Measure includes restoring functions to wetlands and protection against water erosion in 67 powiats. In total, over 1,000 objects are to be built.

The costs of implementing measures in the field of realization and restoration of small retention and microretention objectives in forest areas were estimated at nearly PLN 300 million.

Type no 4: Forests retention, afforestation, reconstruction of forest stands.

Forests are harvested, causing a temporary decline in retention that must be replenished. Forest owners are required to permanent maintain of their conditions and ensure the continuity of their use. In particular, for reintroduction of forest vegetation (forest crops) within 5 years after the removal of the stand. Restoration of landscape retention in forests includes replanting of trees. As a result of the regeneration of the forests, it is possible to obtain 450 million m^3 water retention.

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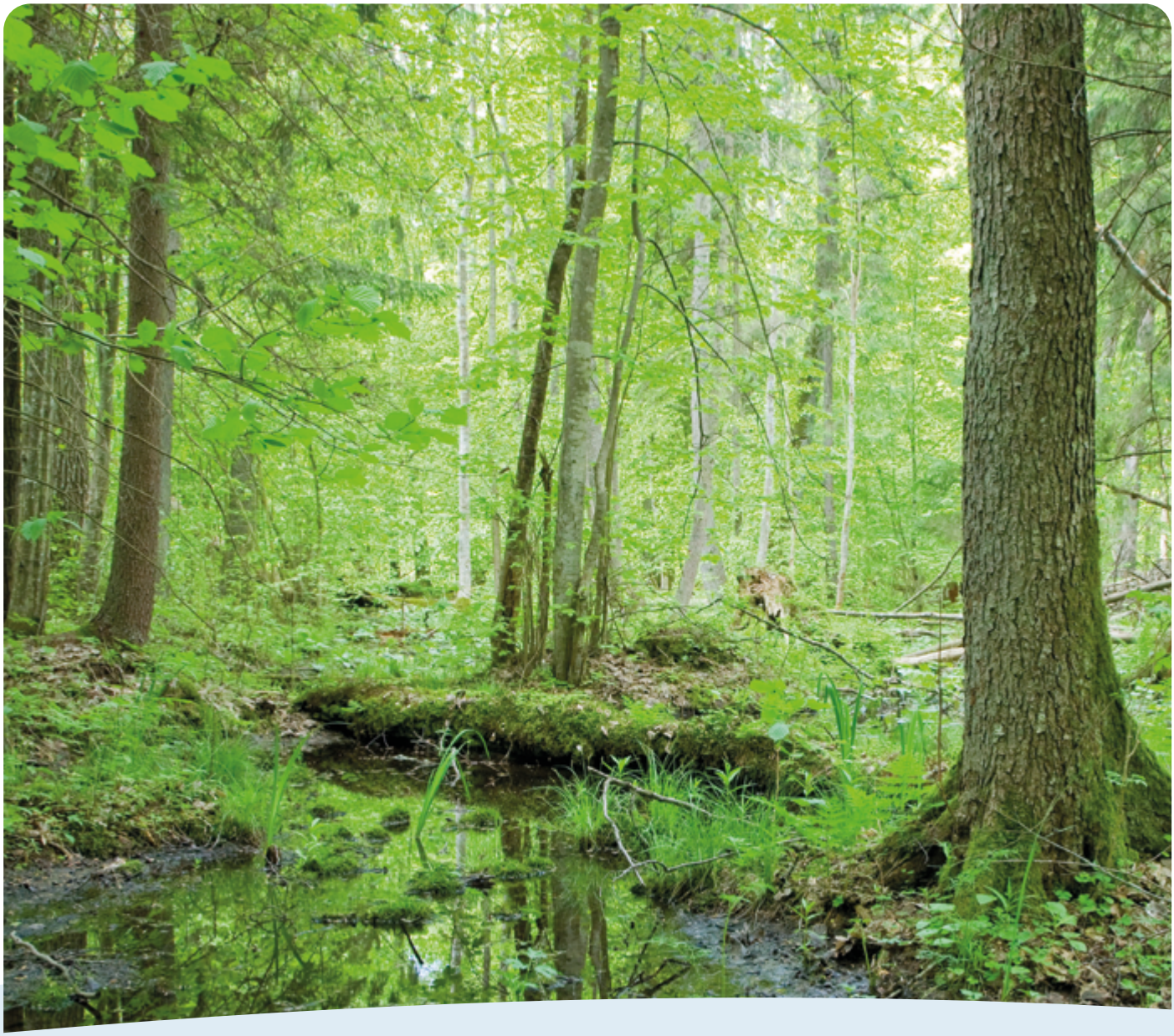


Type no 5: The realization and restoration of small retention and micro retention objects in agricultural areas

In agriculture areas retention can be increased in various ways. Small and microretention allow stopping or slowing down the runoff of surface waters and accumulating water rainfall locally - on the property next to the houses. The construction of small reservoirs and ponds allows for the collection, retention and re-use of rainwater and snowmelt. Conversely, efforts aimed at protecting periodically flooded areas will contribute to an improvement in water retention time and, therefore, to the growth of biodiversity.

Therefore, the measure was divided into sub-types.

Subtype No 5.1: Supporting microretention by creating home water reservoirs

The measure is related to the implementation of one of the priority programs of the National Fund for Environmental Protection and Water Management. In 2020, the second edition of the „My Water" program began. As part of the measure, it is possible to build devices for the management of rainwater.

Assuming that the „My water" program will be continued until 2027 and the value of retained water will be at the level of 2021, the value of retained water under this tasks can be estimated at the level of 10.36 million m^3.

Subtype action No 5.2: Protection of periodically flooded areas

The protection of periodically flooded areas includes the activities against the extensive use of meadows located in the rivers' valleys. Those measures will exclude floodplains from intensive agricultural production. These areas will be reserved for non-intensive types of agricultural use, or they will be completely excluded from use. This will lead to the formation of natural plant communities characteristic of this type of habitat.

The direct result of this action will be the protection of wetlands and peat. The protection will not only involve preserving the existing wetlands, but may also include the restoration of previously drained areas.

The measure is aimed at areas of drained meadows located on periodically flooded areas. In total, it is possible to obtain a level of retention 182 million m^3.

Subtype No 5.3: Wetland farming

One of the measures for wetland farming is the recommendation to introduce paludiculture - marsh agriculture. It consists on maintaining agricultural production while increasing the water level in the areas under cultivation and replacing crops with species that can cope with such conditions, e.g. in willow, herbs, reed, moss. Paludiculture assumes that economic benefits can be achieved with the restoration of wetlands by using appropriate crops and technology without affecting the natural processes occurring in wetlands. The measure applies to farmers on the land of which there is swamp or the land is permanently or periodically flooded. Changing the way of farming in such areas may translate into an increase in soil retention by 86.3 million m^3.

Subtype No.5.4: Protection of existing microretention facilities

The measure covers the protection of microretention objects created as a result of beaver activity - specifically lodges. Consequently, local water fluctuations are reduced. In case of creating beaver ponds, the average level of water retention in the pool at the dam is 3,000 m^3.

Discontinuation of the removal of beaver dams will allow 1.7 million m^3 to be stored.

It should be noted that beaver dams can be used to limit the area flooded by a given dam by using pipes to facilitate the flow through the structure. The example of such solution are measures taken by the Regional Directorate for Environmental Protection in Olsztyn.

Subtype No. 5.5: Supporting microretention by creating in-field reservoirs

The action consists in setting up mid-field ponds. Small field reservoirs have a positive effect on the water balance and create conditions for increasing biological diversity. Natural terrain depressions forming microretention can constitute valuable ecosystems with rich fauna and flora. Inland reservoirs have a positive effect on all components of the environment: surface and underground waters, soil, air, climate and biodiversity. At the same time, they maintain a higher water level and mitigate the effects of drought on agriculture.

Implementing the action to create in-field water reservoirs in natural terrain depressions will help retain over 800 million m^3.

Type no.6: Promotion and implementation of agrotechnical treatments increasing soil retention

Soil erosion results in the rapid discharge of water. Conditions for water retention are worse in dry soil, which results in reduced water availability for plants.

The practices proposed under the measure include strip tillage and the replacement of plow cultivation with no-till cultivation. Both of these types of soil cultivation simplify cultivation by reducing the number of necessary agrotechnical operations. This saves time and money on cultivation, while improving soil structure and water capacity. Due to the low intensity of activities, as well as leaving crop residues, these treatments also reduce evaporation from the soil surface, increasing soil retention and increasing the resistance of areas to drought.

Erosion control measures leading to a reduction in water runoff also include cultivation methods in the direction of the slope, irrigation of rainfall routes, the use of intermediate crops and, in the case of permanent grassland, the mowing of the sward at least once a year.

The above measures may bring the additional retention estimated for approximately 601 million m^3.

Type no 7: Realization and restoration of breeding ponds

Fish ponds are facilities in which water is stored for a certain period, which positively shape local water relations by stabilizing the groundwater level and increasing the moisture content of the soils in the areas adjacent to the ponds. This measure has also a positive effect on the microclimate, improve the water balance of the catchment area and increase air humidity.

It should be noted, however, that breeding ponds, as part of their activities, require water intake for filling - this is usually the spring period, when there are periods with less water availability. Water is also used to replenish losses due to evaporation, which usually occur during periods of drought. Due to the discharge of waters rich in nitrogen and phosphorus compounds during the drainage of breeding ponds, these ponds are also a potential source of pressure on the ecological status of waters.

Type No.8: Creation of new and reconstruction of existing drainage systems in order to provide the functions of irrigation and drainage

Melioration can be used not only as drainage but also as an irrigation device. Combined with channel retention, melioration ensures adequate irrigation of crops, resulting in high harvests.

In order to limit water runoff and improve soil retention, it is reasonable to reconstruct the existing drainage systems and create new ones.

Subtype No. 8.1: Reconstruction of melioration devices

The purpose of reconstruction of melioration devices is to change their function for the irrigation devices or both drainage and irrigation devices. The program for the development of water drainage determined that in the medium and long term[4] reconstruction of drainage sites will cover more than 200 thousand ha of agricultural land.

It is estimated that from the total area of the reconstructed infrastructure will be possible to retain 314.23 thousand m^3 of water.

Subtype No 8.2: Construction of irrigation drainage systems

The construction of new irrigation drainage systems is planned on the area of 526.2 thousand ha of agricultural land. The benefit of these measures is an increase of retention about 600,000 m^3.

This measure should be implemented in the frames of the Water Resource Development Program developed by the State Water Holding Polish Waters, in partnership with municipal governments and water companies to create a sustainable water management.

Type No. 9: Foundation and restoration of midfield, roadside and aquaticside trees and bushes.

The aim of the measure is to create green zones for arable land and permanent crops along roads and waterways. The scope of activity includes the following activities:

- creating green zones on arable land between fields or along the border of a field or field expensive;
- obligatory mowing of vegetation after September 30;
- obligation to collect the mowed sward and biomass;
- prohibition of plowing;
- obligation to remove invasive and alien species;
- prohibition of using mineral and natural fertilizers;
- ban on the use of plant protection products;
- a ban on the storage of manure, hay, straw, or waste;
- obligation to remove waste from green belts;

[4] The program for the medium- and long-term development of water drainage was prepared separately for each voivodeship under the supervision of prof. Edmund Kaca by the National Research Institute of Technology and Life Sciences.

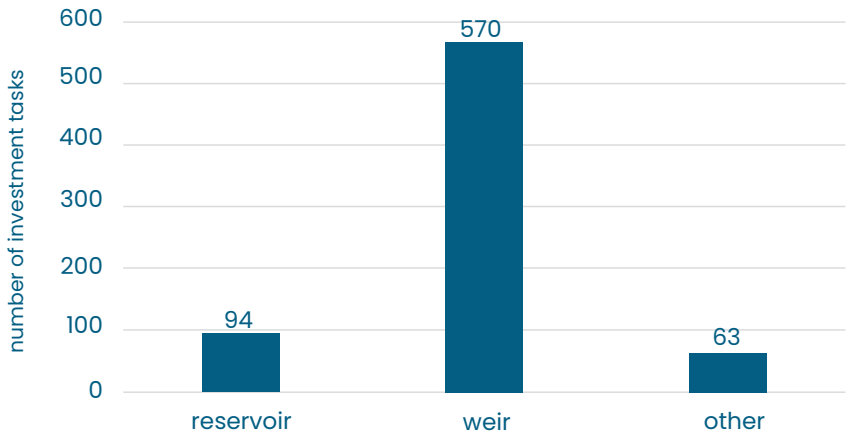
- a ban on the use of sewage sludge;
- prohibition of using natural zones as access roads, places to leave agricultural machinery or passenger cars.

Type no.10: Realization of water retention objects and
Type no.11: Implementation of other measures to improve water retention

Above-mentioned types of measures assume the construction of retention reservoirs and the construction of weirs, dams, and other hydrotechnical objects increasing riverbed retention. With regard to water availability, artificial retention and riverbed retention are a way to counteract the effects of drought and floods.

The Program includes the construction of 94 retention reservoirs and over 600 other measures aimed at improving retention.

Figure 11. Types of hydrotechnical investments in the field of retention



The State Water Holding Polish Waters will be responsible for the fulfilment of most of the tasks. The list of investment tasks is attached as Annex 4 to the Water Scarcity Prevention Program.

Due to the large number of planned investments, the implementation priorities for individual measures were assessed. The following criteria were considered:

- Location in relation to deficit areas;
- Retention efficiency;
- The obtained amount of retention;
- Location in relation to areas with increased water demand;
- Location in relation to deficit areas in the 2030 perspective;
- Provision of financing;
- Linkage with planning documents.

The main goal and effect of the implementation of investment activities is the increase of retention by 1.18 billion m³.

Figure 12. Priorities for the implementation of hydrotechnical investments in the field of retention

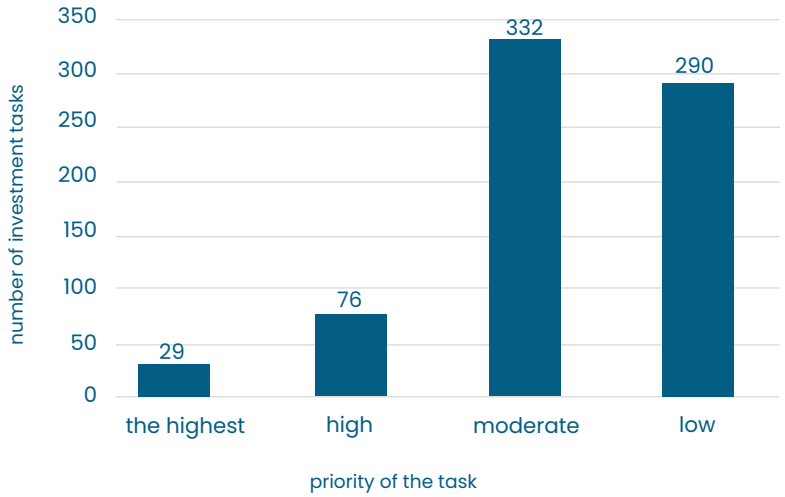
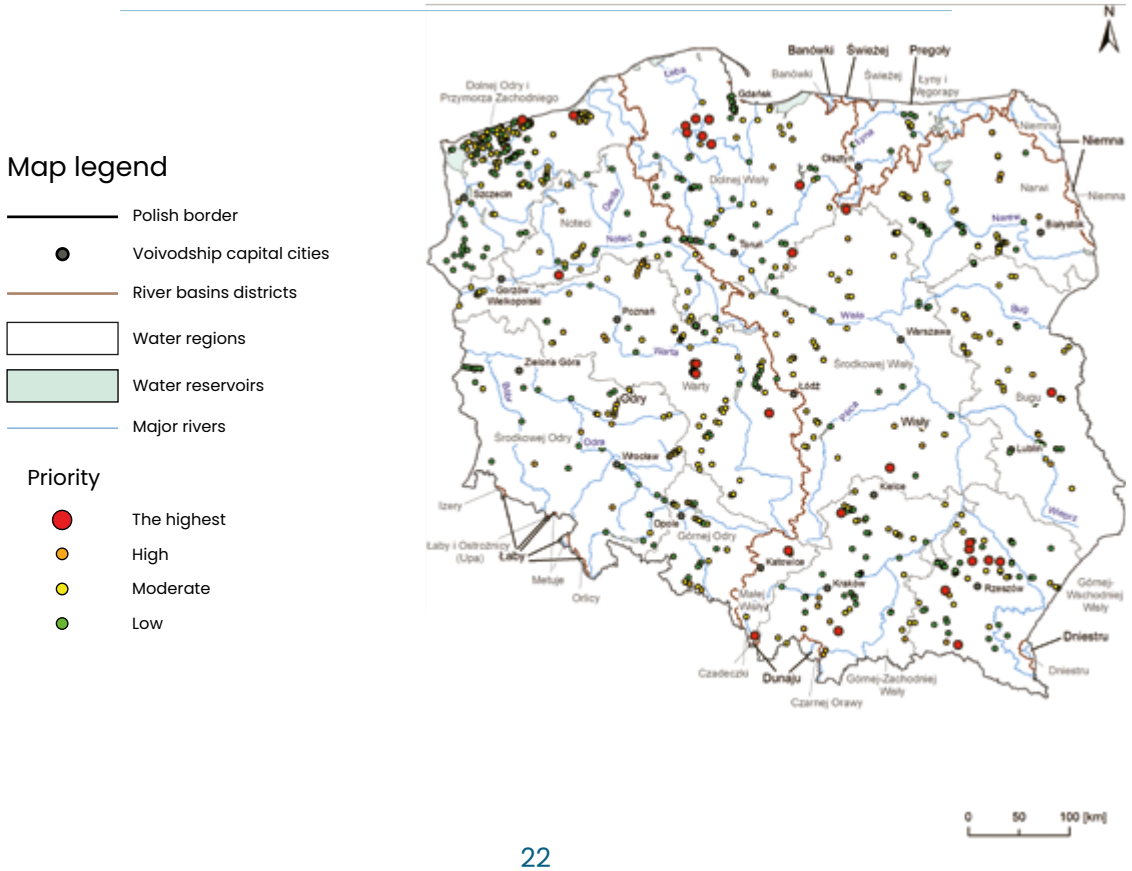


Figure 13. The placement of hydrotechnical investments in the field of retention



Type No. 12: Transformation of selected dry reservoirs into multi-functional reservoirs

Flood protection is the only function of dry reservoirs. Their transformation into a multi-functional reservoir allows storing water also outside periods of high water. Where possible, large retention reservoirs may be created, which will provide a stable level of groundwater and also regulate the river flow. This will help increase the resistance of the adjacent areas to the drought.

The Program contains the analysis for the possibility of transforming a dry reservoir into a multi-functional reservoir for the Kwietniki Reservoir (retention of approximately 0.6 million m^3) and the construction of a reservoir „Pińczów" on the area of planned dry polder, which will assure retention of approximately 1.2 million m^3 of water.

Type no 13: Mining area reclamation and transformation into water reservoirs

Post-mining areas of opencast mines are more and more often reclaimed in the water direction, i.e., they are turned into water retention reservoirs. The impact of gradual flooding of postmining excavations must be evaluated each time with consideration of the negative impact on the environment. This evaluation must be preceded by an analysis of geological, hydrogeological and environmental conditions.

The State Water Holding Polish Waters carries out a project called „Increasing the retention and restoration of water resources in post-mining areas in Eastern Wielkopolska". The purpose of the project is to adapt to climate change through the implementation of measures aimed at increasing the retention and restoration of natural levels of surface waters and groundwater. The implementation of the above project will increase the retention by 871 million m^3.

Type no 14: Implementation of Urban Adaptation Plans for cities and other measures aimed at increasing retention in cities (including blue-green infrastructure, rainwater retention and increasing the share of biologically active area).

It is also possible to increase retention in urban areas. This is supported by the blue-green infrastructure. They are nature-based solutions with economic, and social benefits. The blue-green infrastructure includes:

- retention ponds,
- bioretention basins,
- reservoirs, bioretention ditches,
- valleys of watercourses;
- infiltration ditches,
- rain gardens,
- green stops,
- green tram tracks,
- green roofs, green facades and walls,
- permeable surfaces, structural bases,
- green and wetland areas, etc.

Measures aimed at increasing water retention in cities are undertaken, for example, in Urban Adaptation Plans for cities. The plans include among other topics such as protection of sites with an unsealed surface, modelling of bioretention surface in public space management, protection of natural floodplains, and the construction of small retention reservoirs.

Another measure contributing to increasing retention in urban areas is the „My water" program, which aims to increase individual retention also in urban areas.

6. Effects of the Water scarcity prevention program implementation

The Water scarcity prevention program is a document that integrates the available methods of water retention. The measures proposed in the Program are capable for achieving the target of 15% retained water in relation to the annual average water runoff from the territory of Poland. Implementation of this goal will serve for the explicit response to the problems faced by society, environment and the economy in the context of climate change, especially the effects of extreme hydrological occurrences.

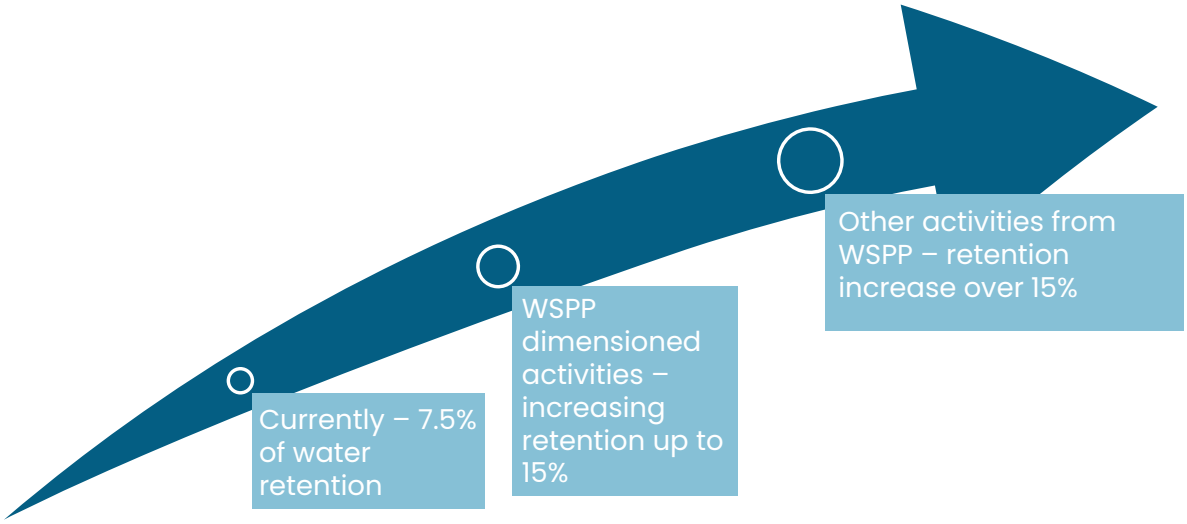
The main effect of the program's implementation is an increase in water retention. By each measure it is possible to retain:

The investment tasks of State Water Holding Polish Waters	approx. 1,176.3 million m^3
River restoration	about 1,149.2 million m^3
Creating and regeneration of small and micro retention objects in agriculture areas	approx. 1,082 million m^3
Mining area reclamation and transformation into water reservoirs	approx. 871 million m^3
Promoting and implementing farming practices, which increase soil retention	about 601 million m^3
Forest retention	over 450 million m^3
Wetland restoration	approx. 79 million m^3
Construction of small retention reservoirs in forests	approx. 2.8 million m^3
Building new and recreating existing drainage systems to provide irrigation and drainage functions	approx. 0.9 million m^3

The goal will be achieved only by using all possible methods and the involvement of all possible social groups and available tools. In total, the measures currently included in the program, for which it was possible to estimate the amount of retained water, will contribute to the achievement of an additional water volume estimated at over 5 billion m^3, which is over 8% of the average annual water outflow from the Polish territory. Thus, their implementation will allow for exceeding the previously unattainable limit of 15% of retained water in relation to average annual water outflow from Poland.

The total cost of implementing the program is estimated at PLN 41 billion.

The effectiveness of individual measures ranges from PLN 0.06 to 21000 for the retention of 1 m^3 of water.



7. Ecological education

One of the priorities of the Water scarcity prevention program is to strengthen public awareness of the need for water retention and saving. The priority can be obtained, among others, by educational, information, and promotional activities. The document includes in total 454 ideas for educational and information activities proposed by 169 institutions.

Measures include projects such as:

- Changes to the curriculum in schools;
- Information campaigns on retention, water saving, adaptation to climate changes creating a blue-green infrastructure;
- Calls for applications of The National Fund for Environmental Protection and Water Management and regional funds
- Production of television programs;
- Trainings and e-learning for farmers;
- Information and legal advice
- The promotion of the developed sets of good practices;
- The publication of press and internet articles;
- Information campaigns in social media;
- industry conferences;
- Competitions and educational activities for children and youth;
- Production of promotional materials, including information boards, leaflets, and brochures.

Measures supporting water retention, such as educational and information tasks, will strengthen the effect and acceptance of the Programs provisions.

Ministry of Infrastructure

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