The Drought Effects Counteracting Plan

I. List of Abbreviations:

1) Revised SWB – Surface Water Body according to the up-to-date information
2) updated RBMP – Update to the River Basin Management Plan
3) ARMA – Agency for Restructuring and Modernisation of Agriculture
4) BAT – Best Available Technology
5) NDTO10k – National Database of Topographic Objects (1:10 000 scale)
6) Comm. – Commune
7) CSO – Central Statistical Office
8) IMWM-NRI – Institute of Meteorology and Water Management – National Research Institute
9) ISSPC-SRI – Institute of Soil Science and Plant Cultivation – State Research Institute
10) SWB – Surface Water Body
11) GWB – Groundwater Body
12) SGU – Self-government Unit
13) CWB – Climatic Water Balance
14) NASC – National Agricultural Support Centre
15) NWMA – National Water Management Authority
16) MHDP – Map of the Hydrographic Division of Poland
17) MIAA – Ministry of Internal Affairs and Administration
18) NFEPWM – National Fund for Environmental Protection and Water Management
19) NOAA – National Oceanic and Atmospheric Administration
20) AAC – Agricultural Advisory Centres
21) SF NFH – State Forests National Forest Holding
22) SWH PW – State Water Holding Polish Waters
23) SRI – State Research Institute
24) PGI-NRI – Polish Geological Institute - National Research Institute
25) PW PIP – Polish Waters Planned Investments Program
26) DECP – Drought Effects Counteracting Plan
27) PHS – Polish Hydrogeological Survey
28) SHMS – State Hydrological and Meteorological Service
29) FRMP – Flood Risk Management Plan
30) GCS – Government Centre for Security
31) RCPs – Representative Concentration Pathways – scenarios of changes in carbon dioxide concentration
32) WFD – Water Framework Directive – Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Official Journal of the European Communities L 327, 22.12.2000, p. 0001-0073 as amended – Official Journal Polish Special Edition, Chapter 15, Vol. 5, p. 275, as amended)
33) RWMB – Regional Water Management Board
34) WMIS – Water Management Information System

35) RWR – Renewable Available Water Resources
36) Non-RWR – Non-Renewable Available Water Resources
37) IEP-NRI – Institute of Environmental Protection - National Research Institute
38) VFEPWM – Voivodeship Fund for Environmental Protection and Water Management
39) CP – Water Catchment Planning

II. List of legislation titles:

1) law:

a) Act of 20th July 2017 of Water Law (Journal of Laws of 2020, Item 624, as amended),
b) Act of 11th September 2019 amending the Water Law Act and certain other acts (Journal of Laws, Item 2170),
c) Act of 7th July 1994 of Construction Law (Journal of Laws of 2020, Item 1333, as amended),
d) Act of 27th April 2001. - Environmental Protection Law (Journal of Laws of 2020, Item 1219, as amended),
e) Act of 26th April 2007 on crisis management (Journal of Laws of 2020, Item 1856, as amended)

2) Regulation and European Union Directives:

a) Regulation of the Minister of Environment of 18th November 2016 on hydrogeological documentation and geological-engineering documentation (Journal of Laws, Item 2033),
b) Directive 2011/92/EU of the European Parliament and of the Council of 13th December 2011 on the assessment of the effects of certain public and private projects on the environment (Official Journal of the EU L 26 of 28.01.2012, p.1, as amended),
c) Directive 2000/60/EC of the European Parliament and of the Council of 23th October 2000 establishing a framework for Community action in the field of water policy

3) conventions:

a) Convention on access to information, public participation in decision-making and access to justice in environmental matters, done at Aarhus on the 25th of June 1998. (Journal of Laws 2003, Item 706).

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1. Analysis of the possibility of increasing the capacity of available water resources

Plan for counteracting the effects of drought (DECP) has been prepared on the basis of Article 183–185 of the Act of 20th July 2017 of Water Law, hereinafter referred to as the "Water Law Act".

According to Article 184 Paragraph 2 of the Water Law Act, DECP includes:

1) an analysis of the possibility of increasing the capacity of available water resources;
2) proposals for the construction or reconstruction of water facilities;
3) proposals for necessary changes in the use of water resources and changes to natural and artificial retention;
4) measures to counteract the effects of drought.

According to Article 14 Paragraph 2 of the Act of 11th September 2019 amending the Water Law Act and certain other acts, the provision of Article 184 Paragraph 2 Subparagraph 4 of the Water Law Act in the above-mentioned version applies to the first update of the DECP for the first time. Therefore, the DECP includes 'a catalogue of measures to counteract the effects of drought', which corresponds to the wording of Article 184 Paragraph 2 Subparagraph 4 of the Water Law Act before its revision.

Drought, as well as floods, is one of the most severe extreme natural phenomena affecting Poland's society, environment and economy. Counteracting the effects of drought, both in Poland and in Europe, is an increasing problem. This is reflected in numerous legal regulations, i. a. in the field of water resource management and crisis management.

Extreme meteorological and hydrological phenomena, including droughts, have always occurred in Poland. However, their occurrence has significantly increased in recent years. Over the last decade, i.e. 2010–2019, droughts occurred twice as often as in previous decades. Droughts of high intensity and covering most of the country occurred in 2011, 2015, 2018 and 2019 (statistically once every 2.5 years). For comparison, in previous period (1989–2009), drought events of high intensity and extent were recorded half as frequently, so once every 5 years (1989, 1992, 2000 and 2003).

The observed changes of the level of threat posed by drought in Poland are consistent with the direction of changes indicated in the results of climate change projections. The analyses of the climate change scenarios (RCP4.5 – the scenario of greenhouse gas emission stabilisation and RCP8.5 – the scenario of very high emissions) carried out for the purposes of the DECP indicate a possible increase in the frequency of drought occurrence in Poland by 2100. This is mainly supported by the established directions of changes in humidity and thermal indicators.

The expected increase in the intensity and frequency of drought is evidenced by the increase in daily temperatures, accompanied by the increase in the total of heavy rainfall. The high daily total of heavy rainfall will not balance the amount of summer evaporation if the indicated temperature increases. The described directions of possible changes indicate the deterioration of the climatic water balance

during the summer and autumn seasons. On the national scale, in spatial terms, a reduction in the risk of atmospheric and agricultural drought for some mountain areas and an increase in the risk of drought in other areas of the country should be expected. The predicted directions for climate change, resulting in an increase in the risk of the occurrence of the drought phenomenon, are significantly important in determining the directions in adaptation to these changes, including the determination of actions to counteract the effects of drought in river basin areas.

According to the long-standing methodology of planning in the field of water management, counteracting the effects of extreme phenomena should be implemented through proactive measures, in this case: measures preventing and reducing the likelihood of negative effects of drought, which are implemented regardless of the actual occurrence of drought. This adaptive (proactive) approach is primarily intended to promote activities aimed at enhancing the properties and processes shaping water resources in catchments in order to reduce losses in the event of possible drought. Hence it is necessary to implement both technical and non-technical measures on a catchment wide and a river basin area wide scale, aimed at shaping water resources and supported by spatial planning instruments, land and water management, protection of aquatic and water-dependent ecosystems and wetlands, as well as instruments to achieve environmental goals. The improvement and restoration of the natural conditions of the water cycle are also supported by actions aimed at strengthening natural retention, including the use of technical solutions. Drought risk management based on the above-mentioned assumptions will serve not only to reduce the scale of the threat and risk caused by drought. In addition, it will result in the reduction of water shortages (restrictions in access to water due to anthropogenic activities), enhancement of flood protection, and improvement of the condition of surface and groundwater bodies. At the same time, it should be noted that the proactive approach is also an action to limit (mitigate) climate change. A synergy of actions taken to minimize the combined risk of flooding and drought, while optimizing costs, is therefore necessary. The measures aimed at strengthening and restoring the retention capacity of a given area, such as:

1) the protection and restoration of ecosystems;
2) the protection and restoration of biodiversity, through i.a.: the restoration and reclamation of aquatic and water-dependent ecosystems and wetlands, forestation, the biologisation of soil,
3) the implementation of the principle of sustainable planning and designing urban areas (the so – called smart city, introducing elements of blue-green infrastructure);
4) changes to reduce economical water consumption,

counteract the effects of drought effectively, but also have a positive impact on creating a climate-neutral economy. Therefore, the adaptive measures used to counteract the effects of drought not only minimise the effects of drought, but also contribute to reducing the risk of this phenomenon.

A key component of DECP is shaping water resources, which results directly from the definition of drought. **Drought** is understood as: **a natural phenomenon caused by a long-term lack of precipitation, resulting in a periodic decrease in the level of surface- or groundwater, which may result in limitations in the possibility of using water, access to water services or the possibility**

of agricultural or forestry production. Depending on drought's types, i.e. whether it is an atmospheric, agricultural, hydrological or hydrogeological drought, it leads to various effects in terms of the use of water resources. The common denominator in all effects of drought is the amount of water resources available to use and to secure the functioning of ecosystems.

Taking into account the above-mentioned effects of drought, the **main objective of the Plan**, which is '**to counteract the effects of drought**', refers to the process of shaping water resources and the rational use of water resources in accordance with applicable standards.

The objectives specifying the main objective of the DECP are in line with Article 184 Paragraph 2 of the Water Law Act and concern the identified risk areas related to drought: the society, the economy and the environment.

The specific objectives of the DECP include:

1) **an effective management of water resources in order to increase the capacity of available water resources in river basin areas;**
2) **increasing retention in river basin areas;**
3) **education and drought risk management;**
4) **formalisation and planning of financing activities to counteract the effects of drought.**

The measures to implement the above-mentioned objectives should be carried out in a planned manner, with an emphasis on actions increasing the resilience of sensitive sectors of the economy as well as society and the environment to losses caused by drought. The tasks mitigating the effects of drought during its occurrence should also be implemented. The correct selection of measures, based on the specification of the condition of water resources, the results of drought risk analysis and the review of needs, increases the potential for achieving effective results of counteracting the effects of drought.

DECP, due to its nationwide scope (divided into river basin areas), the long-term character of the measures included in it (six-year planning cycle – currently 2021–2027) and the generally applicable legal force, is a document that ensures a high level of planning effectiveness.

1.1. DECP analytical possibilities of increasing available water resources – formal and objective scope

Analytical possibilities of increasing available water resources are ones of the four main components of the DECP. This analysis is a diagnostic study. It identifies the scope of applicable legal and administrative instruments necessary to conduct activities, while indicating the scope of non-technical and technical solutions aimed at increasing water resources (primarily by increasing water retention and water retention in the environment/catchment area). **The data analysis (from the 1987–2018 period) shows spatial indications of areas at risk of drought, as those where losses due to drought are to be expected, as well as, in parallel, an assessment of available water resources used to**

identify and prioritise the needs to implement actions aimed at counteracting the effects of drought.

The interoperability of the results as above-mentioned analysis is necessary for the correct data integration with WMIS operated by the Polish Waters (Article 329, Paragraph 2, Subparagraph 19 letter c, of the Water Law Act). The analysis, as the component of the DECP was used to programming and coordinating actions aimed at counteracting the effects of drought. This planning takes into account the division of the country into river basin areas, which is determined, i. a., by the requirement to coordinate with the reviews of water management plans in the river basin areas (Article 326 (4) of the Water Law Act) and the requirement to be consistent with the information presented on flood threats maps and on flood risk maps (Article 326 (2) of the Water Law Act). The results of the analysis of the possibility of increasing the capacity of available water resources and the proposed changes and measures resulting therefrom should be consistent with the set of measures being a component of water management plans in the river basin areas, including basic and complementary measures aimed at improving or maintaining good water status in the river basin areas.

Basic actions are aimed at meeting the minimum requirements for achieving good water status. They include, i. a., measures increasing the availability of water resources, which is essential for the DECP objectives. These measures include:

1) actions undertaken to optimise the principles of shaping water resources and the conditions for their use, including measures to control water abstraction;
2) limiting the intake of surface water and groundwater, taking into account the need to register the intake of surface water and groundwater and to record the consumption restrictions;
3) measures to ensure that significant impacts on the status of water were preceded by measures to maintain the hydromorphological conditions of water bodies at a level that will enable the achievement of the required ecological status or good ecological potential in the case of artificial or heavily modified water bodies, in accordance with the principles of sustainable development. (Article 324 (2) (11) of the Water Law Act).

Complementary actions are aimed particularly at achieving environmental objectives and may indicate:

1) legal, administrative and economic measures necessary to ensure the optimal implementation of the adopted measures;
2) negotiated agreements on the use of the environment;
3) actions to reduce emissions;
4) principles of best practice (in water management, maintenance works, water management, the use of water resources or shaping the retention potential of areas);
5) the restoration and creation of wetlands;
6) measures aimed at the efficient use of water and its re-use, in particular promoting water-efficient technologies for industrial use and water-saving irrigation techniques;
7) technical, research, developmental, demonstrational and educational undertakings/projects.

The analysis of the possibility of increasing the capacity of available water resources also serves the purpose of settling individual cases regarding the rights to use water or access to water services by water administration authorities. According to Article 399 of the Water Law Act, a water permit is refused if the planned way of using water violates, i. a. the DECP arrangements, or does not meet the requirements of protection of human health, environment, nature and cultural property entered in the Register of Historical Monuments. A water permit may be revoked if:

1) groundwater resources have decreased naturally;
2) there is a risk of not achieving the environmental objectives justified by the data acquired from water monitoring and the results of an additional review of water permits;
3) the risk analysis for the water intake was not performed or submitted, if such an analysis was required.

The analysis of the possibility of increasing the capacity of available water resources also defines the public interest of water protection, including the protection of water resources. Granting individual permits to use water and for water services is possible only up to the limits of the collision with the public interest understood in this way. Therefore, the legal and formal aspect of the analysis relates to the scopes of using water resources resulting from the granted permits and influences the proposals for necessary changes.

In the planning aspect, the results of the analysis and the DECP findings are part of water management planning, i.e. they are used to program and coordinate actions aimed at counteracting the effects of drought. The findings of the DECP, due to the obligation to include them in strategic and planning documents at the voivodeship, supra-local, municipal and local levelare binding for these documents (Article 326 (1) of the Water Law Act). Consequently, the legal and formal measures to increase the capacity of available water resources have been clearly defined in the legal regulations, primarily in the field of water management and spatial planning.

For the proper diagnosis and determination of the directions of actions within the counteracting the effects of drought, it is additionally necessary to define the spatial range of drought risk, as well as to indicate the need to increase the capacity of available water resources divided into river basin areas, including the determination of the scope of adequate measures to meet these needs.

1.2. Assessment of the condition of available water resources, taking into account the division of the country into river basin areas

The status of available groundwater resources was assessed on the basis of the definition specified in the Regulation of the Minister of the Environment of 18th November 2016 on hydrogeological documentation and geological engineering documentation (Journal of Laws of 2016, Item 2033). The availability of surface water resources is determined in the framework of the applicable water use conditions developed by RWMB SWH PW and the procedure for granting water permits (Article 403 Paragraph 2 Subparagraph 11 of the Water Law Act). The level of the available water resources

in individual cross-sections of watercourses is determined by guaranteed renewable available resources of a specific guarantee of occurrence, calculated as the difference between the amount of flow of a defined guarantee level and the amount of environmental flow in a given cross-section.

The available renewable resources define the amount of water that can be taken from a given profile while maintaining environmental flow and without worsening water supply conditions for other users with water permits in the catchment. These resources define the amount of water that can be taken from a given cross-section of the river, provided that the user, after using the abstracted water, returns it entirely to the river directly below the point of the abstraction. The non-renewable resources being the permissible amount of non-renewable consumption of the abstracted water are also determined using the criterion of integrity and not reducing the access to resources for other users. They are specified as a fixed value that is a part of renewable available resources, and are also referred to as reserves. Therefore, the amounts of available surface water resources are the result of balance analyses in which water resources are compared with the water needs of users and environmental requirements.

1.2.1 Available surface water resources

451 water level measurement stations (from 1212 stations belonging to SHMS), characterised by full series of daily flow data from the 1987–2017 period, were selected for the analysis of the assessment of the state of available surface water resources. Expert methods to determine the available resources, including on interpolation and extrapolation of results, were used for 117 uncontrolled catchments. In total, 568 catchments were analysed in Poland. The analysis required the determination of the environmental flow for each water level measurement station (QN) in [m^3/s] and converted to the outflow module [$l/s \cdot km^2$]. The calculations assume that the amount of water left in the riverbeds as an environmental flow is determined by the premises resulting from the need to protect the environment and meet the needs of water users. The environmental flow is thus defined as an amount of water expressed in m^3/s that should be kept as a minimum in a given cross-section of a river for biological and social reasons. As a part of the analysis, the environmental flow was calculated on the basis of a hydrobiological criterion (parametric method), the Kostrzewa method as it is called. The basic criterion was the hydrobiological conditions for the maintenance of the basic forms of flora and fauna characteristic for the river's water environment. The environmental flow determined by the Kostrzewa method is a constant value throughout the year.

The values of the environmental flow (QN) [m^3/s] were converted into the module value [$l/s \cdot km^2$] according to this formula:

$$qQN = \frac{QN \cdot 10^3}{A}$$

In which:

QN – environmental flow [m^3/s^{-1}],
A – catchment area [km^2]

The calculated values of the environmental flow module were divided into 3 classes: below 2,480 [l/s·km^2], from 2,480 to 4,959 [l/s·km^2] and above 4,959 [l/s·km^2]. The values of the environmental flow module were determined only for 451 controlled catchments.

53 of the analysed catchments placed in the class with the highest values of the environmental flow module. The highest values of the environmental flow module exceed 10 [l/s·km^2] and are located mostly in the south of Poland. 89 out of the 451 analysed catchments are characterised by the environmental flow module reaching values from 2,480 to 4,959 [l/s·km^2]. The remaining analysed catchments (309) are characterised by the modulus of the environmental flow below 2,479 [l/s·km^2] (Map No. 1).

After determining the environmental flows, the flows of a guarantee of occurrence p = 95% Qgw, p95%, and then the amounts of available resources ([m^3/s] and [l/s·km^2]) in terms of RWR and non-RWR resources and taking into account the impact of groundwater abstractions were calculated. Data on the use, amount and volume of surface and groundwater abstractions and discharges was contained in the database of the planning document 'Identification of pressures in water regions and river basin areas', the results of which were prepared on the basis of information contained in water permits at the end of 2016. They were analysed as to their affiliation to a given catchment area closed by a water level measurement station and converted into an average temporary abstraction/consumption (m^3/s). The following water abstractions were taken into account: surface water abstraction (10 170 objects), groundwater abstraction (21 710 objects), water transfers (38 objects), drainage of structures or construction excavations (1653 objects) and drainage of mining plants (120 objects). The following water discharges were included: municipal wastewater discharges (3,577 objects), domestic wastewater discharges (4,056 objects), industrial wastewater discharges (5,500 objects), liquid animal manure discharges (156 objects), landfill leachate water discharges (151 objects), discharges from facility drainage or construction excavations (1662 objects), aquaculture (5129 objects), and discharges of used brine, healing and thermal waters (48 objects). The indicator of the degree of usage of available resources was calculated on the basis of this formula:

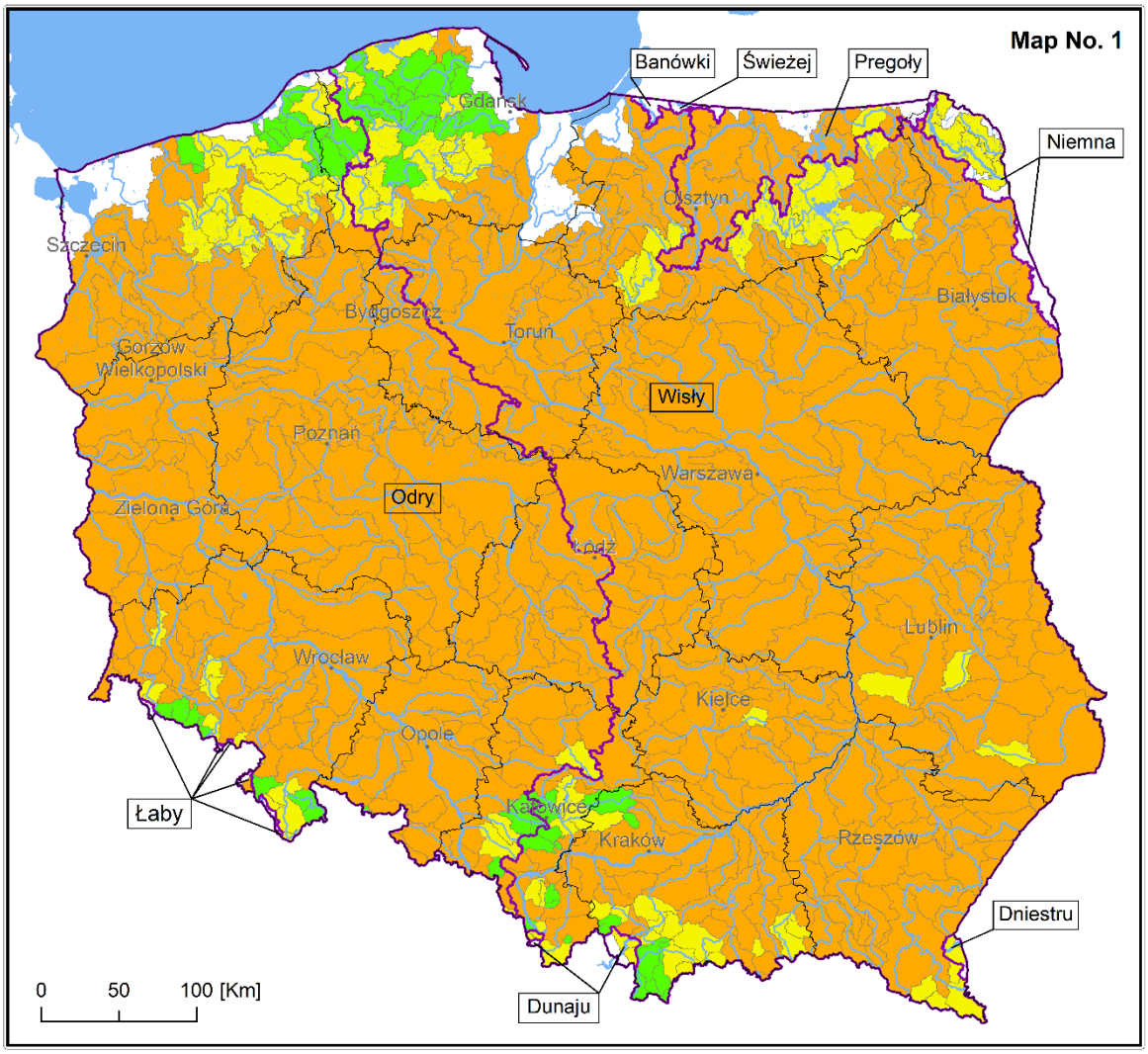
$$\mathrm{qWSWZDZ_x} = \frac{(\Sigma \mathrm{ZDZ_x} - \Sigma \mathrm{PWP_x}) \cdot 10^3}{\mathrm{A}}$$

in which:

qWSWZDZ – module of the degree of usage of available resources,
x – next water level measurement station,
ZDZ_x – sum of available resources in a given balance/differential catchment,
PWPx – sum of abstractions decreased by discharges in a given balance/differential catchment,
A – area of a given balance/differential catchment.

The scale for assessing the degree of usage of surface water resources is identified by 3 classes:

1) **normal level** – exploitation of water does not exhaust all available resources;
2) **intensive level** – there is a clear pressure on resource sustainability and an exploitation of water resources at the maximum level of water resources availability;
3) **very intensive level** – exploitation exceeds amount of water resources.



Environmental Flows module (1987-2017) [l/s-km2]

Legend

Environmental Flows module [l/s·km2]

- > 4,96
- 2,48 - 4,95
- < 2,48
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

The analysis of the intensity of the usage of available surface water resources showed that 38,95% of all the river basin areas in Poland are exploited on a normal level, 37,50% of them are exploited intensively, and 23,55% very intensively (Table No. 1). A very intensive level of use is characteristic for the catchment areas located in the source sections of the rivers in the Sudetes and Carpathians and the Silesian-Krakow Upland. The catchment areas with an intensive degree of usage are also located in the western part of the Central Poland Lowlands, the Wielkopolskie (Greater Poland) Lake District, the northern part of the Południowopomorskie (South Pomeranian) Lake District, the southern part of the Zachodniopomorskie (West Pomeranian) Lake District, the north-western part of the Wschodniopomorskie (East Pomeranian) Lake District, the Iława Lake District, the Lithuanian Lake District, the eastern part of the Północnopodlaskie Lowlands, the Gdańsk Coastal Region, the eastern and central part of the Koszalin Coastal Region and the northern and south-eastern parts of the Szczecin Coastal Region.

Table No. 1 Indicators of the degree of the use of available surface water resources and the state of environmental surface water resources in the river basin areas (hydrological data for years 1987–2017, resource usage status on 31.12.2016)

River basin area	Code of the river basin area	Degree of the use of available surface water resources [%]			Indicator of the state of environmental surface water resources during hydrological drought [%]		
		Normal	Intensive	Very intensive	Available surplus of flow	Not available surplus of flow	Inability to meet the needs of users and ecosystems
Dunaj	1000	0,00	0,00	0,12	0,00	0,00	0,12
Wisła	2000	22,22	25,36	11,15	42,37	3,47	13,21
Świeża	3000	0,04	0,01	0,00	0,05	0,00	0,00
Banówka	4000	0,07	0,00	0,00	0,07	0,00	0,00
Łaba	5000	0,01	0,00	0,03	0,00	0,00	0,08
Odra	6000	16,17	11,39	10,95	26,28	2,26	8,93
Pregoła	7000	0,20	0,55	0,72	1,22	0,34	0,73
Niemen	8000	0,24	0,18	0,50	0,24	0,11	0,46
Dniestr	9000	0,00	0,00	0,07	0,00	0,00	0,08
Poland		38,95	37,50	23,55	70,23	6,17	23,60

The assessment of the possibility of using available surface water resources during drought is determined by the index of the state of inviolable/environmental surface water resources. The results indicate that the inviolable surface water resources are not depleted during hydrological drought covering 70,23% of Poland's area. This means that despite the low water levels, all water users of the catchment area do not have a problem with the lack of water, and aquatic and water-dependent ecosystems function properly. This does not mean, however, that the situation may not deteriorate, e.g. as a result of an increase in the number of water users in the catchment (which will contribute to higher abstraction) or a combination of other negative factors (e.g. high water temperature, which will prevent the operation of power plants using resources of surface waters for technological processes;

a decrease in the oxygen content in the water resulting in the temperature-oxygen squeeze of fish and a reduction in the quality parameters of flowing waters). It should also be noted that the dominant part of surface water users uses their rights seasonally (e.g. to fill ponds). The situation of limited availability of river water resources during deep hydrological drought most often applies to mountain catchments in the range of the Carpathians and Sudetes, the catchment area of the Warta River, the Świętokrzyskie Mountains, but also the Pomeranian catchment area, the Pregoła basin and the north-eastern part of the Wisła basin. The surplus of flow available to water users, including aquatic and water-dependent ecosystems, is more often recorded in the Wisła basin than in the Odra basin area during hydrological drought. Regarding the entire country, an unfavourable situation occurs in 23,60% of its area, where the needs of users, including the needs of aquatic and water-dependent ecosystems, cannot be met during hydrological drought. For 6,17% of the country, the flow is equal to the environmental flow and no surplus flow is available during hydrological drought.

1.2.2 Available groundwater resources

The data set for the analysis of groundwater resources was the database developed by the PGI-NRI as a part of the implementation of the SHS tasks - data on groundwater resources, the volume of mine intake and drainage. The analysis used data on renewable and available resources in balance areas as of 31st December 2019. The SHS also provided data on the volume of groundwater abstraction from over 17,6 thousand groundwater intakes summed up in individual balance areas as of 31st December 2017. In addition, the SHS data was used for the total amount of mine drainage in 28 balance areas as of 31st December 2017 (Table No. 2). All issues related to groundwater management are based on the state of available resources in the balance areas.

Table No. 2 Value of mine drainage in open and closed mining plants in 2017 (in the balance areas given, the amount of drainage exceeds the available resources)

No.	Balance Area No.	Balance Area's Name	Value of mine drainage in open and closed mining plants in 2017 [thousand m^3/year]
1	G-1	Tążyna	169
2	GL-II	Mała Wisła R. to the Przemsza R. estuary	41,166
3	GL-III*	Przemsza	259,629
4	GL-IV	Górna Odra R. (the Odra R. below Kozioł R.)	32,969
5	GL-V*	Kłodnica	47,844
6	K01	Wisła R. from the Przemsza R. to the Skawa R.	615
7	K03	Wisła R. from the Skawa R. to the Dunajec R.	10,650
8	K05	Wisła R. from the Dunajec R. to the Wisłoka R.	27,188
9	K07	Wisła R. from the Wisłoka R. to the San R. (K+R)	4,596
10	P-I	Górna Warta R. (Upper Warta R.)	12,710
11	P-III	Warta R. from the Liswarta R. to the Widawka R.	2,837
12	P-IV**	Widawka R.	200,676
13	P-V	Warta R. from the Widawka R. to the Ner R.	20,000

14	P-VI	Ner R.	5,000
15	P-VII**	Warta R. from the Ner R. to the Prosna R.	182,848
16	P-XIV	Górna Noteć R. (Upper Noteć R.)	22,766
17	W-IV	Mała Panew R.	6,822
18	W-V	Nysa Łużycka R. (right)	5,016
19	W-VI	Bóbr R.	22,692
20	W-VII	Kaczawa R.	3
21	W-XI	Przyodrze (GL+WR)	24,515
22	Z-04	Radomka R.	284
23	Z-05	Wieprz R.	11,438
24	Z-07	Pilica R.	56
25	Z-13	Great Masurian Lakes and the Pisa R. catchment	3
26	Z-14	Bug boundary (L) and the Leśna and Pulwa R.	7,429
27	Z-19	Wisła R. (L) from the Bzura R. to the Korabnik R. below Włocławek	10,278
28	Z-23	Niemen R. (within the borders of Poland)	30

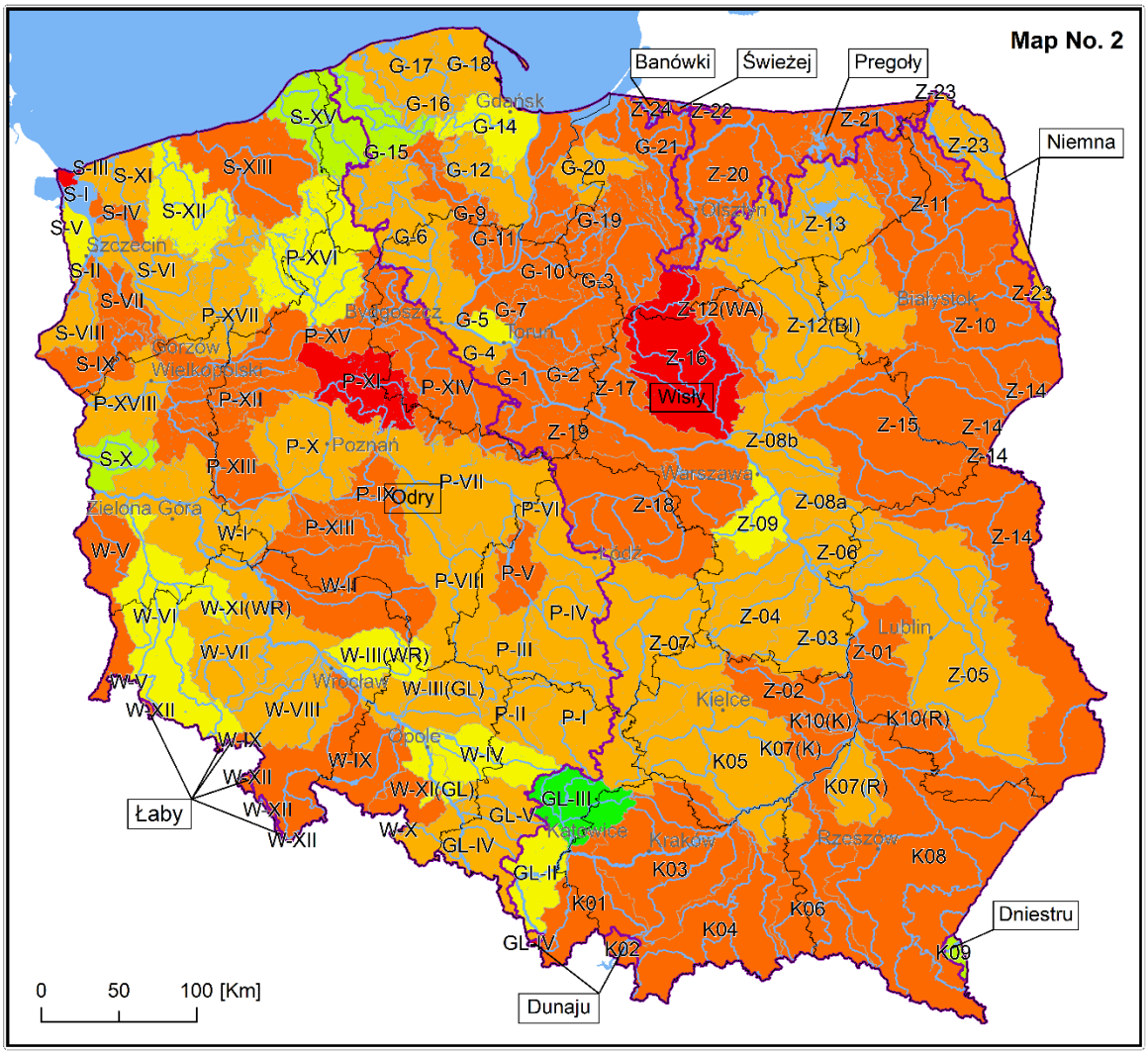
* drainage of underground hard coal mines and opencast mines of rock and sand in Upper Silesia,

** drainage of opencast lignite mines (P-IV – Bełchatów i P-VII – the Konin-Turek region).

Available resources are renewable resources that are reduced by the multiyear average of water flow in order to avoid a significant deterioration of the status of surface waters related to groundwater and significant damage to groundwater-dependent land ecosystems. The available groundwater resources are 33 771,087 m^3/24h as of 31st December 2019, which is 44% of renewable resources. The differentiation of values in individual river basin areas is the result of a very large disproportion between the areas of the river basins. The highest absolute values are in the eastern part of Poland. However, the distribution of values does not reflect the spatial distribution in the rest of the country, because these values depend very much on the area of the balance areas. The unit (modular) values of available resources (Map No. 2) are more reliable. The map of the available resource modules shows that the lowest values (below 50 m^3/24h/km^2) are found in 3 balance areas: S-1 (Uznam Island and Zalew Szczeciński (Szczecin Lagoon), P-XI (the Wełna River catchment) and Z-16 (the Wkra River catchment). In the case of the first two areas, this is due to the low number of renewable resources. On the other hand, in the Wkra catchment area (Z-16), the renewability is high (167 m^3/24h/km^2) and the low modulus of available resources is the result of the presence of large forest areas and the lack of prospects for high water demand. The dependence of the renewable resource module on geographic regions is noticeable: in the Carpathians and Subcarpathia, this module is low, in the Middle-Polish Uplands and in the Sudetes – medium-high (in the Silesian Upland – high), in the Central-Polish Lowlands, in the Greater Poland Lake District and in the Masurian Lake District – low, in the Pomeranian Lake District – high. These values by river basin areas are as presented below (Table No. 3).

Table No. 3 Available groundwater resources and their relation to renewable resources.

River basin area	Code of the river basin area	Available groundwater resources [m^3/24 h]	Renewable resources [%]
Dunaj	1000	22,302	14
Wisła	2000	18,493,989	38
Świeża	3000	12,737	20
Banówka	4000	14,952	23
Łaba	5000	22,220	19
Odra	6000	14,271,648	60
Pregoła	7000	594,295	31
Niemen	8000	290,037	26
Dniestr	9000	48,907	41
Poland		33,771,087	44



Available Groundwater Resources module within hydrogeological units (balance areas) (valid for the day of 31.12.2019) [m3/24hkm2]

Legend

Groundwater Resources module [m3/24h/km2]

- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350

- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

1.3. Assessment of the condition of natural and artificial retention, taking into account the division of the country into river basin areas

Water retention can be defined as the capacity of a river basin, sub-basin or other spatial unit to store water in the landscape, soil and aquifers shaped by both abiotic (topography, rock formations, soil) and biotic factors (vegetation). Water retention can be built naturally or artificially.

Natural retention of water in a river basin includes: landscape retention, soil retention, subsurface and groundwater retention, as well as surface water retention. An additional division results from the possibility of controlling the collection of water. Controlled retention means water retention in water reservoirs or in damming lakes, equipped with the devices regulating the amount of water discharged from the reservoirs. Uncontrolled retention means slowing down, reducing or stopping the outflow from the river basin, using technical and non-technical measures without the possibility of controlling the amount of the outflow.

Artificial retention of water is shaped mainly by the construction of water reservoirs, the purpose of which is to store water during high-water period and the possibility of its use in periods of shortages. Artificial retention can adversely affect the flow conditions below the reservoir if the water use is not properly managed.

Measures in the field of creating, protecting and enhancing water retention can be divided into technical and non-technical measures. Technical measures include most of the hydrotechnical and drainage works aimed at delaying the runoff of surface waters. Technical measures include the construction of small water reservoirs, damming water in streams and lakes, reconstruction of ditches and canals, retention of drainage waters and the use of appropriate methods of draining water from paved surfaces (roofs, squares, streets) creating favourable conditions for retention and infiltration. Technical measures to delay surface water runoff also include the construction of surface water dispersal systems and surface water recharge ponds and infiltration wells. The restoration of small watercourses and floodplains using technical methods is also a technical measure.

Non-technical measures include activities aimed at proper spatial planning, agrotechnical activities improving soil moisture and air conditions, the protection of habitats, and the preservation of unpaved surfaces, as well as activities including, among others, the restoration of watercourses and the passive protection of ecosystems to enable the undisturbed natural processes.

In accordance with the guidelines of the European Commission, **actions involving natural retention methods should be promoted and favoured. The construction of artificial retention in the forms as artificial reservoirs should be a last choice after all the more environmental friendly variants have been analysed (compliance with Article 68 of the Water Law Act).** Investments related to the construction of artificial reservoirs are included in strategic documents. Some of the proposed investments covered by the Article 4 Paragraph 7 of the WFD in the update of river

basin management plans and investments from flood risk management plans are aimed at counteracting the effects of drought and they will be implemented in the current planning cycle. Planning of new investment activities within water management and shaping artificial retention must be preceded by a series of analyses, and the conditions and procedures relating to them must comply with the current environmental regulations, as well as be adequate to the needs for the retention shaping.

The surface water resources retained in watercourse beds and lakes, due to the time and space-varying supply conditions, are values unevenly distributed in time and space. The average value of the runoff coefficient, i.e. the ratio of runoff to rainfall, was 0,28 in Poland (for years 1951–1995). This means that 28% of the water that reaches the earth's surface as rainfall is converted into surface runoff. The largest volume of runoff is in the Wisła River basin area (54% of the annual runoff), much smaller in the Odra river basin area (24%), the Przymorze (Coastal Region) rivers being a part of the river basin areas: Wisła, Odra, Pregoła, Świeża, Banówka and Niemen (9,4%). The inflow from outside the country is 12,6% of the total flowing water resources.

High topographic diversity and altitude of mountains and upland areas causes uneven spatial distribution of rainfall (supply) and, consequently, diversification of water abundance in rivers. Big drops and low permeability of the riverbeds' substrate facilitate the rapid drainage of water to lower located and (at the same time) flat depressions (valleys), where there are often no favourable retention conditions. Much greater water retention capacity is characteristic for coastal, lake-water, marsh-peatland and karst catchments. This results in a high variability of the retention conditions in the basin areas of the Wisła and Odra, especially due to the size and diversity of the area.

The considerable long-term and seasonal randomness of water resources in Poland forces to take measures to regulate the flow by: building water devices to increase retention, as well as implementing measures aimed at retaining water in agricultural catchments (e.g. by plowing across a slope) and forest catchments (e.g. afforestation within the borders of the watershed zones).

A review of data from available literature shows that total water resources of lakes in Poland are estimated at 19,7 billion m^3 (according to the analyses for 1992–1999), which gives an average water layer of 63 mm. The average value of the total resources of lakes is 9,5% of the volume of average precipitation in the analyzed multi-year period (660 mm) and 28,6% of the average annual runoff from Poland (220 mm). However, it should be noted that the above estimates were carried out over twenty years ago, and data published in 2017 indicates that in 2005, the average size of total lake resources decreased by 1 billion m^3, to the level of approximately 18,7 billion m^3.

The spatial distribution of natural retention of lakes is uneven and is actually concentrated in northern Poland. More than half of the water resources of lakes (51,27%) is concentrated in the Masurian Lake District (the Wisła River basin area, Pregoła River basin area and Niemen River basin area). More than 1/3 of the resources (36,12%) is located in the lakes of the Pomeranian Lake District (areas of the Odra and Wisła rivers basins). The lakes of the Wielkopolska-Kujawskie Lake District (the majority of them are located in the Odra River basin area and partly in the eastern part of the Wisła River basin area)

contain 11,93% of the water resources of the Polish lakes. The natural retention of lakes in the rest of Poland is small. It is estimated at 0,7 mm to the south of the range line of the last glaciation.

According to data from the Dams Technical Control Centre (IMWM-NRI 2005), 92 large water reservoirs and 31 smaller reservoirs with a total capacity of 3,46 billion m^3 are located in Poland. There are also several thousand small water reservoirs with a capacity of 1 hm^3, which, despite a small unit capacity, may be important during drought. The total maximum capacity of the 25 largest artificial reservoirs in Poland is 3,12 billion m^3 (data from the Central Statistical Office for 2017), which is 38% of the value of the annual surface water abstraction for the needs of users. 15 of the largest reservoirs are located in the Wisła River basin area. They can store up to 2,23 billion m^3 of water. The remaining 10 reservoirs are located in the Odra River basin area and they can contain up to 0,89 billion m^3 of water.

The water abundance of an area can be determined by the value of the average annual unit runoff (or runoff module). In the area of Polish river basins in the 1987–2017 period (for 451 analysed water level measurement sections), the average annual unit runoff is 8,3 $l/s \cdot km^2$. During hydrological drought, the average unit runoff from Poland's area is 35,2% of the average annual unit runoff (Table No.4). In extreme cases, the values of unit runoff during drought do not exceed 1% of the average annual unit runoff.

Table No. 4 Summary of the value of the average runoff module in the river basin areas.

River basin area	Code of the river basin area	Average runoff module (1987–2017) [$l/s \cdot km^2$]	Percentage of the average runoff during hydrological drought (1987–2017) [%]
Dunaj	1000	13,4	23,1
Wisła	2000	8,7	33,8
Świeża	3000	-	-
Banówka	4000	-	-
Łaba	5000	13,1	17,3
Odra	6000	7,7	38,1
Pregoła	7000	6,6	30,5
Niemen	8000	7,6	53,8
Dniestr	9000	15,1	21,4
Poland		8,3	35,2

In the area of the Wisła River basin, the average runoff module (for the 271 analysed water level measurement sections) is higher than the average one for Poland and it is 8.7 $l/s \cdot km^2$. During hydrological drought, the unit runoff in the Wisła River basin area is 33,8% of the average annual unit runoff from this basin area.

In the Odra River basin area, the average unit runoff (for the analysed 162 water level measurement sections) is 7,7 $l/s \cdot km^2$. During hydrological drought, unit runoff in the Odra River basin area is 38,1% of the average annual unit runoff from this basin area.

In the Dunaj River basin area, the average unit runoff is 13,4 l/s·km^2. During hydrological drought, unit runoff in the Dunaj River basin area is 38,1% of the average annual unit runoff from this basin area.

In the Łaba River basin area, the average unit runoff is 13,1 l/s·km^2. During hydrological drought, unit runoff in the Łaba River basin area is 17,3% of the average annual unit runoff from this basin area.

In the Pregoła River basin area, the average unit runoff (for the analysed 9 water level measurement sections) is 6,6 l/s·km^2. During hydrological drought, unit runoff in the Pregoła River basin area is 30,5% of the average annual unit runoff from this basin area.

In the Niemen River basin area, the average unit runoff (for the analysed 5 water level measurement sections) is 7,6 l/s·km^2. During hydrological drought, unit runoff in the Niemen River basin area is 53,8% of the average annual unit runoff from this basin area.

In the Dniestr River basin area, the average unit runoff is 15,1 l/s·km^2. During hydrological drought, unit runoff in the Dniestr River basin area is 21,4% of the average annual unit runoff from this basin area.

For the Świeża and Banówka river basin areas, due to the lack of a hydrological monitoring network, the above-mentioned indicators of retention cannot be provided.

The assessment of the retention capacity of river basin areas in terms of surface waters shows a direct need to increase the retention of surface waters. Hence, in the part including the catalogue of measures to counteract the effects of drought, measures to increase the level of water retention and increase the available water resources are planned. Educational activities and the development of good practices to raise awareness and consolidate water use patterns in order to ensure results related to the drought risk management process, including hydrological, are also planned.

It should be noted that it is necessary to act complementarily in order to counteract the effects of drought effectively, i.e. it is necessary to implement both technical measures, investments in large and small retention and natural retention activities, such as restoring and protecting e.g. wetlands or increasing river bed retention as well as non-technical ones including shaping good attitudes and educating the public and constructing systems for monitoring and reacting to the phenomenon of drought.

In the case of groundwater retention, the analysis refers to the scope of analyses of the assessment of available resources included in the part 1.2 DECP. The capacity of these resources is evidenced, for example, by the fact that the sum of groundwater abstractions recorded throughout Poland is approx. 21% of available resources. Currently, there are no plans, and no plans are being made within the catalogue of measures to counteract the effects of drought, to recharge aquifers artificially in order to increase the retained groundwater resources. However, attention is drawn to the need to increase the possibilities of precipitation infiltration in order to ensure the recharge and renewal of local groundwater resources. Priority should be given to efforts aimed at increasing groundwater recharge in regions where intensive groundwater extraction is carried out.

Forming water resources in soil is an important aspect of reducing the effects of agricultural drought. The categories of soil vulnerability to drought used in the Agricultural Drought Monitoring System (ISSPC-SRI) indicate the potential of soil water retention. These categories include soils with similar retention properties and the potential amount of water available to plants in the soil profile. The conditions of water retention of soil in agricultural areas (excluding permanent grassland) estimated for the river basin areas, indicate that 26,3% of agricultural land area is characterised by poor soil retention capacity (1st category of soil vulnerability to agricultural drought with soil water capacity below 127,5 mm of water available generally in the soil profile). The areas occupied by 1st and 2nd categories of soil vulnerability to drought (very vulnerable and vulnerable to drought) account for the share of the following river basin areas: Odra – 64,2%, Wisła – 52,6%, Niemen – 58,6%, Pregoła – 34%, Banówka – 25%, Świeża – 16,2%, Dunaj – 17,4%, Łaba – 48%, Dniestr – 13,6% (Table No. 5).

Table No. 5 Categories of soil vulnerability to agricultural drought – conditions of water retention in soil in agricultural areas (excluding permanent grassland) in the river basin areas – percentage share of area in a given category

River basin area	Code of the river basin area	1st Category very vulnerable to drought soil [%]	2nd Category vulnerable to drought soil [%]	3rd Category moderately vulnerable to drought soil [%]	4th Category not very vulnerable to drought soil [%]
Dunaj	1000	5,33	12,10	24,07	58,49
Wisła	2000	26,02	26,58	30,07	17,32
Świeża	3000	7,48	8,73	74,98	8,81
Banówka	4000	8,89	16,07	69,78	5,27
Łaba	5000	18,01	29,93	30,32	21,74
Odra	6000	27,26	36,89	21,71	14,14
Pregoła	7000	17,18	16,85	46,32	19,65
Niemen	8000	42,80	15,83	13,78	27,59
Dniestr	9000	0,23	13,39	52,78	33,60
Poland		26,32	30,02	27,35	16,32

Soil that is not very vulnerable to agricultural drought characterised by good conditions for soil retention, makes up 16,32% of agricultural land in the country (4th category of soils with a particle size distribution from medium clay to silty clay with a water capacity above 202,5 mm expressed in the volume of water available generally). The Dunaj River basin area is characterised by the greatest retention of soils on agricultural land, 58,5% of the area is 4th category - soil not very vulnerable to agricultural drought). In the areas of other river basins, the water capacity of soils at the level of the 4th category is from 5,27% in the Banówka River basin area to 33.6% of the Dniestr River basin area. For the main river basins of the country, the Wisła and the Odra, it is respectively 17,32% and 14,14%.

Analyses of the spatial distribution of categories of soil vulnerable to agricultural drought provided data to be introduced into the catalogue of measures to counteract the effects of drought, fitting into the scope

of activities focused on increasing soil retention, forming water resources on agricultural land and creating and promoting good agricultural practices aimed at rationalising the use of water in agriculture, including irrigation.

1.4. Purpose of measures to increase the capacity of available water resources

The effective management of water resources to increase their available capacity is the one of the specific objectives of the DECP and should be achieved in accordance with the purposefulness and adequacy criteria of the solutions in relation to the level of risk of drought and the degree of its risk in a given area. Hence, the selection of possible solutions and actions to counteract the effects of drought, including actions aimed at increasing and forming water resources, was preceded by a detailed analysis using the results of maps of the risk of occurrence of individual types of drought. The maps obtained as the result of analyses performed for the needs of the DECP are the data for the assessment of the amount of available resources in conditions of drought. They are used to determine the degree of drought risk in terms of the estimated need for measures to increase available resources at the level of river basin areas.

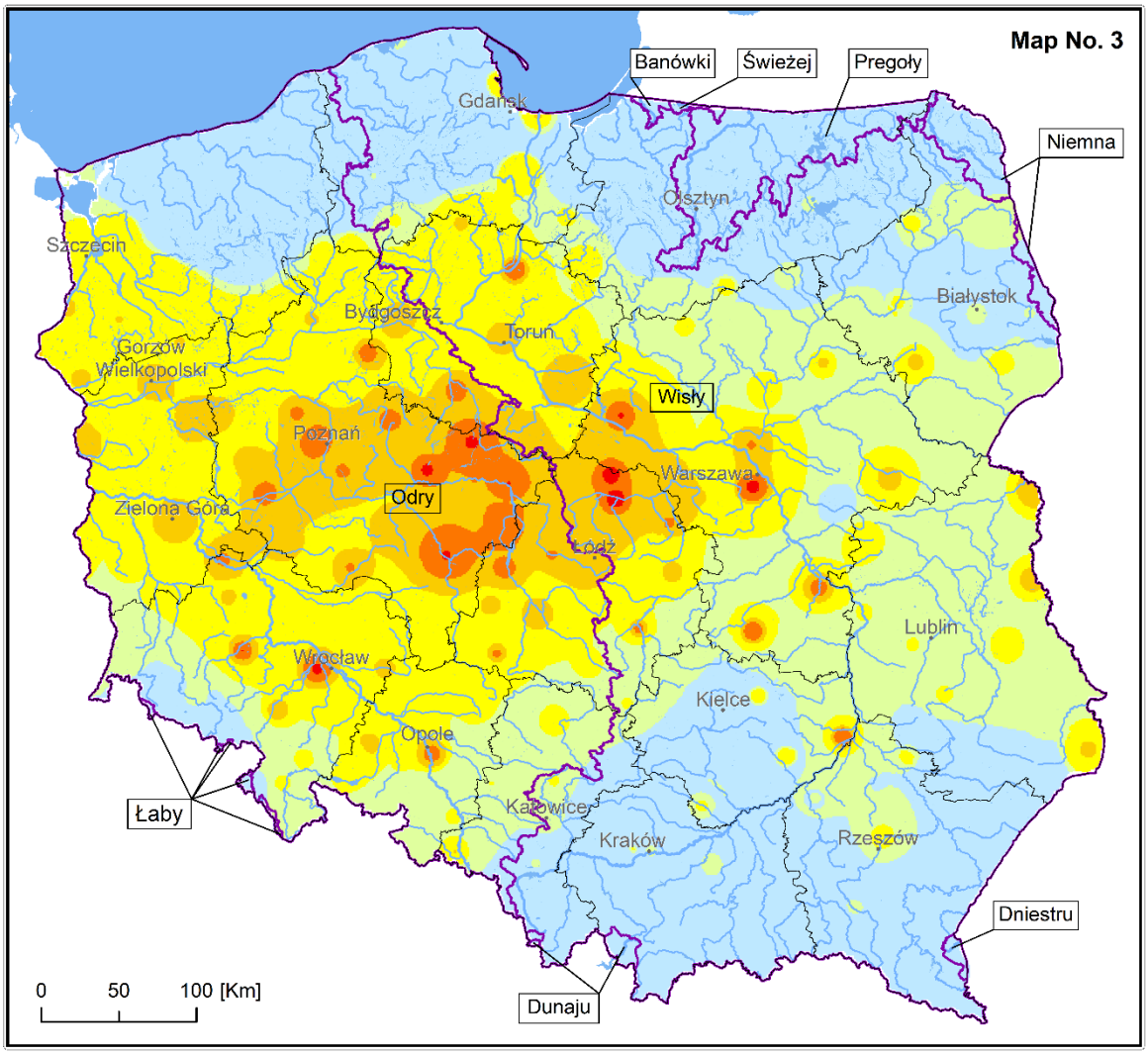
Drought risk management is influenced by the results of the risk assessment of three out of four types of drought: agricultural, hydrological and hydrogeological. The drought risk maps are a direct result of the analysis of precipitation deficits. In the context of counteracting the effects of drought, it is impossible to remove or minimise the threat of drought. In this context, it is important to accept the fact that the threat of atmospheric drought cannot be removed. Drought risk management translates into lowering the risk level and mitigating the course of droughts, without the possibility of influencing the rainfall deficit. However, it should be noted that the data on the sum of precipitation and other parts of the analysis of the risk of atmospheric drought were taken into account in the analysis of agricultural drought.

The diagnosis of areas with a recurring deficit of atmospheric precipitation (threats of atmospheric drought) is applicable for the management of the effects of other types of drought (agricultural, hydrological and hydrogeological) when it refers to the balance approach, i.e. it is based on the results of the CWB. The CWB analysis for the years 1987–2018 was carried out for this purpose. The analysis of the probability of the annual CWB values reaching below -150 mm was used, the values being evidence of rainfall supply deficits and indicating, from the point of view of counteracting the effects of agricultural drought, the increased need for the development of irrigation devices. The probability of the CWB values reaching below -150 mm ranges from 0% to 47% nationwide, which, in extreme cases, indicates a very severe atmospheric drought every 2–3 years on average (Map No. 3). The lowest probability of atmospheric drought, calculated according to the established threshold, occurs in mountain areas, valleys and foothills, as well as the coastal region, in Masuria and Podlasie. The highest risk of an atmospheric drought occurs in central Poland, at the junction of the following voivodeships: Wielkopolskie, Kujawsko-Pomorskie, Łódzkie and Mazowieckie. The increased risk of severe atmospheric droughts occurs in central and western Poland. In the rest of the country, the risk of occurrence of years with severe drought is predominantly local, according to the obtained CWB values.

In terms of river basins, the lowest risk of severe rainfall deficits occurs in the Dunaj and Dniestr River basins, as well as in the Łaba, where the lowest risk class of atmospheric drought dominates, with the probability of a severe rainfall deficit occurring below 5% on the scale of the analysed multiannual period (i.e. approximately once in 30 years). The regions highly and very highly threatened by atmospheric drought, i.e. where exceeding the CWB threshold value below -150 mm is possible, are in the largest river basin areas, i.e. the Wisła River and the Odra River. Such situations are probably observed at least once every 5 years in the area of 22,1% of the Wisła basin area (40 459,7 km^2) and 69,3% of the Odra basin area (81 843,0 km^2) (Table No. 6). Highly threatened areas constitute nearly 25% of the Odra River basin area, mainly in its middle and lower course. On the other hand, in the area of the Wisła River basin area, the most unfavourable conditions, with a predominance of insufficient precipitation over evaporation, occur on the border of its middle and lower course.

Table No. 6 Summary of the share of river basin areas at risk of severe drought for the CWB threshold value below -150 mm (1987–2018). The values in brackets refer to the percentage share of a given class in the total area of the river basin area

River basin area	Code of river basin area	The frequency of the CWB below -150 mm			
		less than every 30 years	no more than every 10 years	no more than every 5 years	at least every 5 years
Dunaj	1000	384,5 km^2 (100,00%)	–	–	–
Wisła	2000	26 649,6 km^2 (14,5%)	116 049,4 km^2 (63,4%)	28 536,1 km^2 (15,6%)	11 923,6 km^2 (6,5%)
Świeża	3000	64,9 km^2 (40.00%)	97,4 km^2 (60,00%)	–	–
Banówka	4000	37,1 km^2 (17,70%)	172,3 km^2 (82,3%)	–	–
Łaba	5000	147,7 km^2 (62,2%)	89,6 km^2 (37,8%)	–	–
Odra	6000	3 234,5 km^2 (2,7%)	32 970,8 km^2 (27,9%)	54 550,2 km^2 (46,2%)	27 292,8 km^2 (23,1%)
Pregoła	7000	168,3 km^2 (2,2%)	7 344,0 km^2 (97,8%)	–	–
Niemen	8000	172,4 km^2 (6,9%)	2 341,2 km^2 (93,1%)	–	–
Dniestr	9000	232,8 km^2 (100,00%)	–	–	–
POLAND		101 723,9 km^2 (32,5%)	84 778,4 km^2 (27,1%)	86 770,1 km^2 (27,8%)	39 408,6 km^2 (12,6%)



Probability of the CWB annual value to reach below -150 mm (1987-2018)

Legend

Probability of the CWB annual value to reach below -150 mm

- 0 - 5
- 5,1 - 10
- 11 - 20
- 21 - 30
- 31 - 45
- 46 - 50 [%]
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

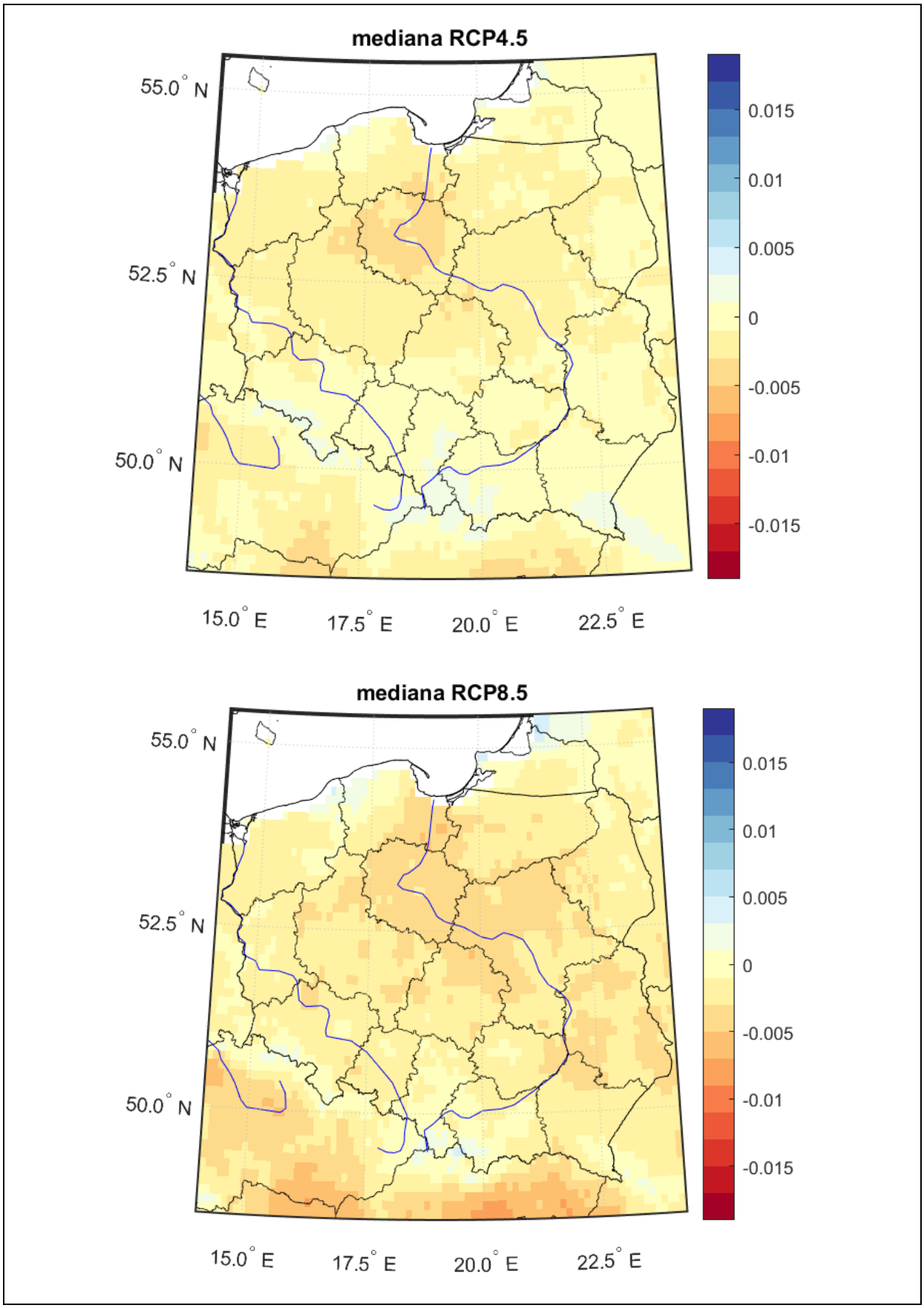
The assessment of the risk of atmospheric drought is supplemented by the established trends of changes in the level of its risk, estimated on the basis of analyses of climate change scenarios, carried out as a part of the DECP. The results of the climate change analyses confirming the present and future need to implement planning tasks in the field of counteracting the effects of drought. The analyses of climate change, developed for the purposes of the DECP, allows to determine the trends of changes in the climatic factors determining the formation of droughts and to determine their impact on the progression or reduction of the risk of drought in Poland in future changed climatic conditions. It should be emphasised that the analyses in the scenario approach only show the view of the direction and intensity of changes in terms of two specific climate scenarios. The values of climate humidity and thermal indicators according to the emission scenarios: RCP4.5 and RCP8.5, were used for the purposes of the analyses. Their results show the estimated climate changes between the future period 2071–2100 compared to the reference period 1971–2000 (the analysis was made in a cluster of 14 climate simulations for each scenario).

The first emission scenario (RCP4.5) is one of scenarios that reflect the picture of average changes in relation to extreme scenarios. The second of the selected scenarios, RCP8.5, assumes the largest changes in the average temperature on the Earth's surface. Conclusions from the estimated impact of climate change on the future degree of drought risk in Poland indicate an increase in the occurrence and the intensity of droughts to come. Taking temperature changes into account the tendency is especially visible. From the perspective of rainfall deficits, the scenarios estimate an increase in rainfall in the future (2071–2100) compared to the reference period (1971–2000). This is indicated by the number of days without precipitation, which was reduced by about 2% in the scenarios and the simultaneous extension by 5,4%–6,6% of periods with precipitation, and an increase (by 16% – 28%) in the amount of maximum rainfall. Despite the increase in the humidity parameters of the climate, the estimated intensity of evaporation, caused by the increase in temperature indices, appears to be the factor determining the increased risk of atmospheric and agricultural drought in Poland. The consequence of these changes in the water balance is the impact on the supply of water resources, and, consequently, the reduction of this supply increases the risk of hydrological and hydrogeological drought. The estimated temperature changes in the analysed climate change scenarios (RCP4.5 and RCP8.5) indicated, respectively, a 65% and 128% increase in the number of days with the maximum temperature of the air above 25°C, as well as an elongation of 73% and 135% of the longest period with maximum air temperature above 25°C.

Due to the level of estimated changes, both in thermal and humidity conditions, the key conclusions were provided by their integrated analysis in terms of the standardised climatic water balance index (SPEI) calculated in the three-month (SPEI 3) and annual (SPEI 12) system. The results of the SPEI analysis provide information on the conditions of rainfall, that is, the conditions for water retention in soil, surface and groundwater. The obtained calculations for the analysed scenarios of climate change suggest a reduction in the risk of atmospheric and agricultural drought for mountain areas and an increase in the risk of drought in other areas. For both emission scenarios, a deterioration of the climatic water balance is forecast for the summer and autumn seasons. The decrease in the value

of the climate water balance in the future was obtained in the results for the summer and autumn seasons for both emission scenarios. For the RCP8.5 scenario, the decrease in the value of the climatic water balance was additionally obtained as a result in the winter season, and for the RCP4.5 scenario in the spring season. In the case of annual data, negative trends of change of SPEI 12 have been established for both emission scenarios. From the perspective of estimating the possible degree of risk of drought in the future, the spatial distribution of the tendencies of changes in the standardised annual climate water balance of SPEI 12 (Map No. 4) and the direction of changes indicate an increased risk of atmospheric and agricultural drought. At the same time, they confirm generally negative consequences for the water cycle, i.e. the escalation of the risk of hydrological and hydrogeological drought. This conclusion emphasises the need to undertake and perform planning activities to counteract the effects of drought.

Map No. 4. Changing trends of the SPEI 12 from 1971 to 2100 according to the RCP4.5 and RCP8.5 scenarios (using the results of the Mann-Kendall test and the Theil-Sen estimator)



The spatially assessed scale of drought risk, both in total and for its individual types, developed on the basis of data from many years, allows to determine the areas where drought has occurred most often and has lasted for the longest time in relation to the scale of its intensity.

Drought risk maps provide important information for planning actions to counteract its effects. The designated ranges were developed in a hierarchical system in a four-level division of the risk of drought - four classes of areas:

1) 1st Class – weakly threatened areas;
2) 2nd Class – moderately threatened areas;
3) 3rd Class – severely threatened areas;
4) 4th Class – extremely threatened areas.

The sources of data for the analysis of the risk of occurrence of particular types of drought:

1) agricultural – sets of meteorological data from the SHMS network in the scope of daily values of average atmospheric air temperatures (from 260 synoptic and climatological stations) and precipitation totals (from 1206 stations), as well as remote sensing data regarding the results of the radiation temperature of the active surface, recorded by the NOAA high-resolution satellite radiometer with a spatial resolution of 1 km^2 (data for the growing season, April–September, decades for 1997–2018);

2) hydrological – full time series of daily flows for 451 out of 1212 hydrometric profiles located on watercourses in Poland (data from SHMS for the 1987–2017 calendar years); the analyses were carried out in water level measurement catchments;

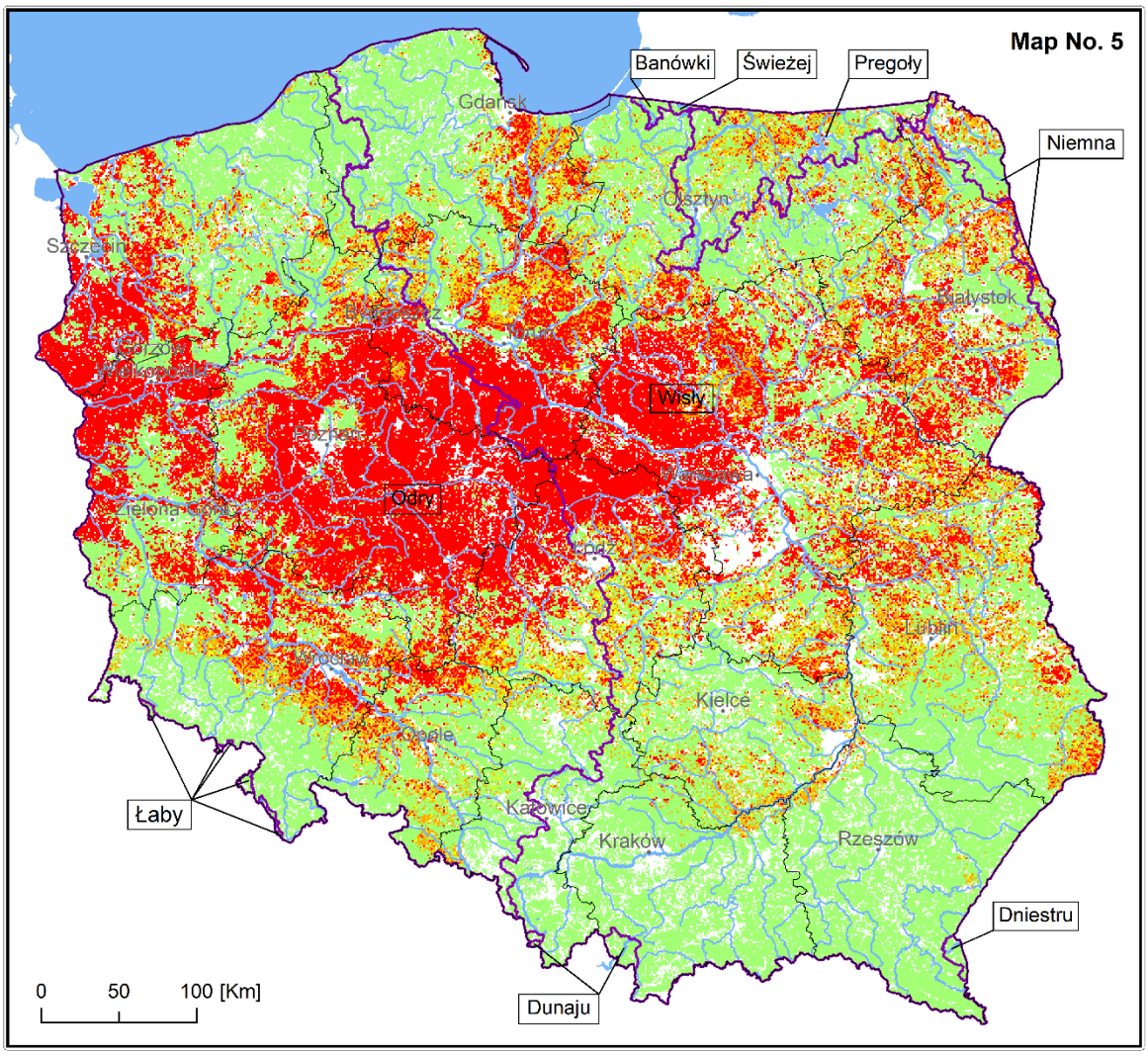
3) hydrogeological – series of monitoring data for the depth to the groundwater table of the first aquifer for 1987-2018 (preliminary analysis covered all points of the SHS measurement network, from which 197 points were finally separated for spatial analyses. The database was supplemented with 2 points from the Biebrzański National Park area and 12 points from Poland's abroad, finally obtaining a set of time series from 211 observation holes); the analyses were carried out in the GWB system.

On the basis of the conducted analyses, 37,80% of agricultural and forest areas in Poland was identified as extremely and strongly threatened by agricultural drought, and together with the areas at moderate risk (7,72%), 45,52% of agricultural and forest areas are significantly threatened by agricultural drought (Map No. 5, Table No. 7). In the Odra River basin, the areas at risk of severe and extreme agricultural drought cover 52% of the river basin area. In the area of the Wisła River basin, these areas cover 37% of the river basin area and are located from the estuary of the Narew River to the estuary of the Drwęca River, in the Drwęca River catchment area and in the western part of the Narew River catchment (Kujawsko-Pomorskie and Mazowieckie voivodeships). A weak and moderate risk of agricultural drought was found in the upper Wisła catchment area from its sources to the estuary of the San River and in the San River basin (Małopolskie and Podkarpackie voivodeships). In the agricultural and forest areas of

the Narew, Wieprz and Wisła rivers catchments from the estuary of the Wieprz River to the estuary of the Narew River, the risk of drought is extreme and severe and covers from 20% to 35% of the catchment area. Within the limits of the Odra River basin, areas strongly threatened by agricultural drought occur in 10,16% of agricultural and forest areas. The greatest extent of extreme risk of the phenomenon of agricultural drought concerns the catchment areas of the Warta River, Barycz River and the lower Odra River (Wielkopolskie, Lubuskie, Łódzkie and Zachodniopomorskie voivodeships). The smallest areas of extreme and severe risk of agricultural drought occur in the catchment area of the upper Odra River, Nysa Łużycka River and in the basin of the Nysa Kłodzka and Bóbr rivers (Śląskie, Opolskie and Dolnośląskie voivodeships). On the other hand, in the Pregoła and Niemen rivers basins, the area of agricultural and forest areas most threatened by agricultural drought (3rd and 4th classes) amounts to 26,30% and 18,70%, respectively. In the river basins of the Dunaj, Dniestr and Łaba rivers, the risk of agricultural drought is low. About 90% of the river basin areas of Świeża and Banówka rivers are slightly threatened by agricultural drought.

Table No. 7 Percentage of river basin areas at risk of agricultural drought [%] – in relation to the area of forests and agricultural land

River basin area	Code of the river basin area	1st Class – weakly threatened areas [%]	2nd Class – moderately threatened areas [%]	3rd Class – severely threatened areas [%]	4th Class – extremely threatened areas [%]
Dunaj	1000	100,0	–	–	–
Wisła	2000	58,10	4,90	15,64	21,36
Świeża	3000	88,61	2,44	7,32	1,63
Banówka	4000	94,51	2,11	3,38	–
Łaba	5000	100,00	–	–	–
Odra	6000	44,75	3,25	10,16	41,84
Pregoła	7000	66,02	7,64	19,88	6,46
Niemen	8000	72,67	8,63	15,51	3,19
Dniestr	9000	100,00	–	–	–
Poland		54,48	7,72	13,35	24,45



Agricultural Drought Hazard Assessment in forests and agricultural land (1997-2018)

Legend

Classes of risk of agricultural drought occurrence:

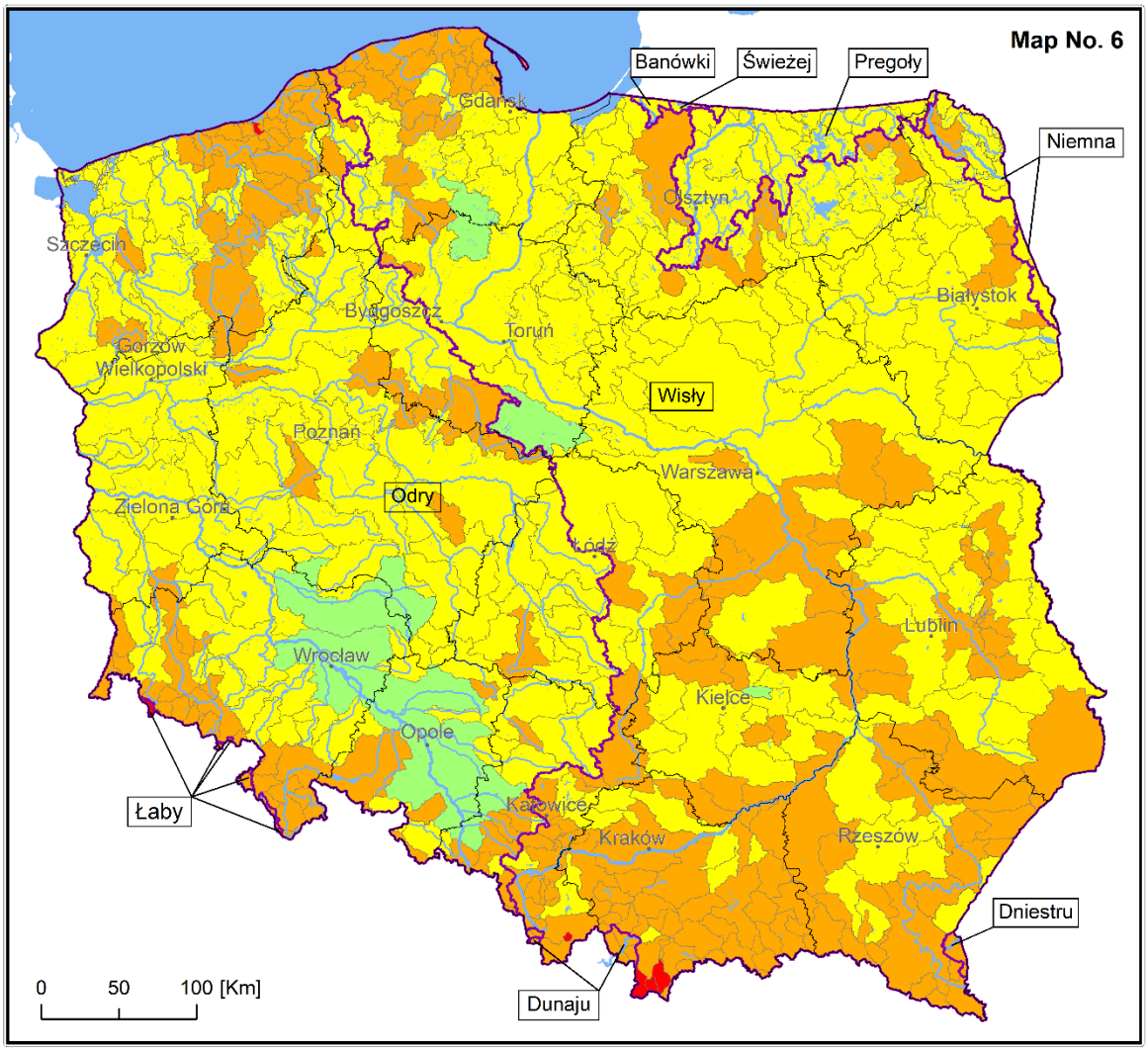
- 1st Class - weakly threatened areas
- 2nd Class - moderately threatened areas
- 3rd Class - severely threatened areas
- 4th class - extremely threatened areas
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

Hydrological drought is a period during which the number of surface water resources is lowered compared to the long-term average level. Hydrological drought is usually the next stage of atmospheric and agricultural drought, but it may also appear and take place after the end of a period of precipitation shortfalls. Its identification concerns the definition of the limit value of flow below which the phenomenon of hydrological drought begins. The analysis of the daily flow data for 1987–2017 provided indications of a degree of risk of hydrological drought.

According to the general assessment of the risk of occurrence of the hydrological drought phenomenon, moderately threatened areas dominate in Poland, which constitute almost 65,6% of the country's area (Table No. 8, Map No. 6). The share of the Odra River basin area in this class is 69,02%, the Wisła River basin area – 62,10%. On the other hand, Świeża, Banówka and Pregoła River basin areas are as a whole moderately threatened by hydrological drought. As much as 29,59% of the territory of Poland is composed of areas strongly threatened by hydrological drought. In terms of the extent of a severe threat of this type of drought, the Wisła River basin area is dominant – 36,17%, Odra – 21,06% and Niemen – 21,06%. Only 0,14% of the territory of Poland are areas extremely threatened by hydrological drought. These are the Dzierżęcinka River catchment in the north of the country and the mountain catchment areas of the Wisła River basin (Dunajec, Bała Dunajec and Żabniczanka rivers), as well as the Izera River catchment area in the Odra River basin area. The river basin area with the highest percentage of areas at extreme risk of hydrological drought is the Łaba River basin area (19,88%, with the remaining 80,12% being highly threatened areas). The Dunaj and Dniestr River basin areas as a whole are at a high risk of hydrological drought. In turn, 4,63% of the area of Poland is at low risk of the phenomenon of hydrological drought. In the Odra basin area, these areas constitute 9,89% of the country's area, and in the Wisła basin – 1,53%.

Table No. 8 Percentage of river basin areas at risk of hydrological drought [%]

River basin area	Code of the river basin area	1st Class area at low risk [%]	2nd Class area at moderate risk [%]	3rd Class area at high risk [%]	4th Class area at extreme high risk [%]
Dunaj	1000	–	–	100,00	–
Wisła	2000	1,53	62,10	36,17	0,20
Świeża	3000	–	100,00	–	–
Banówka	4000	–	100,00	–	–
Łaba	5000	–	–	80,12	19,88
Odra	6000	9,89	69,02	21,06	0,03
Pregoła	7000	–	100,00	–	–
Niemen	8000	–	78,87	21,13	–
Dniestr	9000	–	–	100,00	–
Poland		4,63	65,64	29,59	0,14



Hydrological Drought Hazard Assessment (1987-2017)

Legend

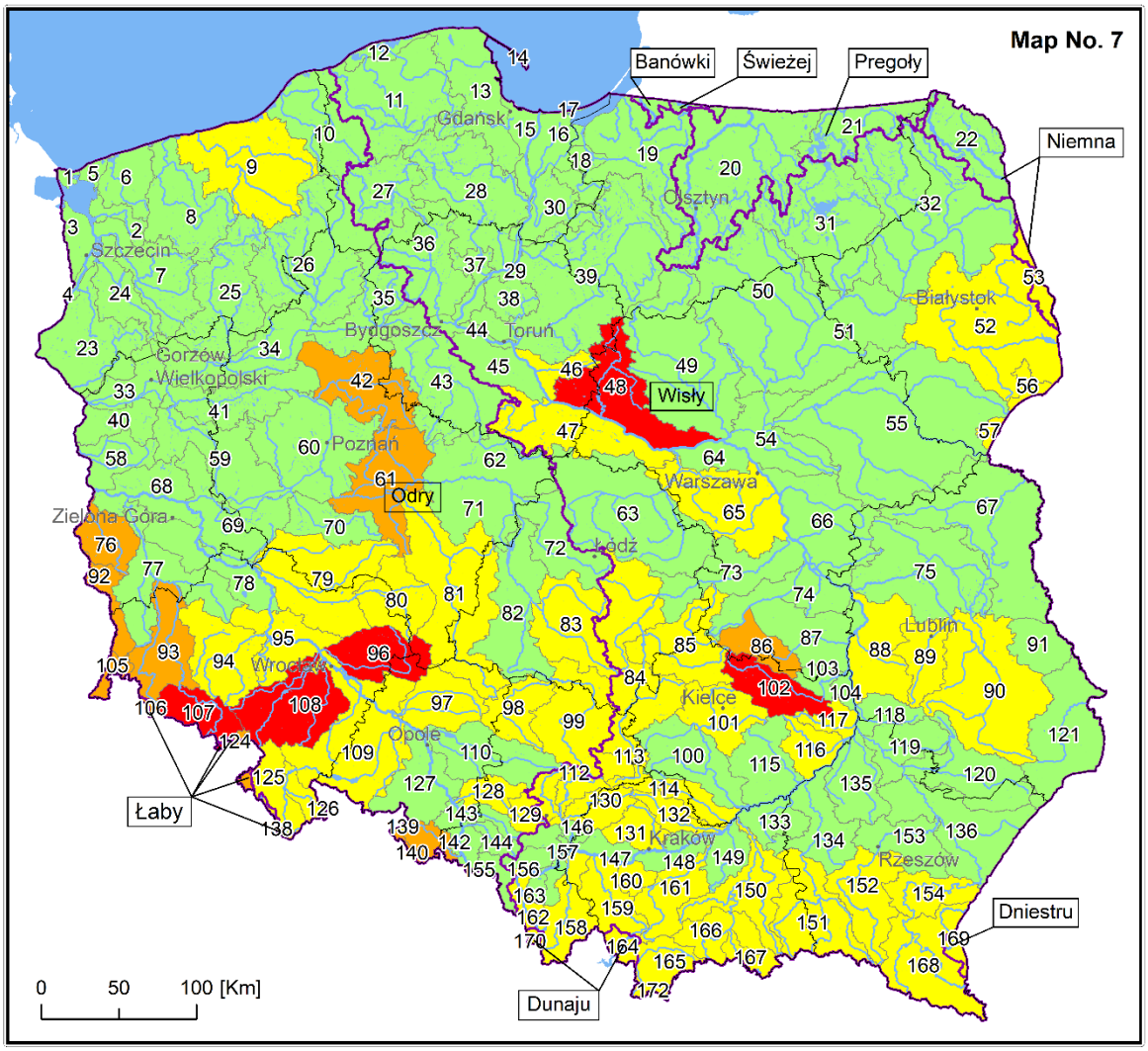
Classes of risk of hydrological drought occurrence:

- 1st Class - weakly threatened areas
- 2nd Class - moderately threatened areas
- 3rd Class - severely threatened areas
- 4th Class - extremely threatened areas
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

Taking into account physico-geographical units, catchments located in the provinces of the Eastern Carpathians with the Eastern Subcarpathia; the Western Carpathians with the Western and Northern Subcarpathia and, with some exceptions, the central and eastern part of the Polish Upland belt (the Lubelsko – Lwowska Upland, except for a part of the Wieprz River catchment) and the Małopolska Upland with an outside part of the Nida River catchment area, are strongly threatened by hydrological drought. These areas also include the eastern and central part of the South Baltic Coasts and the northern and partly eastern part of the South Baltic Lake Districts. The majority of the Mazowiecka Lowland from the Central Polish Lowland belt belongs to areas highly threatened by the phenomenon of hydrological drought. On the other hand, areas at a low risk of hydrological drought include, among others: the northern part of the Szczecin Coast macroregion, the western part of the South Pomeranian Lake Districts, the Lubuskie Lake District, the majority of the Silesian Lowland and the adjacent part of the Trzebnicki Wał, the South Wielkopolska Lowland, and a large part of the Podlasie Lowland.

Hydrogeological drought, also known as hydrogeological low water, manifests itself through lowering the groundwater table below low warning levels. The analysis of the scale of the risk of hydrogeological drought by GWB showed that 7 of them are extremely threatened (Map No. 7). They belong to the water regions of the Middle Wisła (GWB 48, 102), the Middle Odra (GWB 96, 107, 108), Łaba and Ostrożnica (GWB 122) and Metuje (GWB 123).

In the Odra and Łaba River basin areas, groundwater bodies under extreme risk occupy a large area combined, and are additionally adjacent to areas under high risk. The GWBs group strongly threatened by hydrogeological drought is also located in the Upper Odra water region (GWB 140, 141) and within the Middle Wisła water region, where the GWB 86 is adjacent to the extremely threatened GWB 102. Areas at a moderate risk of hydrogeological drought include the water regions of Middle Wisła, Lower Odra and Western Pomerania (GWB 9), the Warta water region (GWB 81, 83, 98, 99), the border of Narew, Bug and Niemen (GWB: 52, 53, 56, 57), and the Bug water regions (GWB 89, 90). The latter are adjacent to the moderately threatened GWB 88 from the Middle Wisła water region. There is also a belt of the Carpathians, which is moderately threatened by hydrogeological drought, belonging mainly to the water regions of the Upper-Western Wisła, Upper-Eastern Wisła, Little Wisła, Dniestr, Dunaj, Czarna Orawa and Czadeczka. The group of moderately threatened groundwater bodies is also located on the border of Warta, Middle Wisła, Little Wisła, Upper-Western Wisła and Upper Odra water regions. A low risk of hydrogeological drought concerns the water regions of the Noteć, Łyna and Węgorapa as well as other small catchments in the north of the country (the Świeża and Banówka River basins as well as Pregoła). In the Lower Wisła water region, only one small GWB in the south is moderately threatened by drought (GWB 46).



Hydrogeological Drought Hazard Assessment in GWBs (1987-2018)

Legend

classes of risk of hydrogeological drought occurrence:

- 1st Class - weakly threatened areas
- 2nd Class - moderately threatened areas
- 3rd Class - severely threatened areas
- 4th Class - extremely threatened areas
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

Table No. 9 presents the results divided into river basin areas. The following basins are the areas with the highest share of extremely and highly threatened areas: Łaba 55,25%, Odra 11,36%, Wisła 2,24% and Niemen 1,03%. The Dniestr basin is completely classified as a moderately threatened area. In the remaining river basin areas, the percentage of areas moderately threatened by hydrogeological drought ranges from a maximum of 68,69% – for Dunaj to 8,25% – for Niemen. On the other hand, Świeża and Banówka River basin areas as a whole and Niemen (90,72%) are characterised by a low risk of hydrogeological drought.

Table No. 9 Percentage of river basin areas at risk of hydrogeological drought [%]

River basin area	Code of the river basin area	1st Class area at low risk [%]	2nd Class area at moderate risk [%]	3rd Class area at high risk [%]	4th Class area at extreme high risk [%]
Dunaj	1000	31,31	68,69	–	–
Wisła	2000	69,38	28,38	1,88	0,36
Świeża	3000	100,00	–	–	–
Banówka	4000	100,00	–	–	–
Łaba	5000	–	44,75	44,40	10,85
Odra	6000	64,58	24,06	9,68	1,68
Pregoła	7000	89,91	10,09	–	–
Niemen	8000	90,72	8,25	1,03	–
Dniestr	9000	–	100,00	–	–
Poland		64,40	28,68	3,65	3,27

The assessment of the total risk of all the above-mentioned types of drought was obtained by summing up the risk results for agricultural, hydrological and hydrogeological drought.

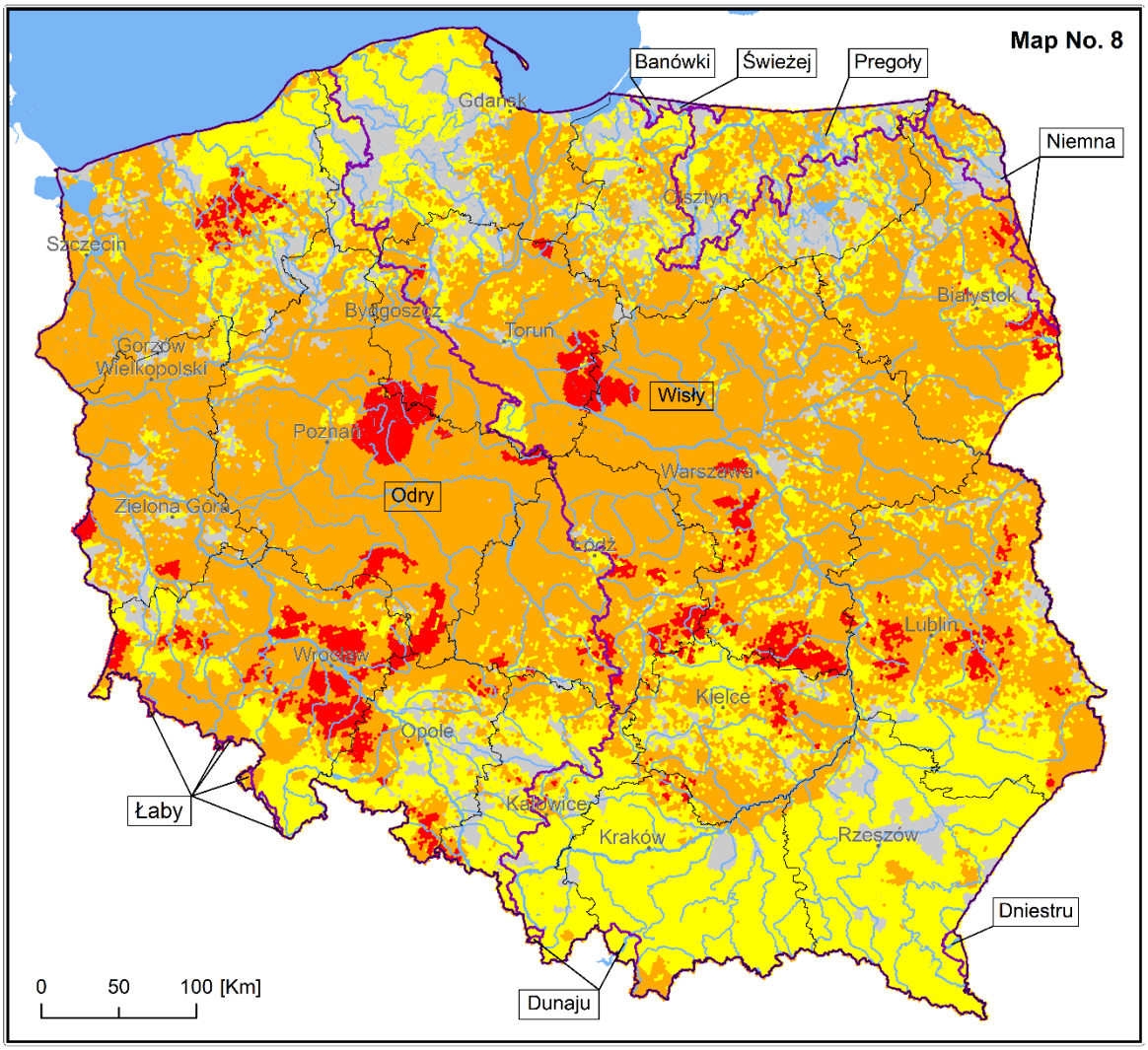
The analysis of the total risk of drought was carried out with the use of geostatistical methods, regarding the methodology for DECP with the country's area divided into a hexagon-shaped grid of basic fields of areas of 3,56 km^2. The results of the analysis of the risk for each of the three drought types was assigned to each field. The hazard/risk classes were converted to scores and they were summed up within each field of the grid. The ranges for the obtained range of variability of the results were established, which allowed to classify the results of the sums of points and assess the total risk of drought. The result includes all the analysed droughts and assesses the risk resulting from the consequences of individual stages of drought development. The obtained result enables administrative bodies and decision-making centres to make optimal decisions in the field of counteracting the effects of drought, based on the DECP catalogue of measures.

According to the conducted analyses, as much as 55,64% of the country's area is at a high risk of drought (Table No. 10). These are the areas where the risk of individual types of drought ranges from classes 2 to 4. The areas at the highest, extreme level of risk cover nearly 5% of the country. These are the areas where the risk of individual types of drought was high or extremely high (Table No. 10). Areas assessed as highly threatened by drought include parts of Western Pomerania, Wielkopolska (Greater Poland), Kujawy, the Silesian Lowlands, the Małopolska and Lublin Uplands, the Wysoczyzna Łódzka,

Mazowsze, the Lublin Upland, Polesie and Podlasie. The areas of the Sudetes and Carpathians together with Roztocze, areas along the coast: the Słupia and Parsęta rivers catchments, as well as the upper lake parts of the Drawa, Brda, Gwda and Wda rivers catchments, are characterised by a moderate risk of drought. The Świeża and Banówka basin areas are characterised by a low risk of drought. In the Odra basin area, the areas at an extreme and severe drought risk constitute 71,45%, and in the Wisła basin, 54,32%. The scale of the threat of drought, divided into its types as well as in total, indicates a strong need to implement measures aimed at reducing the potential risk. Map No. 8 presents the assessment of the risk of drought divided into all analysed types and enables relevant authorities and decision-making centres to make optimal rational decisions in the field of counteracting the effects of drought, including the provisions of the DECP catalogue of measures for the effective implementation of individual measures.

Table No. 10 The degree of drought risk (1987–2018) (total assessment according to the sum of risks of agricultural, hydrological and hydrogeological drought).

River basin area	Code of the river basin area	Percentage of river basin areas [%]			
		at low risk of drought	at moderate risk of drought	at high risk of drought	at extreme high risk of drought
Dunaj	1000	–	99,33	0,67	–
Wisła	2000	8,56	36,96	50,65	3,67
Świeża	3000	61,32	25,14	13,54	–
Banówka	4000	60,86	39,14	–	–
Łaba	5000	–	38,55	60,87	0,59
Odra	6000	7,62	20,55	64,51	6,94
Pregoła	7000	21,20	38,98	39,68	0,14
Niemen	8000	22,42	22,38	53,84	1,37
Dniestr	9000	–	–	100,00	–
Poland		8,68	30,88	55,64	4,80



Drought Hazard Assessment (1987-2018) (the sum of risks of agricultural, hydrological and hydrogeological drought) – hexagonal grid

Legend

Classes of assessment of the total drought risk:

- weakly threatened areas
- moderately threatened areas
- severely threatened areas
- extremely threatened areas
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

1.5. Demand for the increase of the capacity of available water resources

The assessment of the needs and priorities of increasing the capacity of available surface water resources was carried out on the basis of a multi-criteria analysis, which took into account the following:

1) an assessment of the state of available surface water resources (the value of the indicator of the degree of use of available surface water resources was calculated);
2) a reference of above-mentioned results to environmental flow conditions;
3) hydrological drought risk analysis results.

The obtained results indicate the priority of the needs and measures to improve the availability of surface water resources.

The high and very high priority needs in terms of implementation of measures to improve available surface water resources in order to counteract the effects of hydrological drought were identified in 22,6% of the territory of Poland (Table No. 11). The moderate priority needs to implement measures improving the available surface water resources concern almost 41% of the country's area. The low priority needs in the scope of implementation of measures improving available surface water resources were identified in 36,6% of the country's territory. 13,9% of this area belongs to the Wisła River basin and 21,5% to the Odra River basin. In the area of the Odra River basin, the high priority measures aimed at increasing the available resources concern mainly the catchments of the Warta and Noteć rivers, the Sudeten catchments, and, in the Silesia region – the Kłodnica and Brynica rivers catchments. It should be noted that in areas under the pressure of depression cones (due to mine drainage), the course of events in the form of hydrological drought is intensified. It also results in a high priority need to increase the available resources of surface waters. The catchments under pressure related to depression cones face problems resulting from water shortage problems, which the effects of drought overlap.

Table No. 11 The share of river basin areas according to the purpose of taking actions to improve the available surface water resources

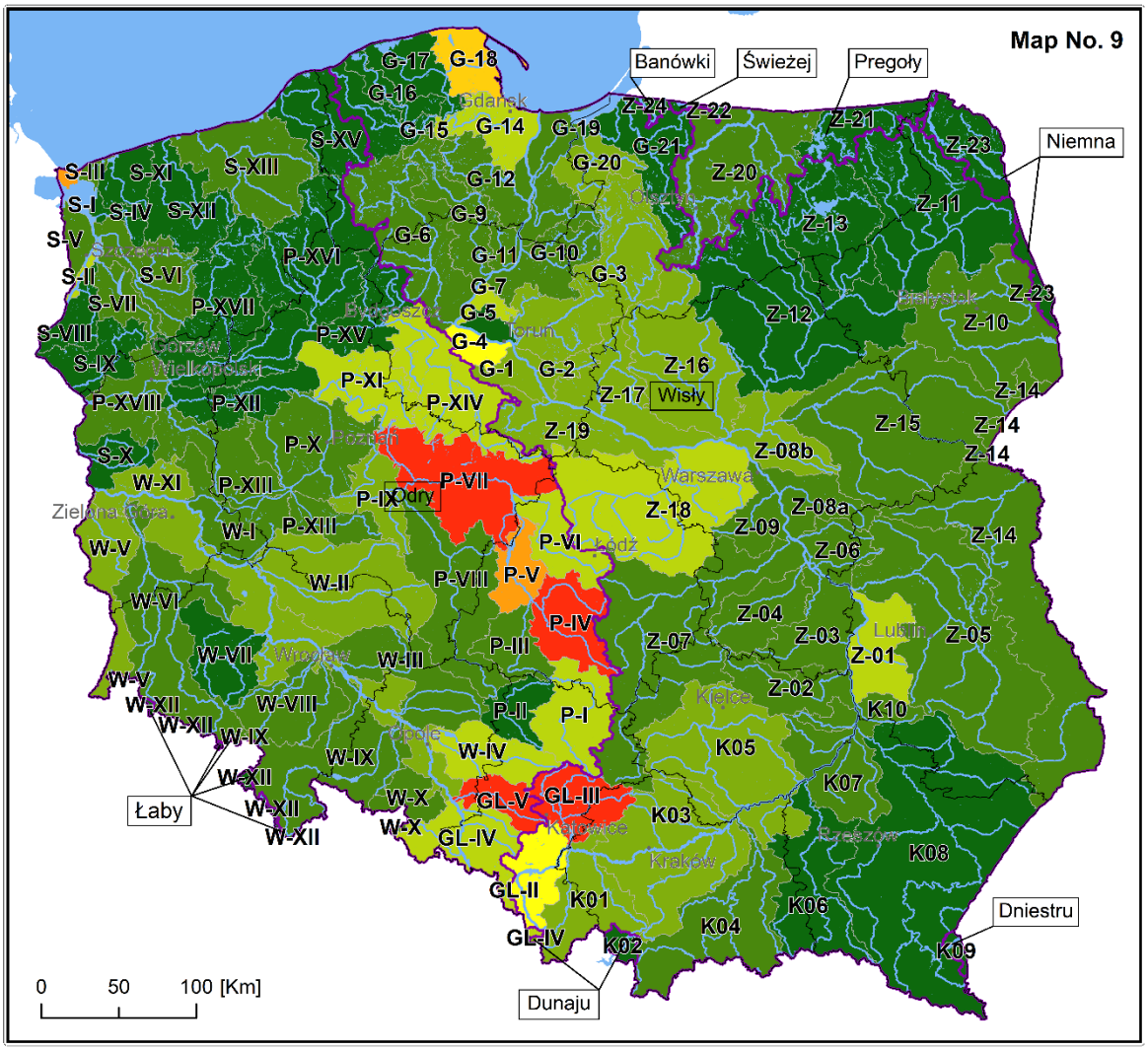
River basin area	Code of the river basin area	Need to improve the available surface water resources [%]			
		very high	high	moderate	low
Dunaj	1000	0,00	0,12	0,00	0,00
Wisła	2000	1,45	11,22	31,85	13,87
Świeża	3000	0,00	0,00	0,05	0,00
Banówka	4000	0,00	0,00	0,07	0,00
Łaba	5000	0,00	0,05	0,02	0,00
Odra	6000	0,46	8,44	7,64	21,45
Pregoła	7000	0,00	0,43	0,86	1,13
Niemen	8000	0,00	0,35	0,30	0,15
Dniestr	9000	0,00	0,07	0,00	0,00
Poland		1,90	20,70	40,79	36,61

The needs to implement measures increasing the capacity of available groundwater resources are the result of the analysis of the degree of their use. This indicator in Poland is generally quite low and in about 90% of the country's area it does not exceed 30% of the available resources (in 33 balance areas it does not exceed even 10%). In 11 areas it is within 30–52%, and only in one – S-1 (Uznam, Zalew Szczeciński) it reaches 68%. This area is characterised by a very low number of renewable groundwater resources, which results in a low module of available resources. While water abstraction is significant (due to the number of health resorts and summer resorts), the level of groundwater reserves is very low. In general, the reserves of available groundwater resources are high, however, they are not distributed evenly within the river basin areas. In four balance areas (GL-III – the Przemsza River catchment, GL-V – the Kłodnica River catchment, P- IV – the Widawka River catchment, and P-VII - the Warta River catchment from the Ner River to the Prosna River), where mine drainage is carried out, the values of these drainages exceed the size of available resources (without resource reserves) (Map No. 9). The impact of depression cones, which intensify the risk of both hydrogeological and other types of drought, concerns 28 balance areas (Table No. 2) where mine drainage is carried out (on 31th December 2017). These drainages are associated with the underground mining in Upper Silesia (areas Gl-III and Gl-V) and opencast mining associated with lignite (P-IV – Bełchatów and P-VII – Konin-Turek area).

The intakes of groundwater together with mine drainage in Poland amount to 7 177,071 m^3 / 24h, which constitute 21,3% of available resources. Therefore, groundwater reserves amount to 78,7% of available resources (Table No. 12 below).

Table No. 12 Summary of groundwater intake from intakes and mine drainage, and the reserves of available resources in the river basin areas (31.12.2017)

River basin area	Code of the river basin area	Total abstraction (intakes+mine drainage) [m^3/24h]	Reserves of available resources	
			value [m^3/24h]	percentage of available resources [%]
Dunaj	1000	236	22,066	98,9
Wisła	2000	3 599,624	14 895,020	80,5
Świeża	3000	559	12,178	95,6
Banówka	4000	268	14,684	98,2
Łaba	5000	441	21,779	98,0
Odra	6000	3 467,116	10 803,877	75,7
Pregoła	7000	88,008	506,287	85,2
Niemen	8000	20,734	269,303	92,8
Dniestr	9000	85	48,822	99,8
Poland		7 177,071	26 594,016	78,7



The use of the Available Groundwater Resources within hydrogeological units (balance areas) (water intakes and drainage) (valid for the day of 31.12.2017)

Legend

The use of the Available Groundwater Resources [%]

- 0,0 - 10,0
- 10,1 - 20,0
- 20,1 - 30,0
- 30,1 - 40,0
- 40,1 - 50,0
- 50,1 - 60,0
- 60,1 - 70,0
- 70,1 - 80,0
- 80,1 - 172,8

- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

1.6. Description of possibilities of increasing the capacity of available water resources

Possibilities of increasing the capacity of available water resources belong directly to the scope of the DECP. They include both technical and non-technical methods (possibilities) of increasing natural and artificial retention, implemented e.g. by works involving the construction or reconstruction of broadly understood water devices (including drainage systems and water devices such as weirs or gates). This element of the DECP also includes actions introducing changes in the use of resources, also divided into technical and non-technical solutions. In relation to the second category, non-technical should be understood as all available or planned legal and formal mechanisms that may lead to positive changes in the use of resources in order to counteract the effects of drought. They include: shaping the landscape in agricultural areas (e.g. introducing mid-field trees), using agro-drainage treatments and changing the use of resources through constructing or reconstructing water facilities (new intakes, damming structures). These actions are aimed at changing the current scope of using water resources in a given area and implementing measures necessary to counteract the effects of drought. The possibilities of increasing the capacity of available resources, in line with the above and in line with the DECP objectives, may result in solutions regarding:

1) increasing (creating and restoring) natural and artificial retention;
2) administration and legislation;
3) education.

Sound management and use of a given river catchment is an important part of water resources protection. The idea of the necessity to increase the available resources through increasing, i.a. restoring the retention capacity of individual catchments, is included both in the planning objectives of water management and, as a permanent part, in the flood risk management. It is also an instrument of spatial planning and the protection of aquatic and dependent water ecosystems. Solutions increasing water resources through retention are based on the reconstruction of the lost water retention capacity of the basin and the preservation of the still existing natural water retention capacity in a given area. **The surface retention** includes: lake retention, reservoir retention, riverbeds and river valleys retention, snow retention and forest, soil and landscape retention.

Therefore, retention is the result of many natural factors, primarily: geological structure and hydrogeological conditions, the graining and arrangement of the layers of the soil profile, topography, land cover, and anthropogenic factors, such as land use, agro-technics, hydrotechnical structures and irrigation and drainage systems. Hence, retention solutions must be implemented both in agricultural, forest and urban areas, and in areas under forms of nature conservation. In terms of the possibility of increasing the available resources, it is also appropriate to look at the range of available solutions for the protection and enhancement of surface water and groundwater retention. It is also important to determine the possibilities of increasing the capacity of water resources as part of the activities of various sectors of the economy, e.g. forest, agriculture, industry, or in the social dimension.

Possibilities of increasing the capacity of available water resources described below should be indicated at least for the purposes of achieving the DECP objectives. They are the basis for establishing operational measures aimed at counteracting the effects of drought, described in further parts of the Plan. In addition, it should be noted that the selection of appropriate measures for individual areas (water catchments) should be made while taking into account the possibilities and characteristics of a given area.

1.6.1. Natural retention

Natural retention supports the achievement of environmental objectives for surface waters, groundwater, their protection and nature, agriculture, forestry, urban risk management, natural disaster management, green growth and adaptation to climate change. Actions in the field of natural retention bring positive effects in the normalisation of water relations on a catchment's scale, and above all limit and slow down surface water runoff which is essential in the context of flood and drought risk. Therefore, the actions' objective is to shape a small water cycle in catchments. Non-technical activities, i.e. using the natural conditions in a catchment area, reduce the risk of extreme phenomena, including drought, while improving the condition of surface and groundwater bodies. The size of the natural retention potential is determined by the environmental capacity of an area to store water. Increasing natural retention includes implementing non-technical measures supported by legal instruments for the protection of ecosystems and parts of nature. In particular, through increasing retention in forest and agricultural areas, as well as on biologically active areas of urbanised areas. Natural retention includes restoring the retention of river valleys, but also strengthening and restoring wetlands (swamps, peatlands and, in general, wetlands). In this aspect, attention should be paid to the important role of restoration activities aimed at, i. a., the restoration of watercourse beds and their banks. The role of restoration activities on water courses and in catchment areas is to restore natural geomorphological processes supporting the development of hydrogenic habitats. In the case of significantly distorted flowing water ecosystems, restoration activities are technical in nature and related to the decommissioning of objects, their reconstruction and restoration of morphological continuity of watercourses, etc. Restoration tasks at the level of supporting planning in water management are included in the national program of surface water restoration developed in 2020, which is in line with the objectives of water resource protection included in the updated RBMPs. The program includes a list of the proposed Areas Requiring Restoration and Priority Areas, in which restoration activities should be implemented in the first place, while taking into account environmental and economic conditions. Each body of surface water (river, lake, transitional and coastal) that has been included in these areas has been assigned potential sets of restoration measures, however the specification and definition of a specific method of action requires further detailed analyses on a local scale. The program has also been coordinated with the objectives of the existing and planned strategic and planning documents, including the DECP.

1.6.2. Wetlands

Wetlands play an important role in the environment, maintaining the water cycle. Hydrogenic habitats are of great importance in the water balance of a catchment, because they influence the volume and dynamics of the water flow in the watercourse, the location of groundwater and the amount of water resources. Peat bogs, which are sometimes compared to lakes and referred to as retention reservoirs, play a special role. 75–85% of non-drained peat deposits are filled with water. It is estimated that 35 billion m^3 of water is stored in peat deposits in Poland, of which only approximately 480 million m^3 (less than 1,4%) are involved in active water circulation during the year. It is water that flows out of the peat bog or evaporates from its surface or floor. Apart from peat bogs, wetlands of other types also, retain water in deposits of hydrogenic formations or on the ground surface, permanently or periodically, and prevent excessive depletion of underground and surface resources. Their capacity in this respect results mainly from the conditions of water inflow and outflow. The greater the surface share of wetlands (and thus various types of land depressions) in a given area, the greater its retention capacity.

Drainage is currently a major threat to wetlands. All kinds of drainage of hydrogenic habitats contribute to the disturbance of natural water relations, which causes unfavourable changes in the hydrological regime. The phenomenon of the disappearance of wetlands has a very negative impact on the water management of entire regions, as well as their water balance. Therefore, the protection and restoration of wetlands may be one of the possibilities of increasing the capacity of available water resources. The tasks of restoration and protection from drying out of wetlands at a level that supports planning in water management are included in the developed in 2020. National Surface Water Restoration Program.

1.6.3. River bed and valley retention

Retention of river beds and valleys is the effect of filling the watercourse and its valley with flood water and then stopping its outflow. Pools form in the local depressions in the flood plains. The water collected in them increases the groundwater retention resources of the valley, and also supplies the river bed, increasing the runoff in periods without rainfall. An example of the possibility of increasing retention in river valleys is also the restoration of natural floodplains. Retention of riverbeds and valleys is created in flooded valleys and oxbow lakes, as well as in polder areas. It is rebuilt during periodic floods of the river, and its range is limited by flood embankments. Therefore, the space for high water flow should not be excessively restricted as a result of the construction of flood embankments. If the valley is properly equipped with damming devices (weirs, gates), they can be used to limit the outflow, and significantly increase the retention of watercourse beds and river valleys at the same time. The implementation of such development is conditional on maintaining the biological patency of the watercourses.

Activities increasing the retention in river valleys like reconstruction of embankments including increasing their spacing, lowering or liquidating enable, among others, to increase the capacity of the floodplain between the embankments, and thus increase their capacity of water retention.

Increasing capacity of polders in river valleys includes constructing appropriate relief structures, which may not only effectively affect the transformation of flood waves, but also may have a significant ecological significance, contributing to the restoration of natural valley habitats.

1.6.4. Reservoir retention

Multipurpose reservoirs enable to regulate river runoff and are used for the purposes of collecting water, meeting economic, energy, shipping (an important function of inland waterways is to stabilize the quantity of water resources; reservoirs used for inland navigation are also water retention features), and recreational needs, flood protection and fire protection. Retention reservoirs ensure water supply, accumulate its surplus during periods of excess, and in a controlled manner supply rivers during periods of drought while preventing the effects of floods. In terms of the DECP, the most important functions of retention reservoirs are to equalize flows in rivers and prevent water shortages. Reservoirs fulfil these functions storing water during high flows in order to use the surplus to support the flows below the reservoir during hydrological drought. In addition, retention reservoirs enable to maintain the necessary environmental flow in a given cross-section of the watercourse and in a given period of the year. Water reservoirs also raise the drainage base for groundwater, inhibiting their outflow and increasing their status in the near-reservoir zone, sometimes of quite a large extent.

The total capacity of large retention reservoirs in Poland is three times lower than what is considered as sufficient for safe water supply and flood protection in Europe. Insufficient reservoir retention does not allow for a significant equalization of the outflows, it is also not enough to significantly reduce the risk of flooding the country. Therefore it is difficult to talk about a significant possibility of river runoff management in Poland. The usable capacity of the existing reservoirs (including reservoirs under construction with a capacity of more than 1 million m^3) accounts for about 6% (i.e. about 3,6 billion m^3) of the average annual runoff from the country, while rational management of water resources requires that the capacity of these reservoirs is about 20% (i.e. about 11–12 billion m^3). Ultimately, in Poland (taking into account topographic conditions, population density and the degree of development of the country), it is possible to achieve reservoir retention at the level of approximately 15% (i.e. 8,4 billion m^3). However, it should be remembered that investment activities must be preceded by an analysis of environmental conditions and an analysis of the impact on the environmental objectives specified for SWBs and on Natura 2000 sites and other forms of nature protection.

1.6.5. Lakes and fish ponds

Lake retention occurs mainly due to the damming of natural lakes, similarly to reservoir retention, and has a beneficial effect not only on the hydrology of flowing waters (equalization of runoff), but also on the regime of groundwater. Obtaining additional retention due to damming lakes is possible in areas already rich in standing waters. The report of the Ministry of Agriculture and Rural Development on the implementation of small retention facilities for 2016 shows that the retention of 360 dammed lakes amounted to 268,4 million m^3 of water (which constitute 0,74% of surface water resources). The total water resources of lakes in Poland are estimated at approximately 19 billion m^3. Despite the fact that

they are about five times larger than the total capacity of reservoir retention in Poland, the direct use of lake retention is small.

Fish ponds positively shape local water conditions through stabilising the groundwater level and increasing the moisture of the soil in the areas adjacent to the ponds. Pond facilities have a positive effect on the water cycle in agricultural areas and on the rational and more effective use of water resources, which is a benefit for agricultural production. They strengthen the biological diversity of the natural environment in their surroundings, and thus improve landscape values and the microclimate, as well as contribute to the protection of the natural environment. In quantitative terms, according to the data for 2016 collected by the Inland Fisheries Institute compiled under the Program of Statistical Research of Public Statistics, the usable area of fish ponds amounted to 52,933 ha. Assuming the average pond depth of 1,2 m, the estimated volume of water retained in fish ponds is 635,20 million m^3. The following amount of water is collected in earth ponds (ponds with stagnant water) divided by voivodeships (Table No. 13):

Table No. 13 Estimated volume of ponds in voivodeships (2016)

Voivodeship	Estimated volume of earth ponds [million m^3]	Percentage share in pond retention capacity [%]
Dolnośląskie	105,50	16,61
Lubelskie	90,99	14,32
Wielkopolskie	60,99	9,60
Śląskie	59,99	9,45
Mazowieckie	46,28	7,29
Łódzkie	38,77	6,10
Podkarpackie	36,00	5,67
Świętokrzyskie	34,69	5,46
Małopolskie	32,78	5,16
Opolskie	29,81	4,69
Lubuskie	27,56	4,34
Warmińsko-Mazurskie	22,75	3,58
Kujawsko-Pomorskie	18,77	2,95
Zachodniopomorskie	13,94	2,20
Podlaskie	13,71	2,16
Pomorskie	2,67	0,42

1.6.6. Forests

The forest is a natural water reservoir. Its hydrological role is mainly based on the fact that the forested area:

1) stores moisture reserves, increasing soil retention;

2) accumulates part of the rainfall while the excess returns to the atmosphere;
3) reduces direct evaporation from the ground compared to agricultural areas, increasing transpiration;
4) increases the runoff in the period of low water levels and reduces it in the period of high water levels in watercourses;
5) reduces surface runoff;
6) extends the duration of the spring surface runoff;
7) prevents the rapid increase of water in watercourses and reduces the culmination of flood waves in the forested part of the catchment area;
8) prevents an excessive drop in the water level in rivers during drought;
9) acts as a filter and has a significant impact on the biological and chemical composition of surface and groundwater.

The runoff from woodlands equals to even more than from non-forested areas, because the forest soil slows and equalise it. Although water accumulated in the forest and forest soils is not an available resource, an estimated 5–25 mm of water may accumulate in the 10 cm layer of forest soil. In the tree stand, water is 50–60% of the wood, and after converting this amount of water to a soil layer with a thickness of 1 m and the volume of the stand of 400 m^3/ha, 1500 m^3 of water in the soil and 400 m^3 in the tree stand per 1 m^2 of area can be obtained. For example, the calculations of the Forest Research Institute show that the sum of the retention effects caused by the forest is 9,05 m^3/ha/year per 1% of forest cover. Estimates indicate that the potential water capacity of the forests managed by the SF NFH is 11,5 billion m^3.

Increasing forest cover in the country, a proper distribution of forests in catchments and an intensification of forest management in terms of increasing forest cover, create conditions beneficial not only for the optimal use of forest production opportunities, but the levelling of outflows, and in particular the increasing of the volume of flow in rivers during the summer half-year. Due to the high retention capacity of forest soils, these areas act as natural compensation reservoirs, retaining water in the period of excess and returning it in the period of shortage. As a result, forests contribute to both counteracting the effects of drought and flood protection.

1.6.7. Agriculture

Soil retention plays an important role in terms of retention in agricultural areas. The amount of retention in the soil depends on many factors, including the type and species of soil, the content of clay and silty particulars and the thickness of the humus layer, as well as the culture of soil use (actions slowing down surface runoff). The water accumulated in the soil profile is not an available resource in the context of water use determined by the rules of water use.

In agricultural areas, the available resource is water accumulated in drainage systems (systems for shaping water resources in agricultural areas). The main task of the water drainage and irrigation devices is to drain the surplus of spring snowmelt waters and water from storm rains, as well as to store

water and irrigate crops. Optimal drainage activities should, in addition to creating good conditions for agricultural production, take into account the need to preserve natural values and protect water resources in the agricultural landscape. Water drainage should be aimed at regulating water relations and increasing the total water resources by accumulating reserves and increasing the water retention of soils and subsoils. Moreover, in agricultural areas, all types of mid-field ponds play an important role in the water management of agricultural areas and are an important part of the so-called small retention. If they are properly used, they increase retention and contribute to the local reduction of water shortages in catchments during periods of drought. The so-called retention adaptation of the catchment area includes: the use of appropriate agronomy techniques and irrigation/drainage systems or activities aimed at increasing the thickets area (field trees counteract wind and water erosion of the soil, and thus increase water retention in the soil) and afforestation.

In addition, as part of agriculture, the most important activities include:

1) not using equipment to compact the soil layer under the arable layer and loosening this layer;
2) increasing the share of humus in the soil;
3) introducing and cultivating plants resistant to water deficit and drought;
4) plowing across the slopes and creating terraces;
5) using catch crops and rotation;
6) recreating the land microrelief (slight irregularities of a land surface);
7) maintaining and restoring mid-field ponds.

The activities formulated under the DECP to be directed to agricultural areas are:

1) increasing the amount and duration of water retention on agricultural land;
2) the use of water from drainage systems for fertilisation and irrigation of field crops;
3) the construction and reconstruction of water irrigation and drainage devices to increase soil retention.

1.6.8. Industry

In order to reduce the impact of industry on water resources and reduce the drought risk industry faces, it is important to introduce the obligation to apply closed water circuits in sectors of the economy characterised by high water consumption. The rationalisation of the industrial use of water resources may be, for example, the use of closed loop water systems in production systems in case of water resource shortages, sealing technological processes, and the reuse of water. For example, the use of a closed loop cooling system in the plastics manufacturing process can reduce water consumption by 90 percent. Other measures to implement the above-mentioned objectives include e.g. the construction and operation of on-site wastewater pretreatment plants to reuse water in the technological cycle or for other purposes in the plant, the introduction of the recovery of water from the technological process, and the introduction of changes in technological processes (replacement of one process with another), limiting water consumption.

The reliability of the implementation of the rights to use water resources in relation to the obtained permits is an important aspect in the formal context related to the balancing of resources and the economic effect at the level of enterprises, equally as the reliable and cyclical verification of the allocated rights in terms of the amount of water abstraction by administration authorities.

1.6.9. Urbanized areas

Urbanisation causes the greatest transformations of water resources and their relations among all anthropogenic processes, including lowering the retention potential of a given catchment area and disturbances in the hydrological cycle. The consequences of anthropogenic impact on water conditions are manifested, among others, by the elimination of watercourse beds, the drainage of wetlands, water pollution, river regulation, and changes of the surface of partial catchments and the runoff regime. Rivers with a rectilinear course, with concrete banks reinforced with slabs, are characterised by a different hydrological regime than natural rivers, which is more susceptible to the threat of hydrological drought. The dense network of ditches and channels draining urban areas increases the frequency and intensity of extreme phenomena such as droughts, especially agricultural and hydrological droughts. The increase in the sealing of urban areas requires the use of additional solutions to increase water retention at the site of precipitation. It is possible to increase retention in urbanised areas through activities as: unsealing impermeable surfaces in order to enable the infiltration of precipitation into the ground, the use of green-blue and green infrastructure, building reservoirs (surface or underground) to retain rainwater, the use of plants not requiring watering and enabling the infiltration of precipitation in biologically active areas. These activities contribute to delaying the outflow of water from urbanised areas and ensure their greater retention, which may indirectly translate into an increase in the amount of available resources in river systems and aquifers.

Increasing the capacity of available water resources may also be the result of educational activities promoting the economical use of water, as well as building social awareness of the phenomenon of drought and its consequences. The legitimacy of these actions is also indicated by the results of a survey conducted for the needs of the DECP, in which as many as 14,9% of responses in the scope of actions desired to be implemented as counteracting the effects of drought indicated the need to conduct educational and information activities aimed at various social groups.

1.6.10. Groundwater

The reserves of available groundwater resources, apart from areas where mining drainage is carried out, are high and there is no need to look for artificial or technical possibilities to increase their capacity at this moment. However, in some balance areas there may be a significant reduction in reserves in the longer term, which may result in the need for measures aimed at increasing available groundwater resources, which is a difficult and costly undertaking (e.g. the transfer of drainage water and its placement into selected aquifers). In areas with concentrated groundwater abstraction (large agglomerations), it is beneficial to build infiltration intakes, provided that they are located near a river with a significant flow and a stable hydrological regime, and carrying water of an appropriate quality.

In areas with mining drainage, compensation solutions should be introduced both in terms of the use of water intended for human consumption and the environment.

The most desirable and rational action to increase or maintain the amount of groundwater resources is to protect their resources, in particular the first aquifer from the surface of the free water table, as well as to facilitate the infiltration of atmospheric precipitation to ensure the efficiency of supplying aquifers (unsealing of paved surfaces). The available resources of groundwater are part of renewable resources, which mainly come from an infiltration feed from precipitation. Groundwater resources, of all aquifers in the hydrogeological system (e.g. in the catchment area), react to atmospheric drought according to the following principle: the deeper the level, the more delayed its reaction. For this reason, the groundwater of deeper aquifers, being an essential part of the renewable and available resources, is hardly exposed to the effects of drought, especially short-term drought. In order to maintain their renewal, it is important to ensure proper conditions for rainfall retention at the place of its formation and to increase the retention capacity of the soil and the soil profile in agricultural areas.

The infiltration of surface waters, hardly present in natural conditions, occurring in depression cones at shallow usable levels, also plays a role in shaping renewable resources.

A change in the applicable legal regulations, enabling the registration of drilled wells for normal use of water, within the meaning of the Water Law Act (currently without the obligation to obtain water permits and pay fees for water services), and thus obtaining the possibility of controlling groundwater abstraction to the full extent, may give positive changes. This is particularly important in the case of intakes that are based on the resources of the first aquifer (by assumption up to 30 m), which is the most sensitive to infiltration supply deficiencies.

The results of the analysis of the possibility of increasing the available water resources have a fundamental impact on the range of activities of the catalogue aimed at counteracting the effects of drought, which is the operational result of the DECP.

2. Proposals for the construction or reconstruction of water facilities

2.1. Legal conditions and goals related to the construction or reconstruction of water facilities counteracting the effects of drought

According to Article 16 (65) of the Water Law Act, water facilities are devices or structures used to shape or use water resources. The following types of water devices are of particular importance for the effective management, prevention and limitation of the effects of drought:

1) damming, anti-flood and regulatory devices or structures, as well as canals and ditches;
2) artificial reservoirs located on flowing waters and objects related to these reservoirs;
3) ponds, in particular fish ponds and ponds intended for sewage treatment or recreation;
4) facilities that intake surface water and groundwater.

To the listed water facilities one should also add water melioration facilities to which according to Article 17 Paragraph 1 Subparagraph 3 of the Water Law Act the regulations concerning water facilities apply. Irrigation and drainage devices that meet the Plan's goal, i.e. are used to DECP, are: ditches with structures functionally related to them (provided that they fulfil the irrigation and drainage function), as well as structures preventing water erosion. Laws on water facilities may also apply to measures improving physical and chemical properties as well as water relations in low-class soils, through cultivation or/and fertilisation treatments, and also restoration treatments (tree planting, bushing and turfing). When planning, implementing and maintaining water devices, the needs to maintain diverse field and meadow biocenosis, achieve good water status and environmental goals (Article 198 of the Water Law Act) should be an overriding priority.

Investment activities aimed at counteracting and limiting the effects of drought are characterised by a different scope and scale. Due to the scope and purpose of construction works, their performance may be classified as construction, reconstruction or renovation within the meaning of Article 3 Paragraph 6, 7a and 8 of the Act of 7 July 1994 – Construction Law.

Construction – an execution of a civil structure in a specific place, as well as its reconstruction and outward and upward extension.

Reconstruction – a performance of construction works as a result of which the functional or technical parameters of the existing structure change, except for characteristic parameters such as: cubature, building area, height, length, width or number of storeys.

Renovation – a performance of construction works in an existing structure in order to restore its original condition (excluding current maintenance), during which the use of construction products other than those used in the original condition is allowed.

The catalogue of the DECP activities includes proposals for the construction or reconstruction of water facilities, among others, in the following activities:

1) increasing the amount and duration of water retention on agricultural land (in terms of water facilities) (Action No. 1);
2) increasing natural and artificial retention on forest land (in terms of water facilities) (Action No. 2);
3) the retention and management of rainwater and snowmelt in urbanised areas (Action No. 3);
4) the implementation of projects aimed at increasing or restoring natural retention (in terms of reconstruction of existing devices and construction of devices supporting natural retention) (Action No. 4);
5) water damming of lakes in order to counteract the effects of drought (Action No. 5);
6) the implementation of investment activities in the field of shaping water resources by increasing artificial retention (Action No. 7);
7) the construction and reconstruction of irrigation and drainage devices to increase soil retention (Action No. 8);
8) the construction and reconstruction of groundwater intakes for abstraction for agricultural irrigation and construction and reconstruction of water-saving irrigation systems using groundwater resources (Action No. 10);
9) the construction or reconstruction of groundwater intakes and construction or reconstruction of main water pipelines to transfer water to areas at risk of hydrological drought for the purposes of collective water supply for human consumption of inhabitants of these areas (Action No. 14).

The investment projects intended for implementation under the DECP, the implementation of which will affect the formation of retention, thus counteracting the effects of drought, were selected from the applicable, related planning documents, i.e. updated RBWPs and the FRMPs. These tasks will also be the basis for the development of other documents and programs related to the content of the DECP, i. a. devoted to the issues of water retention, shaping resources in general and shaping available water resources. Among the projects listed, the construction of water reservoirs is of significant importance for increasing artificial retention, and especially the reservoirs the implementation of which is planned to accomplish, according to the above-mentioned documents and as a main or an additional objective: increased retention, protection against drought, and increasing the river bed and valley retention through the construction, reconstruction or renovation of damming devices.

Some investment projects in the field of construction or reconstruction of water devices may affect the possibility of achieving environmental goals in water bodies. Under Article 66 Paragraph 1 of the Water Law Act, the possibility of failure to achieve good ecological status or good ecological potential and prevent deterioration of ecological status or ecological potential is allowed, if it is the result of new changes in the physical properties of surface water bodies. Such investments must be included in the river basin management plans or their subsequent updates Article 318 (1) (22) of the Water Law Act). In order to be implemented, they must meet all the conditions referred to in Article 68 of the Water

Law Act, with appropriate justification for the necessity of their implementation. During the planning cycle, the investment plans of water administration authorities can be analysed in terms of their impact on the SWBs through water-legal assessment. The procedure related to the water-legal assessment has been regulated by the provisions of Chapter 5, Section 9 of the Water Law Act.

In order to implement these tasks, other environmental protection requirements should be met in addition to the requirements concerning the analysis of the impact of investment activities on the condition and the possibility of achieving environmental objectives in water bodies. In this aspect, it is particularly important to take into account the legal regime of protected areas, as well as threats and protective measures resulting from protection plans or plans of protective tasks, especially in terms of establishing the existence and requirements for the protection of habitats and/or species sensitive to changes in hydrological conditions.

It is expected that the source of financing of the activities listed in the attachments No. 1–3 to DECP will be: own funds of SHW PW, state budget, budgets of local government units and funds from external sources: NFEPWM, VFEPWM, coming from the budget of the European Union (among others from the Operational Program Infrastructure and Environment, Regional Operational Programme) and possibly funds from loans and credits or from other forms of support for the implementation of investments and activities, granted by the European Investment Bank and the World Bank. The estimated cost of investments indicated in: attachment No. 1 to DECP amounts to PLN 10,6 billion; attachment No. 2 to DECP – PLN 137 million, attachment No. 3 to DECP – PLN 2.2 billion (estimated value for 83 out of 182 investments). The planned cost of investments listed in attachments No. 1 and 2 to DECP has been estimated on the basis of bills of quantities and catalogs for particular objects and type of works separately. In the absence of investor's cost estimates, the estimated cost was calculated on the basis of similar works already performed or manufacturers' instructions. On the other hand, the estimated/planned costs of investments from attachment No. 3 to the DECP were calculated on the basis of notifications sent by applicants of individual investments. With the caveat that estimation was possible for 83 out of 182 investments. For the remaining investments, no data on estimated investment costs was received.

2.2. Proposals for the construction or reconstruction of water facilities – taking into account the division of the country into river basin areas

In addition to the indication of the types of water facilities and related legal and planning instruments, the Plan also provides a set of investment tasks implementing the objective of counteracting the effects of drought.

Views on the scale of the needs of the implementation of activities including the construction and reconstruction of water devices in order to increase retention, and thus increase available resources, are expressed, among others, in the results of the survey conducted as part of the work on the DECP.

When asked to indicate the actions needed in this regard, stakeholders selected, among others: 133 tasks related to the construction and reconstruction of water reservoirs, 167 tasks related to the implementation of damming devices and structures, 88 tasks related to drainage and 33 investments related to the construction or reconstruction of ponds. The results of the study enabled the identification of the potential for the implementation of investment tasks in the field of the construction and reconstruction of water facilities to counteract the effects of drought in the planning cycle for 2021–2027.

As a part of their statutory tasks, the SWH PW adopted 2 lists of investment tasks: list of investment tasks from the PW PIP, and supporting the drought mitigation effect (list A as attachment 1 of DECP) and a list of investment tasks related to increasing channel retention in catchments in rural catchment areas (list B as attachment 2 of DECP) (Table No. 14, Map No.10). The third list C as Attachment 3 of DECP, is a list of investments submitted by external entities (outside the SWH PW) during the six-month public consultation. The tasks from list number 3 have successfully passed the preliminary multi-criteria assessment of the viability of the investment in terms of its usefulness for counteracting the effects of drought on a local level. It is recommended to develop the required documentation and obtain the required administrative decisions necessary to undertake the investment process for them. However, it should be remembered that the final assessment of the legitimacy of these investments will be made through obtaining the administrative decisions required by law. The list of investment tasks, proposed mainly by local government units and voivodeship offices, includes 182 items, among which dominate investment tasks related to the construction of retention reservoirs.

78 investment tasks of the PW PIP (Attachment 1 of DECP) implementing the goal of, i. a., increasing retention and supporting the prevention of the effects of drought, include the planned construction and reconstruction of, among others: 6 weirs, 24 water reservoirs, 11 devices for stabilising or damming water in lakes, and 5 water dams. In order to maintain the consistency of the DECP with other documents developed for the years 2021–2027 (with a perspective until 2030) under attachment 1 and 2, the investments meeting the DECP objectives from attachment 1 to the ‘Assumptions to the Program for Counteracting Water Deficits’ were selected.

The response to the identified risk of agricultural drought are investment projects implemented by SWH PW in the field of reconstruction and construction of water facilities, including adding an irrigation function to the existing drainage devices. They were included in list B (attachment 2). They are investments indicated in the assumptions for the Water Resource Development Program. In the attachment 2 for DECP indicates, among other things, tasks for the construction, reconstruction and rehabilitation of 145 valves, 81 weirs and 101 other structures for water retention. The planned increase in the level of river bed retention under the tasks from list B (attachment 2) is over 10,883 thousand m^3.

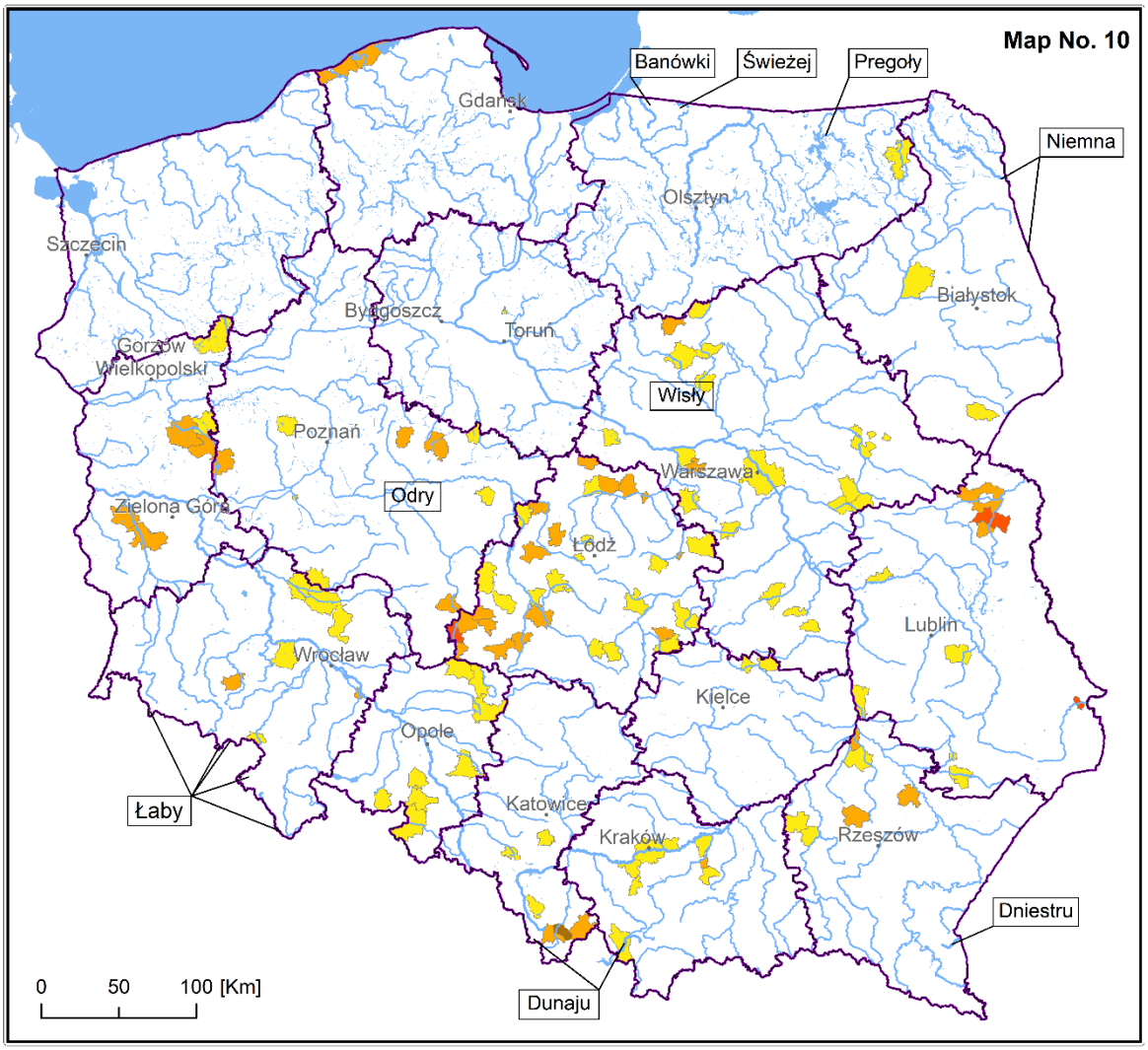
Table No. 14 Summary of the number of investments for the construction and reconstruction of water facilities in river basin areas

River basin area	Code of the river basin area	Investments		
		list A attachment 1	list B attachment 2	list C attachment 3
Dunaj	1000	–	–	–
Wisła	2000	41	101	106+1*
Świeża	3000	–	–	–
Banówka	4000	–	–	–
Łaba	5000	–	–	–
Odra	6000	36	229	75 +1*
Pregoła	7000	1	4	–
Niemen	8000	–	–	–
Dniestr	9000	–	–	–
Poland		**78**	**334**	**182**

* Investment task submitted by the commune located in the watershed

It should be emphasised that the prepared list of tasks is not a closed list. It takes into account only the tasks planned by the SWH PW as of the date of this document, which, mainly, in terms of list A, are already included in the water management plans and flood risk management plans. It also includes investments indicated and selected as a result of public consultations on the DECP. Therefore, other tasks in the field of construction and reconstruction of water facilities may or even should be undertaken for the full implementation of the DECP objectives. These tasks were recorded in the part of the DECP devoted to the catalogue of measures to counteract the effects of drought. Both catalogue activities and activities aimed at increasing retention formulated in the list of tasks planned under the PW PIP should also be considered in terms of the legitimacy of their inclusion in other planning programs and documents, in order to obtain consistency of the directions and scopes of activities in water management planning.

The investment tasks related to the construction and reconstruction of water facilities in order to increase e.g. retention and support the prevention of the effects of drought proposed for the 3rd planning cycle of WFD are listed in the tables of attachment 1, 2, 3 for DECP and Map No. 10.



Location of investments in the field of construction and reconstruction of water facilities to counteract the effects of drought, planned for implementation by the Polish Waters for the years 2021-2027, and the location of investments submitted during public consultations

Legend

List C - the number of investment tasks in municipalites

- 1
- 2 - 4
- 5 - 7
- 8 - 9

- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

3. Presentation of proposals for necessary changes in the use of water resources and changes in natural and artificial retention

3.1. The scope of planned changes and the assessment of the scale and rationality of the use of water resources

The effective management of water resources, as defined in Article 10 of the Water Law Act **serves to satisfy both the needs of the population and the economy, as well as to protect waters and the environment associated with these resources. It concerns, among others, the protection against floods and droughts, the protection of water resources against over-exploitation, as well as other issues aimed at meeting the water needs of users and the natural environment.** The priority is given to the provision of water intended for human consumption, as highlighted above. In the above context, it should be emphasised that the use of water resources, in accordance with Article 29 of the Water Law Act, may not deteriorate the status of waters and ecosystems dependent on them, except in cases specified in the Act. In particular, it may not infringe on the provisions of the river basin management plan, cause wastage of water or water energy, and may not cause damage to the environment. The principle of sustainable development in water management must be the overarching guideline for driving change in the use of water resources. It is particularly important during periods of drought, which limits the availability of water resources, and therefore threatens the ability to meet the above-mentioned requirements.

In the context of counteracting the effects of drought, the scope of changes in the use of water resources in the DECP includes changes:

1) formal, possible to be carried out in the applicable legal system (for example reviews of water permits and the inclusion of drought scenarios in crisis management procedures);
2) indicating the scope of legislative changes necessary for the implementation of the DECP's specific objective: the formalisation and planning of financing activities aimed at counteracting the effects of drought, including changes in insurance mechanisms and creating incentives to take actions to counteract the effects of drought in a proactive manner;
3) in the manner of exercising the rights to use water resources by water users, including changes understood as shaping adequate social attitudes in relation to the use of water resources during drought (saving), conscious participation in spatial planning processes regarding the exercise of ownership in the management of rainwater and meltwater within the plot, or increasing the retention of soil on agricultural land due to the use of specific agricultural practices.

These changes are expected to intensify the process of taking action to counteract the effects of drought. The expected method of counteracting the effects of drought is to develop resistance to drought of given areas (agricultural, urban, forest), as well as water and water-dependent ecosystems. It is also important to shape adequate social attitudes towards drought and the risk of drought.

The Water Law Act defines three scopes of water use: general, ordinary and special (described successively in Articles 32, Articles 33 and Articles 34 of this Act). Identification of the structure of using water resources enables to assess the scale of users to whom drought causes negative effects, i.e. limits the possibility of exercising their rights and limits the scope of water services.

On the basis of data on the volume of abstractions under water permits for the abstraction of surface waters (status for 2016) collected in the database of the study 'Identification of pressures in water regions and river basin areas (results for part 1 – Hydro morphological database and database and for part II – database on other pressures) of the NWMA, the following structure of users is indicated: 80,9% of water permits belong to users from the agricultural sector (including 56,1% from the aquaculture sector), 11,3% for industry (including 4,8% for energy), 4,3% are entitlements for water abstraction for the purpose of supplying people with drinking water intended for consumption, and 3,6% are for users from the forestry sector.

In the river basins of the Banówka, Świeża and Dniestr rivers, no intake of surface water was found. The structure of abstractions in quantitative distribution in the remaining river basin areas is as follows: 55,2% of the water abstraction takes place in the Odra basin, 43,6% in the Wisła basin, 0,9% in the Pregoła basin and 0,2% in the Niemen basin area. The remaining 0,1% is allocated to the areas of other river basins (Table No. 15).

Table No. 15 Results of the assessment of the scale of the use of surface water resources

River basin area	Code of the river basin area	Number of users		Abstraction's goal	Number of users		Volume of abstracted water [m^3/year], [%]	
Dunaj	1000	6	0,10%	Population*	6	100,0%	35 660,0	100,0%
				Industry	0	0,0%	0,0	0,0%
				Agriculture	0	0,0%	0,0	0,0%
				Aquaculture	0	0,0%	0,0	0,0%
				Forestry	0	0,0%	0,0	0,0%
Wisła	2000	4058	48,50%	Population*	330	8,1%	195 137 828,1	9,2%
				Industry	433	10,7%	143 574 251,6	6,8%
				Agriculture	1255	30,9%	177 553 862,0	8,4%
				Aquaculture	1939	47,8%	1 583 482 603,4	74,7%
				Forestry	101	2,5%	20 983 568,1	1,0%
Świeża	3000	0	0,00%	Population*	0	0,0%	0,0	0,0%
				Industry	0	0,0%	0,0	0,0%
				Agriculture	0	0,0%	0,0	0,0%
				Aquaculture	0	0,0%	0,0	0,0%
				Forestry	0	0,0%	0,0	0,0%
Banówka	4000	0	0,00%	Population*	0	0,0%	0,0	0,0%
				Industry	0	0,0%	0,0	0,0%
				Agriculture	0	0,0%	0,0	0,0%
				Aquaculture	0	0,0%	0,0	0,0%
				Forestry	0	0,0%	0,0	0,0%
Łaba	5000	7	0,10%	Population*	0	0,0%	0,0	0,0%
				Industry	0	0,0%	0,0	0,0%
				Agriculture	0	0,0%	0.0	0,0%
				Aquaculture	7	100,0%	441 504,0	100,0%

				Forestry	0	0,0%	0,0	0,0%
Odra	6000	4158	49,70%	Population*	25	0,6%	27437 011,8	1,0%
				Industry	473	11,4%	235 292 044,9	8,8%
				Agriculture	791	19,0%	331 368 083,6	12,4%
				Aquaculture	2673	64,3%	206 9565 301,3	77,2%
				Forestry	196	2,5%	18 247 664,2	0,7%
Pregoła	7000	121	1,40%	Population*	0	0,0%	0,0	0,0%
				Industry	34	28,1%	2 758 438,2	6,0%
				Agriculture	10	8,3%	6 616 652,7	14,2%
				Aquaculture	74	61,2%	36 625 112,9	79,5%
				Forestry	3	2,5%	54 365,9	0,1%
Niemen	8000	24	0,30%	Population*	0	0,0%	0,0	0,0%
				Industry	3	12,5%	0,0	0,0%
				Agriculture	17	70,8 %	30 048,0	0,3 %
				Aquaculture	4	16,7%	9 933 840,0	99,7%
				Forestry	0	0,0%	0,0	0,0%
Dniestr	9000	0	0,00%	Population*	0	0,0%	0,0	0,0%
				Industry	0	0,0%	0,0	0,0%
				Agriculture	0	0,0%	0,0	0,0%
				Aquaculture	0	0,0%	0,0	0,0%
				Forestry	0	0,0%	0,0	0,0%
Poland		8 374	100%	Population*	361	4,3%	222 610 499,8	4,6%
				Industry	943	11,3%	381 624 734,6	7,9%
				Agriculture	2073	24,8%	515 568 646,3	10,6%
				Aquaculture	4697	56,1%	3 700 048 361,6	76,1%
				Forestry	300	3,6%	39 285 598,2	0,8%

*municipal intakes

According to Article 393 of the Water Law Act, groundwater should be abstracted in the first place in order to provide the population with water intended for human consumption. This requirement is reflected in the table showing the scale of specific use of groundwater resources (Table No. 16).

The scale of specific use of groundwater resources was analysed using data from the above-mentioned database on pressure identification, which listed 21,730 intakes with an assigned abstraction's goal. The results of the assessment of the scale of use of groundwater resources in division into river basin areas are presented in the table above (Table 16).

Table No. 16 Results of the assessment of the scale of the use of groundwater resources

River basin area	Code of the river basin area	Number of users		Abstraction's goal	Number of users		Volume of used water [m^3/year], [%]	
Dunaj	1000	49	0,23%	Population*	31	63,3%	104 969	45.3%
				Industry	11	35,5%	104 928	45.2%
				Agriculture	0	0%	0	0%
				Other	7	1,2%	22 070	9.5%
Wisła	2000	12048	55,45%	Population*	7 370	61,2%	961 425 358	88.8%
				Industry	1 230	10,2%	82 974 048	7.7%
				Agriculture	1 615	13,4%	8 869 808	0.8%
				Other	1 833	15,2%	29 009 243	2.7%
Świeża	3000	4	0,02%	Population*	4	100%	193 582	100%
				Industry	0	0%	0	0%
				Agriculture	0	0%	0	0%

				Other	0	0%	0	0%
Banówka	4000	13	0,06%	Population*	11	84,6%	148 844	98,2%
				Industry	0	0%	0	0%
				Agriculture	1	7,7%	0	0%
				Other	1	7,7%	2 750	1,8%
Łaba	5000	14	0,06%	Population*	9	64,3%	123 281	80,0%
				Industry	4	28,6%	30 800	20,0%
				Agriculture	0	0%	0	0%
				Other	1	7,1%	0	0%
Odra	6000	9244	42,54%	Population*	5 274	57,2%	442 839 836	87,2%
				Industry	1 460	15,8%	48 830 833	9,6%
				Agriculture	1 932	20,9%	7 883 901	1,6%
				Other	523	6,1%	8 592 365	1,6%
Pregoła	7000	270	1,24%	Population*	211	78,2%	25,612,888	99,2%
				Industry	10	3,7%	118 247	0,5%
				Agriculture	22	8,2%	90 795	0,3%
				Other	27	9,9%	1 676	0%
Niemen	8000	81	0,37%	Population*	43	53,1%	4 755 531	94,3%
				Industry	8	9,9%	247 809	4,9%
				Agriculture	3	3,7%	0	0%
				Other	15	33,3%	39 267	0,8%
Dniestr	9000	7	0,03%	Population*	6	85,7%	115 653	99,2%
				Industry	1	14,3%	875	0,8%
				Agriculture	0	0%	0	0%
				Other	0	0%	0	0%
Poland		21730	100,00%	Population*	12 959	59,8%	1 435 319 942	88,5%
				Industry	2 725	12,6%	132 307 540	8,2%
				Agriculture	3 574	16,5%	16 845 379	1,0%
				Other	2 407	11,1%	37 667 371	2,3%

* municipal intakes

Municipal consumption is dominant (from 53,1% of the number of users) in each river basin area and its advantage increases even more, taking into account the amount of water used (only in the Dunaj river basin area the share of the municipal sector drops below 50%). The second sector using the most volume of water is industry (although the number of users is smaller than in the agricultural sector), and the least - agriculture (1,0%). In the scale of Poland as a whole and locally, in the areas of some river basins, there is also visible consumption for other purposes that has been jointly classified in the table as 'Other'. In total, all users consumed approximately 1,622 million m^3 of groundwater in 2016. Groundwater was also exploited in connection with mine drainage - users from the Odra basin area dominated (61 users; 1 034 051 661 m^3), and, to a lesser extent, users from the Wisła basin area (58 users; 73 107 715 m^3). The exploitation of groundwater for construction drainage purposes was also visible on the scale of Poland as a whole, where a total of 1,651 users were authorised to intake 386 119 083 m^3 of water.

3.2. Goals of changes in the use of water resources

The assessment of the necessary changes that should be introduced in the use of water resources in order to achieve effective and efficient counteracting of the effects of drought refers to changes resulting from the needs of:

1) the construction, reconstruction or changes in the functions of water devices, including devices for drainage and irrigation as well as water retention, in order to enable the shaping of water resources in a way that counteracts the effects of drought;
2) the verification of the actual scope of use of water resources by plants, within the meaning of the Water Law Act, from the point of view of both the reliability of the balance of these resources and the possibility of granting further authorisations in the field of water use and water services, as well as the rationalisation and optimisation of the scope of already granted permissions;
3) direct changes to water management, including water maintenance;
4) legislative changes in relation to provisions that encounter difficulties in applying them;
5) The application of regulations and practices that serve to counteract the effects of drought and could be implemented in the process of water use. Failure to apply these regulations and practices is due to lack of knowledge or competence on the part of, among others, administrations, utilities and other water users.

The purpose of the changes, which are currently considered necessary, is to rationalise water consumption in all sectors, to change awareness of water reuse, to secure water supplies for food production and drinking water supply, as well as to manage rainwater in urban areas.

3.3. Proposals of necessary changes in the use of water resources

Changes in the use of water refer both to the national and local scale and apply to all areas of the economy affected by drought. The objective defined in the previous section is implemented by the following actions from the catalogue of actions to counteract the effects of drought:

1) the development of a set of best practices to rationalise water consumption in agriculture (Action No. 22);
2) the promotion of water reuse (Action no. 23);
3) the construction and reconstruction of water drainage devices to increase soil retention (Action No. 8) – mainly the reconstruction from drainage to irrigation/drainage ones;
4) the use of water from drainage systems to fertilise and irrigate field crops (Action No. 9);
5) the construction and reconstruction of groundwater intakes and the construction or reconstruction of main water pipelines to transfer water to areas at risk of hydrological drought for the purposes of collective water supply for human consumption of residents of these areas (Action No. 14);
6) the retention and management of rainwater and snowmelt in urbanised areas (Action No. 3);
7) the verification of the rules of water management in retention reservoirs (Action No. 24);
8) the review of water permits and integrated permits in areas of available resources of intensive and very intensive use (Action No. 25);
9) the development of an effective drought risk management system in terms of temporary limitation in water use (Action No.15);

10) temporary restriction of water use (Action No. 17);
11) the temporary limitation of water consumption from the water supply (Action No. 16).

In the above-mentioned context, the transitional measures in the first period of the DECP validity are considered necessary as follows:

1) a review of water permits and an analysis of integrated permits (Article 416 of the Water Law Act, Act of 27th April 2001 – Environmental Protection Law);
2) change of integrated permits adjusting these permits to BAT conclusions (Article 215 of the Environmental Protection Law);
3) change of water or integrated permits in order to establish the actual maximum amounts of water consumed by plants in these permits (at the request of plants) (Article 562 of the Water Law Act);
4) a risk analysis for the purposes of the possible establishment of a water intake protection zone covering the area of indirect protection (Article 551 Paragraph 2 of the Water Law Act);
5) a review and update of the lists of surface and groundwater bodies (Article 556 of the Water Law Act) intended to supply the population with drinking water (Article 317 Paragraph 4 Subparagraph 1 of the Water Law Act).

On a legal and administrative level, the following issues are also considered necessary to highlight:

1) the priority of using groundwater for human consumption (Article 30 of the Water Law Act);
2) the priority of obtaining a water permit for plants collecting water intended for human consumption and plants whose use of water will contribute to the increase of natural or artificial water retention or the improvement of biological conditions in the aquatic environment (Article 393 of the Water Law Act);
3) the need of unequivocal identification of the priority of a collective water supply system and collective sewage disposal over individual systems, and over other water users, in particular by changing and practicing the application of technical and construction regulations.

In jurisdiction practice concerning individual cases within the scope of the Water Law Act (e.g. in the context of water permits), it is considered necessary to actually implement and intensify the application of recommendations, including:

1) enforcing the design, construction and maintenance of water facilities, taking into account the need to achieve good water status and its characteristic biocenoses, the need to achieve environmental goals and the need to maintain biological conditions in the aquatic environment and water-dependent terrestrial ecosystems (Article 187 of the Water Law Act);
2) determining participation in the costs of designing and/or constructing water facilities in the case of protection against drought, water abstraction, energy use of water facilities, sewage discharge or discharge into water facilities and other water services (Article 187a of the Water Law Act);

3) limiting or withdrawing a water permit due to the natural reduction of groundwater resources, the threat to achieve environmental objectives, the lack of proper maintenance of water facilities, the lack of risk analysis regarding water intakes, or due to the public interest related to the DECP (Article 415 and 417 of the Water Law Act).

In planning documents, plans and programs, activities implementing the above-defined goal, of various scale and scope, most often take the form of general records and references. The sectoral documents, however, indicate the following activities:

1) developing a code of best drainage practices for the maintenance of watercourses in agricultural areas, canals and drainage systems (including ditches);
2) establishing legal and financial mechanisms favouring the rational use of water resources and the implementation of water-saving technologies;
3) the modernisation of drainage and irrigation systems;
4) counteracting the effects of drought in agricultural areas as a result of drainage and irrigation works and activities related to water retention;
5) ensuring a reserve of land for new groundwater intakes to ensure the continuity of water supply, primarily for the purposes of supplying the population with drinking water and for social and living purposes;
6) rainwater management in urbanised areas through various forms of retention and the development of green infrastructure.

As it has been already indicated above, a significant change in the local use of water is the management of rainwater and meltwater and their use leading to a delay in surface runoff to increase retention, including infiltration at the precipitation site. As a part of this type of action, both non-technical and technical actions supporting the proper management of rainwater can be considered. It is important to recognise the type of soil and land use and indicate priority areas for the implementation of such solutions. The results of the analyses will be, i.a., proposals of methods to manage rainwater. Activities in the field of rainwater management are activities derived from the FRMP and include:

1) an analysis of the possibility to increase the retention in urbanised areas in the PB of the Bug Graniczny River as a part of maintaining and increasing the existing retention capacity in the Middle Wisła water region;
2) an analysis of the possibility to increase the retention in forest, agricultural and urbanised areas in the area of the Bug PB as a part of maintaining and increasing the existing retention capacity in the Middle Wisła water region;
3) a concept of retention of flood waters above Słupsk and implementation of solutions resulting from this concept;
4) an analysis of the possibility to increase retention in agricultural and urbanised areas in the planning catchment area Łyna and Węgorapa Planning Basin as a part of maintaining and increasing the existing retention capacity in the Łyna and Węgorapa water region;
5) protecting/increasing retention in urbanised areas (group of directions of the FRMP measures);

6) protecting/increasing retention in agricultural areas (group of directions of the FRMP measures);
7) the development of a detailed analysis and design of the possibility to increase the retention of urbanised areas (Kędzierzyn-Koźle, Racibórz, Gliwice);
8) the development of a detailed analysis and design of the possibility to increase the retention of agricultural areas in the lowland catchments regarding the catchments of the Bóbr, Nysa Łużycka, Kaczawa, Bystrzyca, Nysa Kłodzka, Barycz, Ślęza, Widawa, Oława and Odra rivers catchments;
9) the development of a detailed analysis and design of the possibility to increase the retention of urbanised areas (individually for a city of more than 50,000 inhabitants), i.e. Wrocław, Zielona Góra, Legnica, Wałbrzych, Leszno, Głogów, Lubin, Świdnica, Tarnowskie Góry, Jelenia Góra, Opole); the development of a detailed analysis and design of the possibility to increase the retention of urbanised areas (individually for a city of more than 50,000 inhabitants), i.e. Poznań, Częstochowa, Gorzów Wlkp., Kalisz, Ostrów Wlkp., Konin, Piła, Zawiercie, Łódź, Gniezno, Inowrocław, Bełchatów, Pabianice;
10) the development of a detailed analysis and design of the possibility to increase the retention of urbanised areas (individually for a city of more than 20,000 inhabitants), i.e. Szczecin, Koszalin, Stargard Szczeciński, Kołobrzeg, Świnoujście, Police, Białogard, Goleniów, Gryfino.

3.4. Needs and proposals for changes in natural and artificial retention taking into account the division of the country into river basin areas

The assessment determining what changes should be introduced in the field of natural and artificial retention relates to the following needs, which at the same time define the purpose of these activities:

1) increasing natural and soil retention in **agricultural** areas;
2) increasing natural and artificial retention in **forest** areas;
3) increasing retention in **urbanised** areas;
4) increasing **artificial retention** through investment activities.

When analysing the current legal situation, in the jurisdiction practice in individual cases in the field of Water Law, it is considered necessary to actually implement and intensify the application of the recommendations, including:

1) determining the obligation (both in the first instance and in the second instance) to restore the retention by building water facilities for this purpose or by implementing other projects if the natural or artificial retention of inland waters is reduced in connection with the execution of the water permit (Article 403 Paragraph 6 Subparagraph 4 of the Water Law Act);
2) undertaking interventions resulting in orders to restore the previous function of a water device or to implement devices preventing damage or liquidation of damages, or to define a new function of a water device, its reconstructing or decommissioning - in case of improper maintenance of a water device, the consequence of which is a change in the function of this

device or the harmful impact of this device devices on water or land (Article 191 of the Water Law Act);
3) application of the criterion of compliance with the DECP as a criterion for the admissibility of legalisation of water facilities (Article 190 Paragraph 2 Subparagraph 3 of the Water Law Act).

With regard to the issues of field retention, the following are justified:

1) Coordinate the provisions for the construction of irrigation and anti-erosion systems with the provisions for the construction and financing of water reclamation (Article 195, Article 197, Article 198 and Article 206 of the Water Law) and also the implementation of activities from the DECP for protection against flooding (Article 165 of the Water Law);
2) determining further incentive instruments with regard to the dependence of the unit rate of the fee for reducing field retention on the level of retention compensation (Articles 34, Articles 269, Articles 270 of the Water Law Act);
3) applying provisions concerning the enforcement of the obligation to perform works maintaining water drainage facilities (Articles 205, Articles 206 of the Water Law Act);
4) creating support instruments for water companies, in particular companies operating in the field of providing water to the public, including water treatment and supply; as well as water drainage and rational management on drained land.

The national and regional planning documents indicate general activities aimed at shaping natural and artificial retention. Among them, the following were indicated: pro-ecological management of local water resources, including shaping of landscapes enabling water retention, appropriate agrotechnical measures; special protection of springs and spring areas, including the prohibition of drainage; increasing forest cover and introducing trees to agricultural and urban space as a substitute for forest, horizontal thematic activities in the area of counteracting and preventing natural hazards and disasters, aimed at, i. a. preventing drought through development of small retention.

Other activities in the catalogue of drought mitigation activities that are designed to alter natural and artificial retention are:

1) damming lake waters to counteract the effects of drought (Action no. 5);
2) the implementation of projects aimed at increasing or restoring natural retention (Action No. 4);
3) increasing the amount and duration of water retention on agricultural land (Action No. 1);
4) increasing natural and artificial retention on forest land (Action No. 2);
5) an analysis of the possibility to increase retention in catchments with the use of natural and artificial retention (Action No. 6).

It should be noted that, in accordance with the Water Law Act, counteracting the effects of drought is the task of the government, local administration and the SWH PW. Hence, the proposals for necessary changes in artificial retention relate to the investment activities of water administration units, self-government administration units and state forest administration units, and may concern

the construction of large facilities or facilities with a small area, and insignificant damming of the so-called small retention. A detailed list of investments that are planned to be implemented by the SHW PW is presented in the part of DECP concerning the proposal for the construction and reconstruction of water facilities. The investment plans for large retention facilities presented in Attachment 1 of DECP come from the applicable planning documents, such as: update to RBMPs and FRMP, the SWH PW Planned Investments Program, as well as from the 'Assumptions to the Water Deficits Counteracting Program'. This action is listed in the catalogue of drought mitigation activities as: the implementation of investment activities in the field of shaping water resources by increasing artificial retention.

4. The catalogue of measures to counteract the effects of drought

4.1. Identification of measures

The catalogue of measures to counteract the effects of drought hereinafter also referred to as "the catalogue", finds its legal basis in has its legal basis in Article 184 Paragraph 2 Subparagraph 4 of the Water Law Act. This catalogue is an integral part of the DECP. At the same time, it has an increased rank in relation to the other components of the document: while the remaining parts of the DECP have the value of an analysis or a proposal, the catalogue, in its own way, results from them, and its content has an operational dimension. Due to the change in the above-mentioned provision, the catalogue of activities will constitute a specific part of the current Plan and the planning period.
The catalogue of measures corresponds to the information contained in the water management plans about the planned and undertaken measures that serve to implement the principle of reimbursement of the costs of water services, determined taking into account the contribution made by water users as well as environmental and resource costs.
The catalogued set of activities includes a set of solutions aimed at achieving the specific objectives formulated in the first part of the DECP, and thus achieving the main goal of this document, i.e. counteracting the effects of drought.
Each of the activities contributes significantly to the achievement of at least one of the defined specific objectives. For each of the measures, the following has been defined: the scope of works that make up a given measure, its expected effects and its implementation priority.
Part of the criteria of the S.M.A.R.T. rule was used to assess the validity of including specific measures into the catalogue. When using them, it was tested whether a given action is:

1) **Specific** – whether the subject, scope, purpose and identified problems for the activity correspond to the needs indicating the legitimacy of implementation,
2) **Measurable** – whether the expected effects of the proposed solution and the possibility of their quantification and implementation control have been identified,
3) **Relevant** – whether the given action is adequate to the diagnosed problems for which it is to be a solution.

The applied criteria allowed for defining and including activities into the catalogue in an orderly and coherent manner with the entire structure of the document. The actions additionally complement each other, thus ensuring the logical order of the process of their implementation. At the same time, their description corresponds to the activities and data contained in other planning documents in water management, fulfilling the statutory requirement of consistency of these documents (Article 326 Paragraph 2 and 4 of the Water Law Act).

The identification of activities included in the catalogue was first based on the analysis of the proposed measures indicated in the results of the update of the study ‘Protection against drought in water management planning – methodology’. A separate set of proposed activities was confronted with

the results of the survey conducted for the purpose of developing the Plan, the findings of the DECP working group at the NWMA and the arrangements made with the ministries listed in Article 185 Paragraph 1 of the Water Law Act. The basis for determining the activities in the DECP was also the result of the analysis of planning documents and programs taking into account the aspect of limitation and counteracting effects of drought. The records of the following documents were verified:

1) planning documents at the national and regional level;
2) domestic and foreign studies in the field of broadly understood retention and protection against drought;
3) best agricultural practices;
4) best practices and guidelines for water reuse;

studies published by the National Research Institute (IMWM-NRI, IEP-NRI, ISSPC-SRI, PGI-NRI) and other scientific and research units.

The significance of the results of the above-mentioned survey was emphasised primarily at the stage of assessment according to the indicated three parts of the S.M.A.R.T. rule. Taking into account the socialisation of the DECP preparation process, the survey carried out for the purpose of developing the DECP covered a wide range of stakeholders, i.e. administration entities and groups of water users. Stakeholders answered the questions directly related to the measures to counteract the effects of drought (implemented, under implementation, planned and desirable activities). Additionally, the results of analysis of the survey indicated the economic, social and environmental areas most sensitive to the effects of drought. As a part of the survey, following activities were chosen:

1) monitoring of drought in general and with an indication of its individual types;
2) rainwater retention in urbanised areas;
3) the construction of drinking water intakes of groundwater and surface waters;
4) a system of compensation for damages caused by drought and subsidies to premiums for concluding insurance contracts against drought risk, rules and methods of material and financial support for victims of the effects of drought;
5) the need of education on drought and water saving;
6) carrying out analyses and expert opinions on the subject appropriate to the statutory scope of the DECP.

A review of over 60 planning documents, programs and strategies developed at various levels of administration and coming from various economic sectors, provided information confirming the importance of the activities indicated in the catalogue. In many cases, the analysed documents included measures contributing to counteracting the effects of drought, whether by increasing retention, increasing the capacity of available resources, improving social awareness, or reducing agricultural losses or compensating them. The gathered information enabled the specification of the scopes of activities in the catalogue, as well as to indicate new activities. Out of nearly 130 actions indicated

in the documents, the most numerous group is actions in the field of increasing retention - as many as 86 proposed solutions, of which:

1) 32 comply with the catalogue activity covering the implementation of projects aimed at increasing or restoring natural retention;
2) 16 comply with the catalogue activity covering the implementation of investment activities in the field of shaping water resources by increasing artificial retention;
3) 14 comply with the catalogue activity covering the increase of natural and artificial retention on forest land;
4) 12 comply with the catalogue activity covering retention and management of rainwater and snowmelt in urbanised areas;
5) 9 comply with the catalogue activity covering the construction and reconstruction of drainage devices;
6) 3 comply with the catalogue activity covering increasing the amount and duration of water retention on agricultural land.

The second largest group of activities identified in planning documents were educational activities –16 responses. In terms of the subject scope, the proposals concerned both education in the broad context of the phenomenon of drought, and education of farmers on increasing retention on agricultural land and promoting crops less sensitive to drought, as well as promoting water reuse and creating a collection of best practices in the field of rationalisation of water consumption in agriculture.

Summing up, the review of the documents indicated that the problem of drought and the need to counteract its effects are noticed. The solutions planned in the documents are aimed at increasing the resistance of the areas to the effects of drought. In addition, the need to create public awareness of drought has also been noticed.

The creation of the catalogue of activities and their implementation is supported by a number of legal instruments. Examples of activities directly related to legal instruments are:

1) Increasing the amount and duration of water retention on agricultural land - showing connection with the regulations on making the administrative and legal requirements less formal with regard to activities retaining water in ditches, inhibiting the outflow of water from drainage facilities and capturing rainwater or meltwater with the use of water drainage devices;
2) The construction and reconstruction of water drainage devices to increase soil retention - legal instruments providing for:
    a) covering irrigation and anti-erosion systems with the provisions on water irrigation and drainage,
    b) public, including the EU, funding for the construction of water drainage facilities and other water facilities regulating water conditions in order to improve the productivity of soil and facilitate its cultivation,
    c) an order to perform works related to the maintenance of water irrigation and drainage devices,

d) an order to restore the previous function of a water device or to implement devices preventing damage or liquidated damages, as well as the possibility of determining a new function of a water device, its reconstruction or decommissioning in case of improper maintenance of a water device, the consequence of which is a change in the function of this device or the harmful impact of this device on water or land,

e) imposing the obligation to perform works or participate in the costs of designing, constructing or maintaining water facilities in accordance with the current or forecast benefits, the performance of works or participation in the costs of water maintenance in accordance with the increase in these costs in connection with the implementation of a water permit or restoration of retention through construction of water facilities or implementation of other projects for this purpose, if, the natural or artificial retention of inland waters is reduced due to the implementation of the water permit;

3) The development of an effective drought risk management system in terms of temporary limitation of water use - legal regulations providing for:

a) the possibility of introducing a temporary limitation in the use of water, in particular in terms of water abstraction or discharge of sewage into water or into the ground, as well as changes in water management in retention reservoirs, as well as suspending the rights resulting from water permits for this purpose by the voivode in the case of introducing a state of natural disaster, in order to prevent the effects of drought,

b) the possibility of issuing orders addressed to public administration bodies by voivodes in emergency situations, including crisis situations,

c) the procedures for water and sewage companies in case of a failure to maintain the continuity of services and appropriate parameters of the water supplied, established by municipal councils in the regulations for water supply and sewage disposal,

d) covering tasks in the field of civil planning and crisis management plans for drought proceedings,

e) issuing order regulations setting restrictions on the use of water by municipal authorities;

4) Increasing natural and artificial retention on forest land - legal provisions on:

a) the obligation to protect soil and forest water, as well as the order to perform protective measures in forests by their owners (not owned by the State Treasury),

b) the obligation to protect forest soils and waters, as specified in forest management plans and the forest fire protection instructions;

5) The verification of the principles of water management in retention reservoirs - standards establishing:

a) the regulation of the flow regime: water permits - water management instructions, water management logs,

b) the application of the provisions on special use of water for water transfers;

6) Implementation of projects aimed at increasing or restoring natural retention - connection with legal regulations providing for:
    a) the obligation to restore the retention by the construction of water facilities for this purpose or the implementation of other projects in a water permit, if the natural or artificial retention of inland waters will be reduced due to the implementation of the water permit,
    b) the priority of obtaining a water permit for plants collecting water in order to supply the population with water intended for human consumption and plants whose use of water will contribute to the increase of natural or artificial water retention or the improvement of biological relations in the aquatic environment,
    c) the fee for reducing field retention, as well as the dependence of the unit rate of the fee on the level of the retention compensation,
    d) establishing forms of nature protection that protect aquatic and water-dependent ecosystems;
7) A review of water permits and integrated permits in balance areas with limited available resources, which are intensively or very intensively used - legal provisions on:
    a) determining the fixed fee for surface and groundwater abstraction, the discharge of wastewater, rainwater, meltwater and ground drainage water into the water within the administrative boundaries of cities in relation to the maximum amounts resulting from the water permit or the integrated permit,
    b) the refusal to issue a water permit due to the violation of the provisions of the DECP or the requirements for the protection of human health, the environment and nature,
    c) the limitation or withdrawal of the water permit due to the natural reduction of groundwater resources, the threat of not achieving environmental goals, the lack of proper maintenance of water facilities, the lack of risk analysis regarding water intakes, as well as due to the public interest in the DECP,
    d) the compliance with the DECP as a criterion for the admissibility of legalisation of water devices,
    e) the obligation to specify an environmental flow in the water permit.

The types and groups of activities in the catalogue indicate that the instruments implementing the DECP do not have to strictly or literally refer to the issue of drought and do not have to be directly subject to regulations. However, their application will be significant for the effectiveness of the activities included in the DECP. The identification of instruments for the implementation of the DECP should assume the drought to not only be a subject of regulation, but an aspect of many different activities, indicated in regulations concerning various areas and different spheres of social life (regulations not directly related to water management, e.g. agriculture and food, financial or even criminal regulations may be significant).

The review of documents and survey results allowed for the definition of 27 activities in the catalogue, of which: 18 were implemented from an update of the study "Drought Protection in Watershed Management Planning - A Methodology to Follow." 9 activities were added as new, and 4 activities were

modified due to the survey results. This process enabled the selection of a list of measures to counteract the effects of drought, valid as of the date of the document's development. It should be emphasised that this set is open, which means that counteracting the effects of drought is not limited only to the indicated catalogue of solutions. During the duration of the DECP, other complementary measures may be implemented to counteract the effects of drought, provided that the formal and environmental requirements appropriate to their scope are met.

4.2. Structure of the catalogue of measures counteracting the effects of drought

The catalogue of measures to counteract the effects of drought, constituting attachment No. 4 to the DECP, was developed in the form of a table collecting and organizing information characterizing a given measure (constituting attachment No. 4 to the PPSS). Within this structure, each measure was described by the following set of attributes:

1) an ordinal number;
2) the type of action – an indication of what subject area the action concerns, i.e. whether it is an educational action (Education), an action specifying the formal framework for counteracting the effects of drought (Formal), a construction or a reconstruction (Construction), an action implementing the objective of increasing water retention (Retention), or an action regarding change of use (Change of use);
3) the name of the action;
4) the description of the activity – defines the subject and scope of the activity, as well as clarifies of the name and indication of the components of a given activity;
5) the scope of impact (national, regional, local) – determines the scope of the action, taking into account its specificity and the expected effects of its implementation;
6) the authority responsible for:
    a) the development/preparation of a legal act/grounds for the implementation of the action,
    b) the implementation;
7) the expected result of the action – determination of the effects of the action's implementation, taking into account groups of water users;
8) the priority of implementation (defined according to a two-stage scale: high, medium) determining the significance of the implementation of the measure in the context of counteracting the effects of drought. A high priority indicates the need to start the implementation from the very beginning of the planning period, i.e. from 2021. A high priority has been given to formal measures, like developing legal and administrative instruments for the implementation of investment activities and executive measures for the use of water resources. It has also been given to design and investment activities for which legal and financial instruments already exist, as well as for time-consuming projects, often exceeding the 6-year planning period. Educational activities for agriculture and introducing drought to the core

curricula in primary and secondary education were marked with high priority. On the other hand, the medium priority applies to the activities that can be implemented only after the implementation of the activities forming the basis for their performance and activities dependent on the cyclical nature of work in water management.

The following activities stand out among the catalogue activities:

1) 10 actions at a national level;
2) 2 regional actions;
3) 3 actions of both regional and local scope;
4) 10 local actions;
5) 2 actions at the national, regional and local level.

In the case of division into types of activities, the following were identified:

1) 2 educational activities;
2) 3 activities in the field of construction and reconstruction of water devices;
3) 3 activities in the field of increasing retention;
4) 11 formal activities;
5) 3 activities, both formal and educational;
6) 3 activities both in the field of construction and retention;
7) 1 activity involving change of use.

The catalogue activities implement the main goal of the DECP, and their scope fits into specific objective or into several specific objectives.

4.3. Characteristics and location of measures counteracting the effects of drought in planning units

In order to maintain the legibility of the activities, all associated characteristics have been summarised in the table in Attachment 4 of DECP.

The introduction of the catalogue activities within specific water bodies will serve not only to counteract the effects of drought, but also contribute actively to the improvement of their condition and enable the achievement of environmental objectives in planning units. For this purpose, the updated division into water bodies (revised SWB) was used, which will be in force from the moment of acceptance of the second update of the river basin management plans. This is to preserve consistency of planning documents.

The catalogue activities, according to strictly selected criteria, should be introduced throughout the country. The selection of adequate measures for the revised SWBs creates specific guidelines and

recommendations for introducing the catalogue measures into the river basin areas. The appropriate selection of activities, especially those related to shaping water resources and building retention in various areas is the basis for increasing the available resources. Capacity. The selection criteria for the revised SWB were developed for the 10 activities listed below:

1) increasing the amount and duration of water retention on agricultural land (Action No. 1);
2) the retention and management of rainwater and snowmelt in urbanised areas (Action No. 3);
3) the implementation of projects aimed at increasing or restoring natural retention (Action No. 4);
4) lake water damming in order to counteract the effects of drought (Action No. 5);
   an analysis of the possibilities of increasing retention in catchments with the use of natural and artificial retention (Action No. 6);
5) the construction and reconstruction of irrigation and drainage devices to increase soil retention (Action No. 8);
6) the use of water from drainage systems for fertilisation and irrigation of field crops (Action No. 9);
7) the construction and reconstruction of groundwater intakes for agricultural irrigation, as well as construction and reconstruction of water-saving irrigation systems using groundwater resources (Action No. 10);
8) the verification of the principles of water management in retention reservoirs (Action No. 24);
9) a review of water permits and integrated permits in areas of intensive and very intensive use of available water resources (Action No. 25).

It should be emphasised that the set of activities includes technical and non-technical undertakings (i a. activities related to shaping natural retention). The purpose of these actions is multidirectional and does not apply only to counteracting the effects of drought but also to the other water management tasks. These activities will also contribute to counteracting floods by retaining excess water in areas with different types of use, flattening the flood wave, improving the condition of water and water-dependent ecosystems (also restoring those that have been degraded as a result of local conditions or the anthropogenic pressure), and creating habitats and refuges (including creating watering places for wild animals). Over 17,000 activities are recommended to be introduced on the basis of the developed criteria for 3,344 revised SWBs. Map No. 11 shows the number of activities proposed in each revised SWB. The next maps present recommendations for individual actions (Maps No. 12–21).

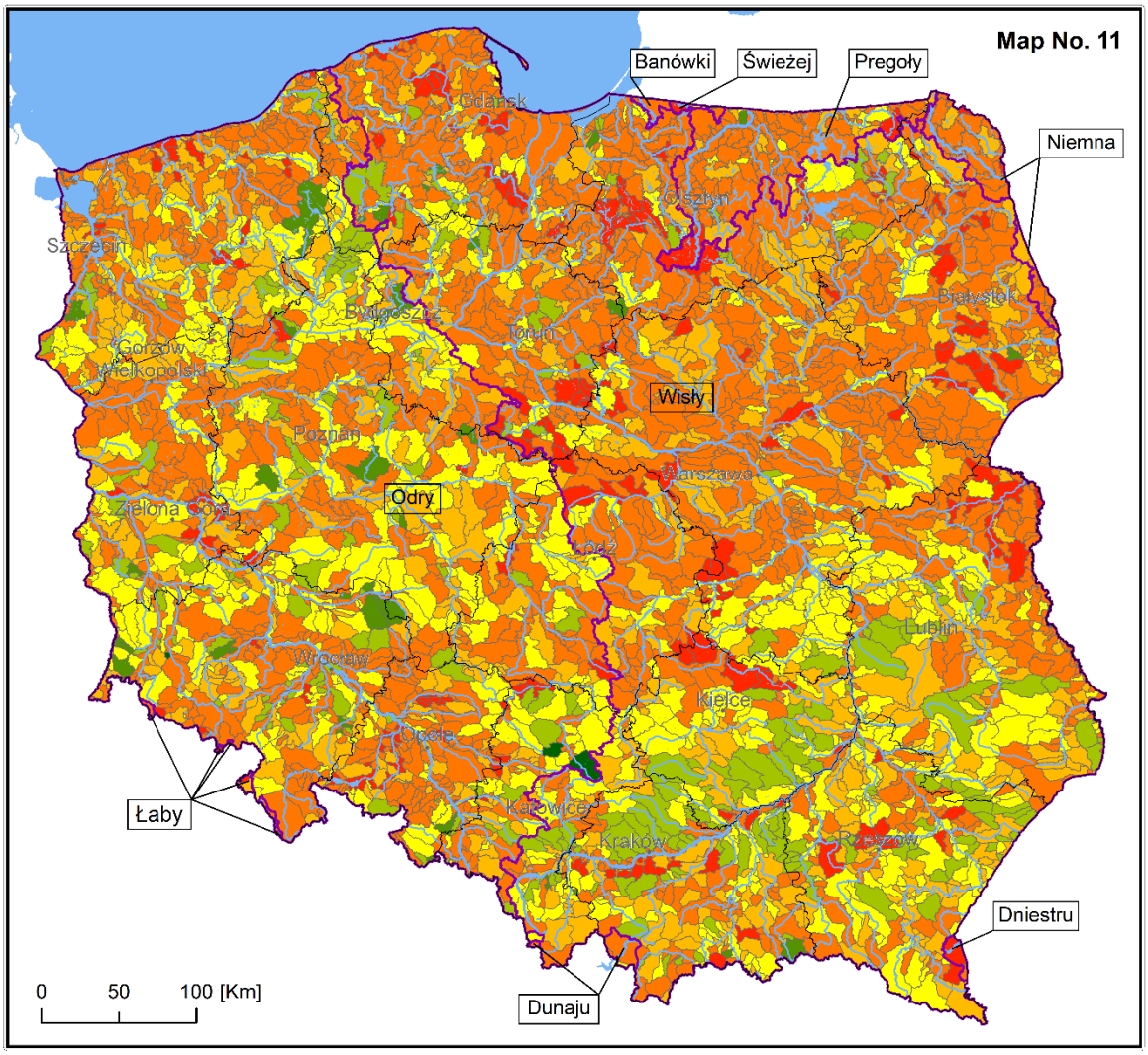
Activities related to nature-friendly non-technical solutions, the restoration of natural retention, wetlands, as well as activities aimed at improving water conditions in agricultural areas (through, among others: appropriate agrotechnical treatments or landscaping) are recommended in 3,315 (Action No. 1) and 2,618 (Action No. 4) revised SWBs. These activities are in line with the requirements of the Water Framework Directive and the guidelines of the European Commission on increasing retention. The above-mentioned measures will contribute to the improvement of the condition of surface water bodies and will constitute a component in supporting the process of achieving environmental goals (including environmental goals in protected areas within the meaning of the WFD). These activities, due to their connections, will also contribute to the improvement of the condition of water and

water-dependent ecosystems, as well as support the protection of these areas by maintaining their integrity and an appropriate degree of conservation of objects of protection.

Action No. 6 (Analysis of the possibility to increase retention in catchments with the use of natural and artificial retention) is important from the point of view of the possibility to increase the capacity of available resources. The analysis, determined by this action, is recommended to be carried out in 1,111 revised SWBs' catchments indicated as threatened by extreme and severe hydrological drought, as well as moderate and severe agricultural drought. Obviously, Action No. 6 should also be carried out in other catchments, in accordance with the principle of adequacy to the needs resulting from e.g. local conditions of susceptibility to the effects of drought. This action will support the decision-making process in terms of implementing new investments. The procedure related to a wide range of environmental analyses for new investments in water management, carried out at a very early stage, is planned in accordance with both the Water Framework Directive and WFD and the Convention on access to information, public participation in decision-making and access to justice in environmental matters, drawn up in Aarhus on 25 June 1998 and the Directive of the European Parliament and of the Council 2011/92/EU of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment.

The DECP, through catalogue activities, also draws attention to the problem of water management in urban areas (Action No. 3), including its accordance with the principles of sustainable planning and urban design. Action No. 3 is recommended for implementation in urbanised areas threatened by extreme to moderate hydrological drought, and at least moderate agricultural drought at the same time. This action is related to, i. a. planning and strategic documents aimed at developing plans of urban adaptation to climate change.

As it has already been mentioned, the Plan, through its structure and scope, is also focused on counteracting the effects of drought, but through the proposed actions it actively supports the process of achieving environmental objectives in water bodies. As a consequence, the DECP influences a number of other documents, plans and strategies developed for various sectors.



The number of activities proposed in each revised SWB

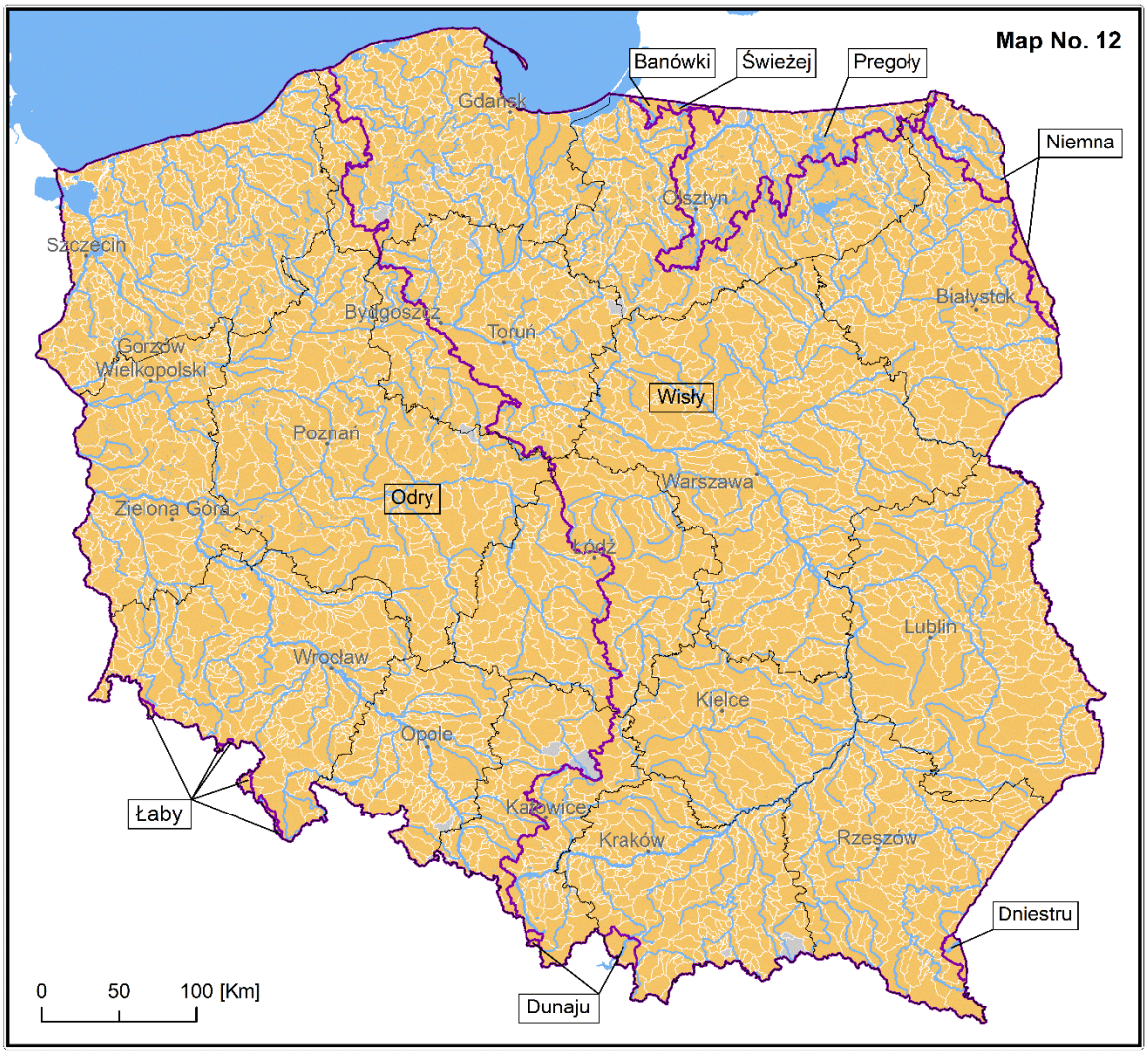
The Map of selected 10 form 27 activities proposed for introducing the catalogue measures into the river basin areas

Legend

The number of proposed activities:

- 2
- 3
- 4
- 5
- 6
- 7
- 8

- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

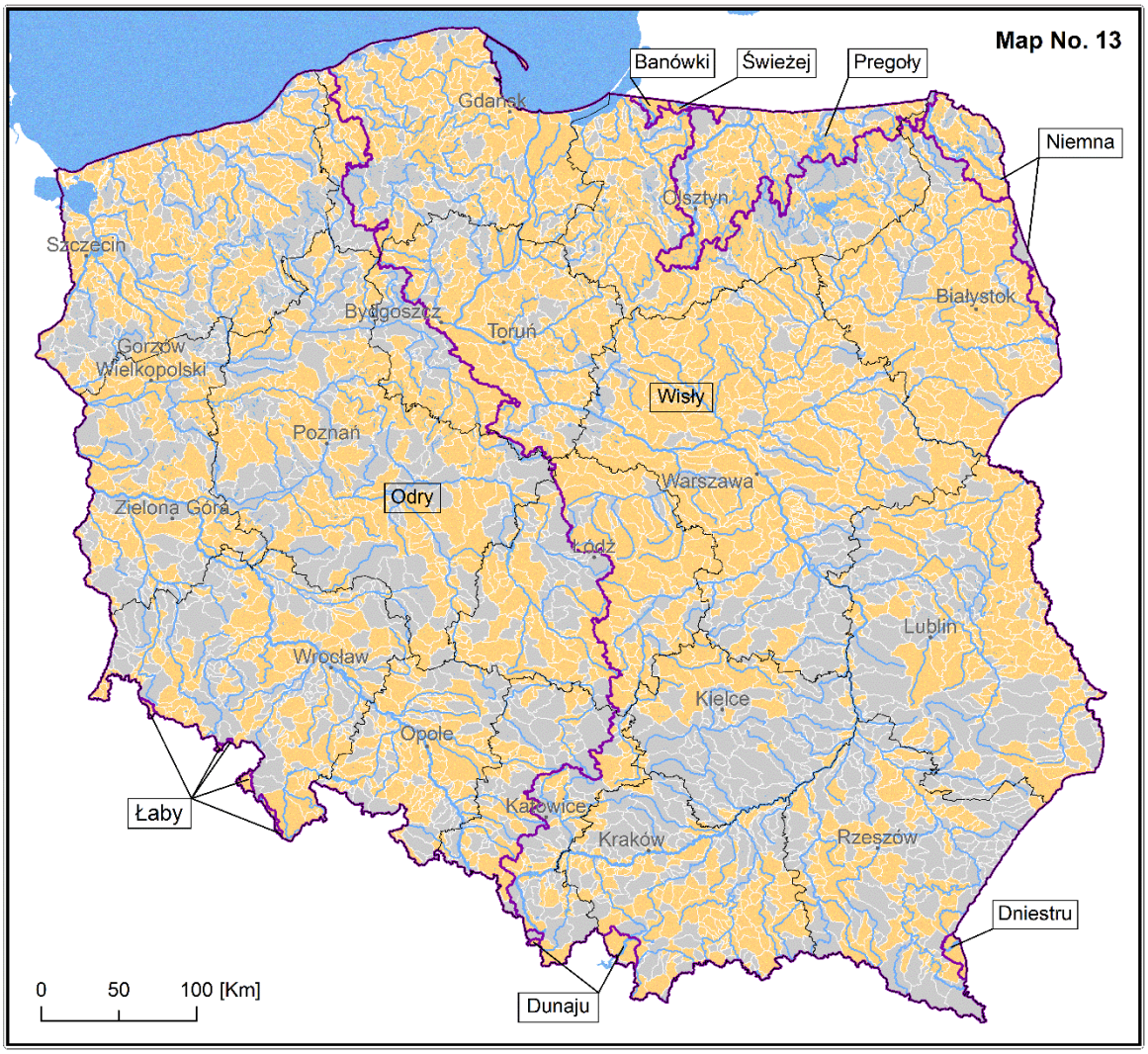


The Map of revised SWB with Action 1 as recommended for implementation:

Increasing the amount and duration of water retention on agricultural land (Action 1)

Legend

- revised SWB recommended for Action implementation
- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

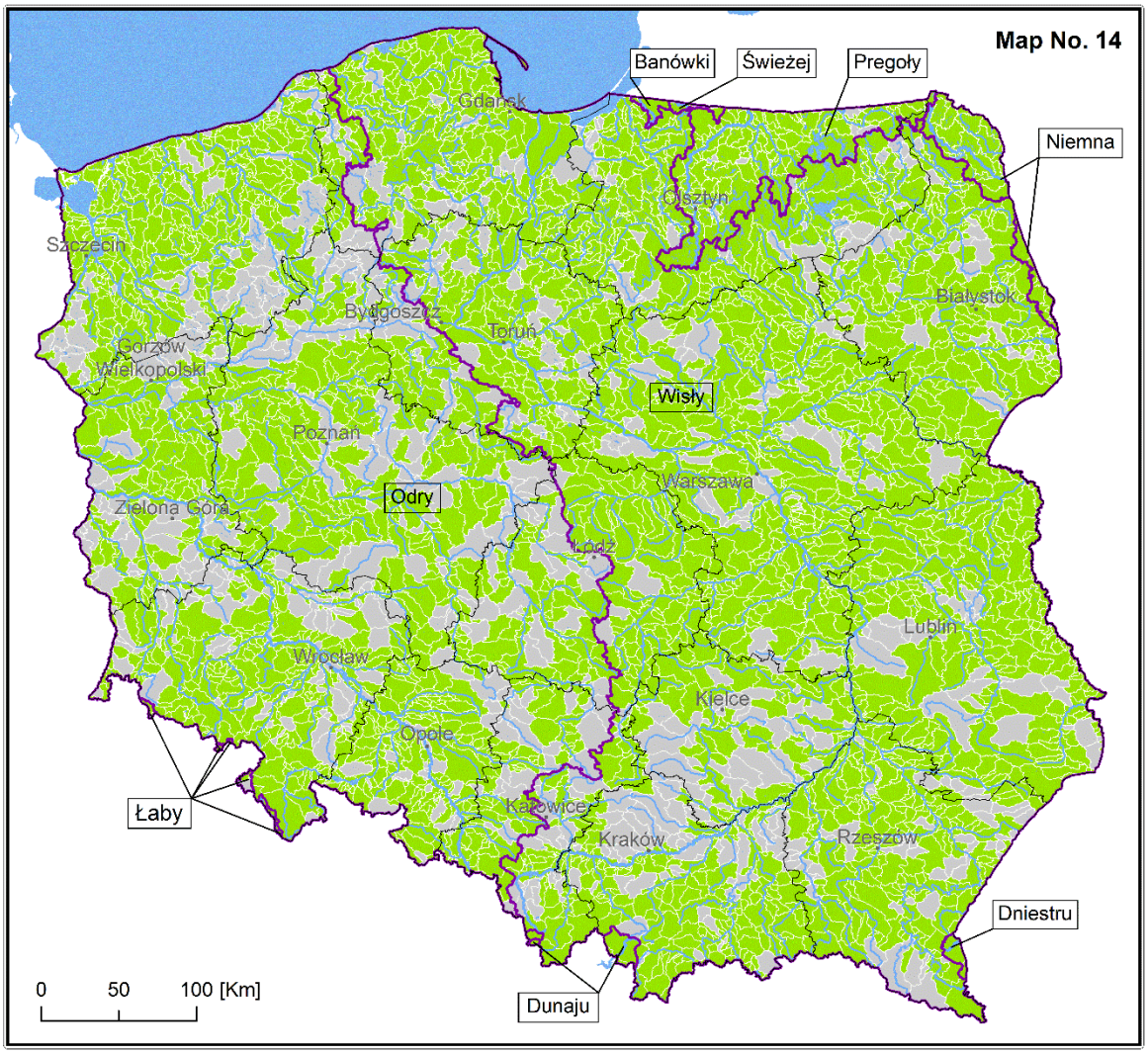


The Map of revised SWB with Action 3 as recommended for implementation:

Retention and management of rainwater and snowmelt in urbanised areas (Action 3)

Legend

- revised SWB recommended for Action implementation
- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

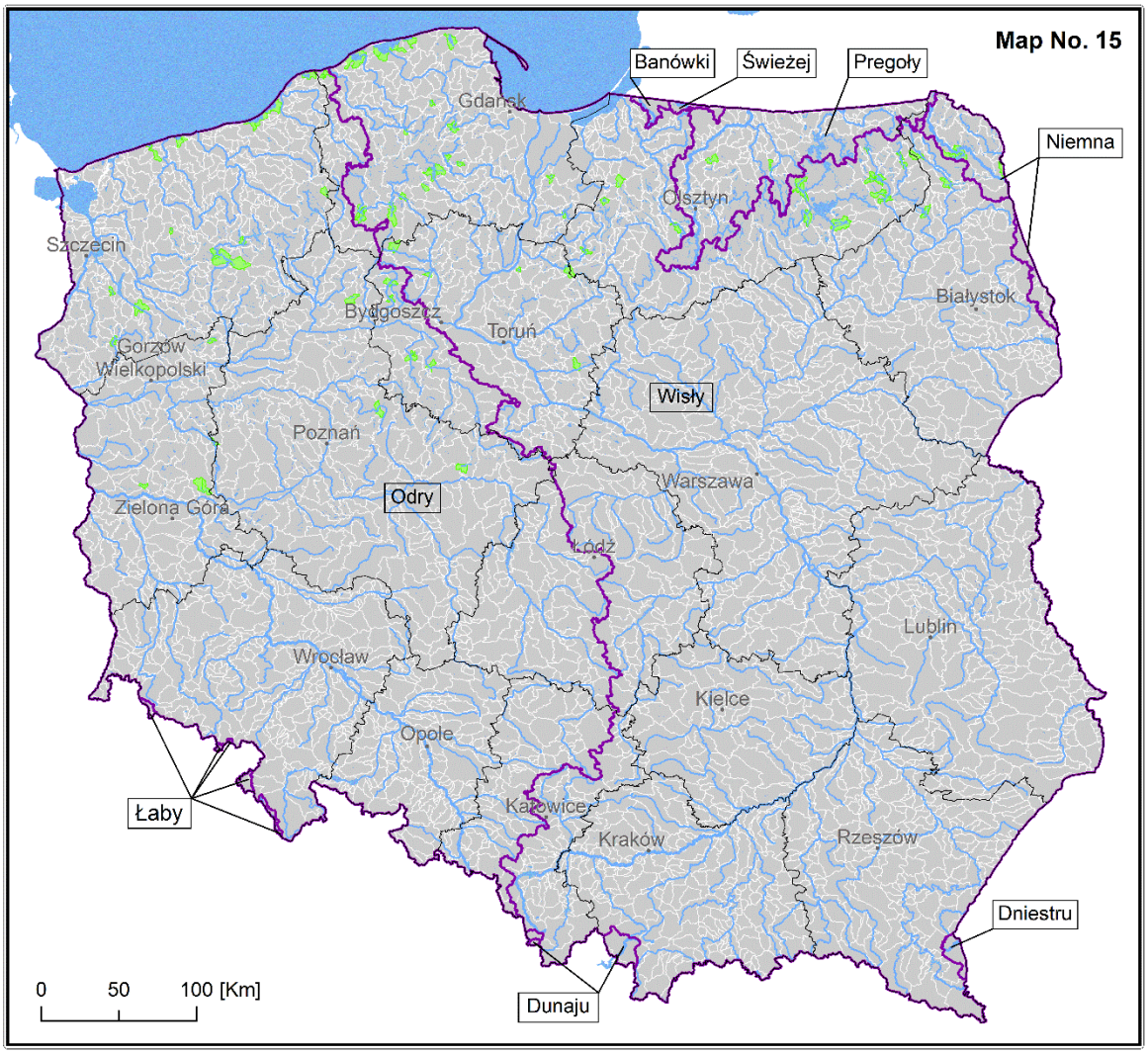


The Map of revised SWB with Action 4 as recommended for implementation:

Implementation of projects aimed at increasing or restoring natural retention (Action 4)

Legend

- revised SWB recommended for Action implementation
- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

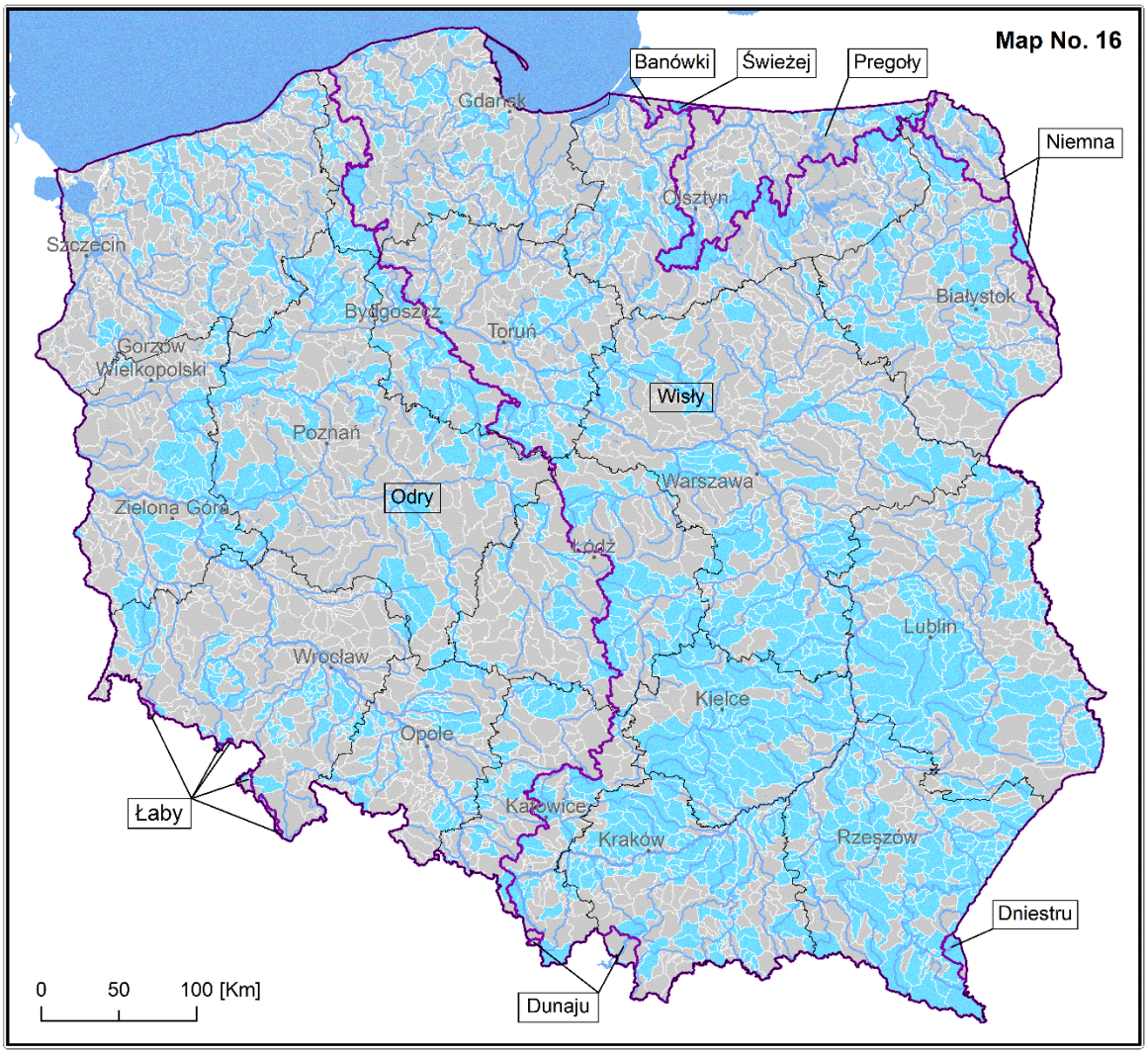


The Map of revised SWB with Action 5 as recommended for implementation:

Lake water damming in order to counteract the effects of drought (Action 5)

Legend

- revised SWB recommended for Action implementation
- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

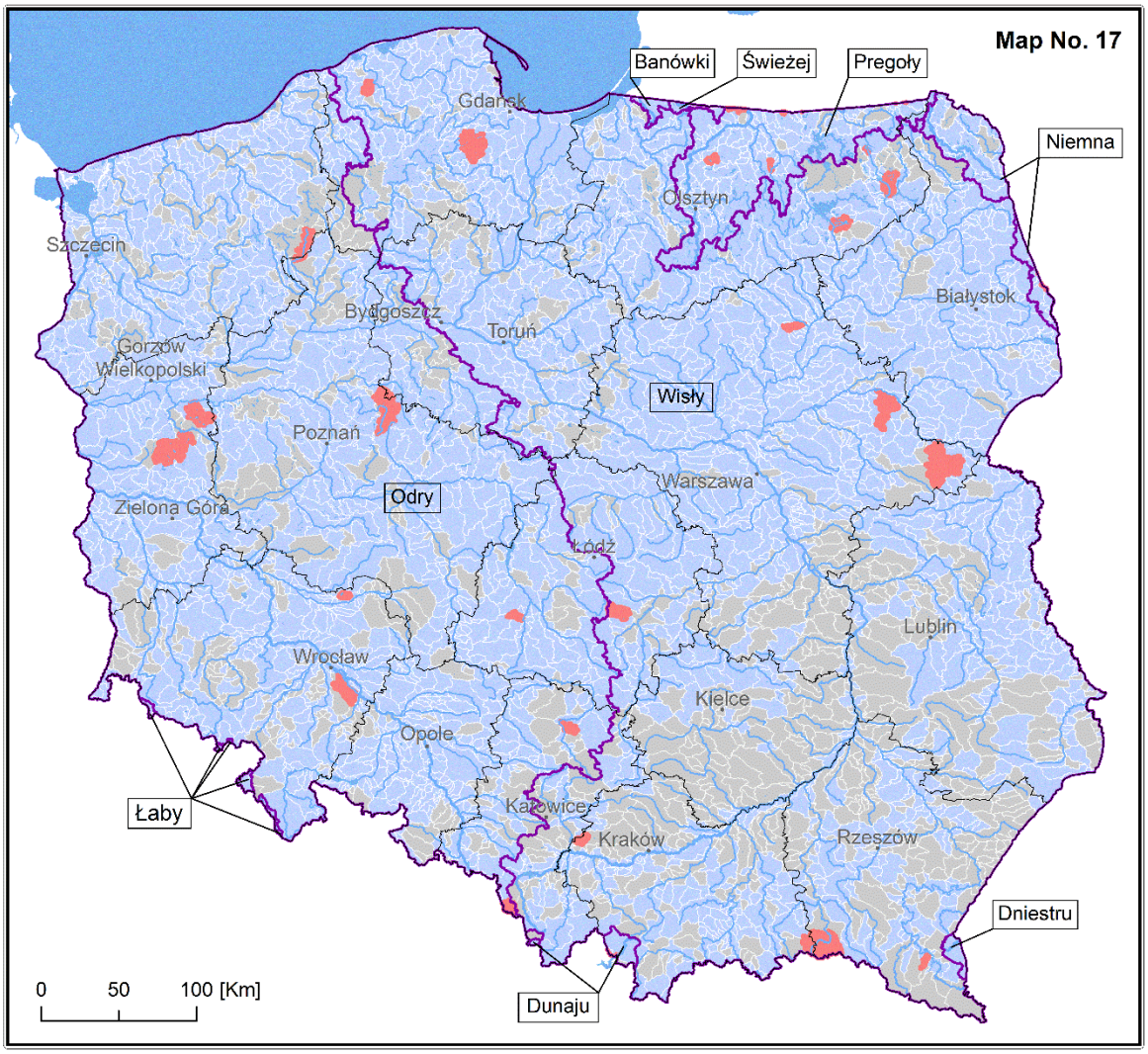


The Map of revised SWB with Action 6 as recommended for implementation:

Analysis of the possibilities of increasing retention in catchments with the use of natural and artificial retention (Action 6)

Legend

- revised SWB recommended for Action implementation
- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

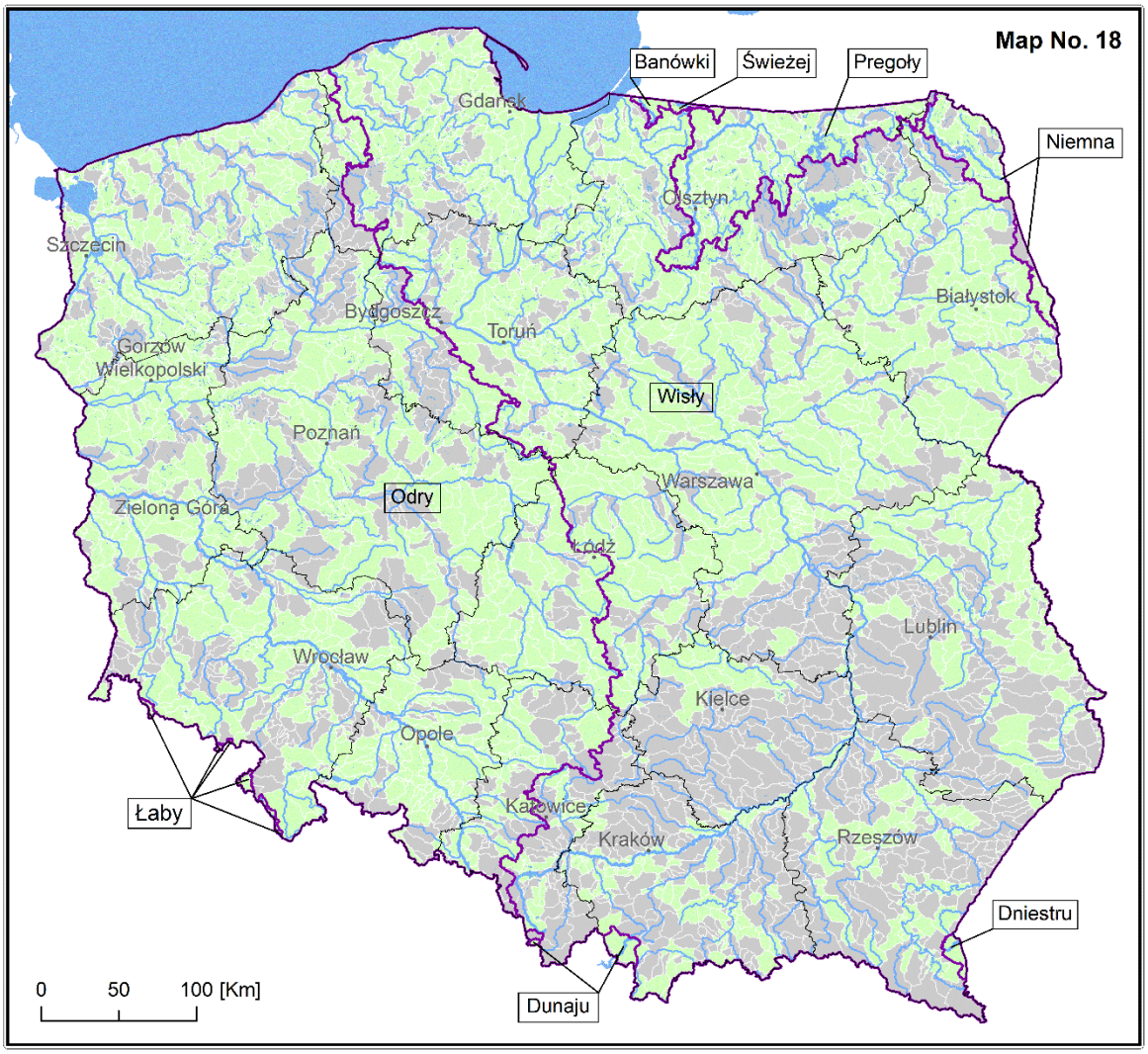


The Map of revised SWB with Action 8 as recommended for implementation:

Construction and reconstruction of irrigation and drainage devices to increase soil retention (Action 8)

Legend

- revised SWB recommended for Action implementation (new irrigation and drainage constructions action)
- revised SWB recommended for Action implementation (reconstruction actions)
- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

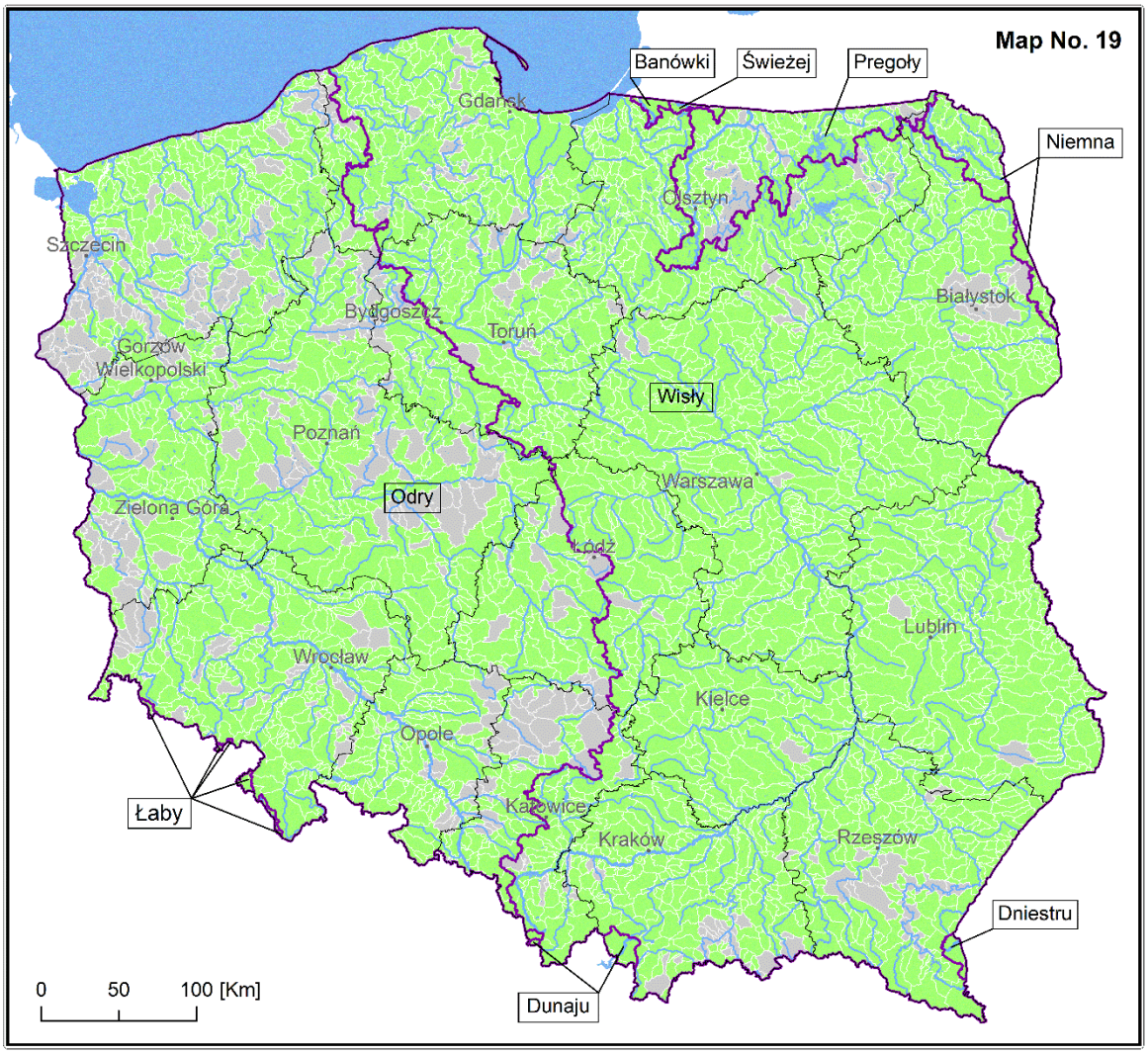


The Map of revised SWB with Action 9 as recommended for implementation:

The use of water from drainage systems for fertilisation and irrigation of field crops (Action 9)

Legend

- revised SWB recommended for Action implementation
- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

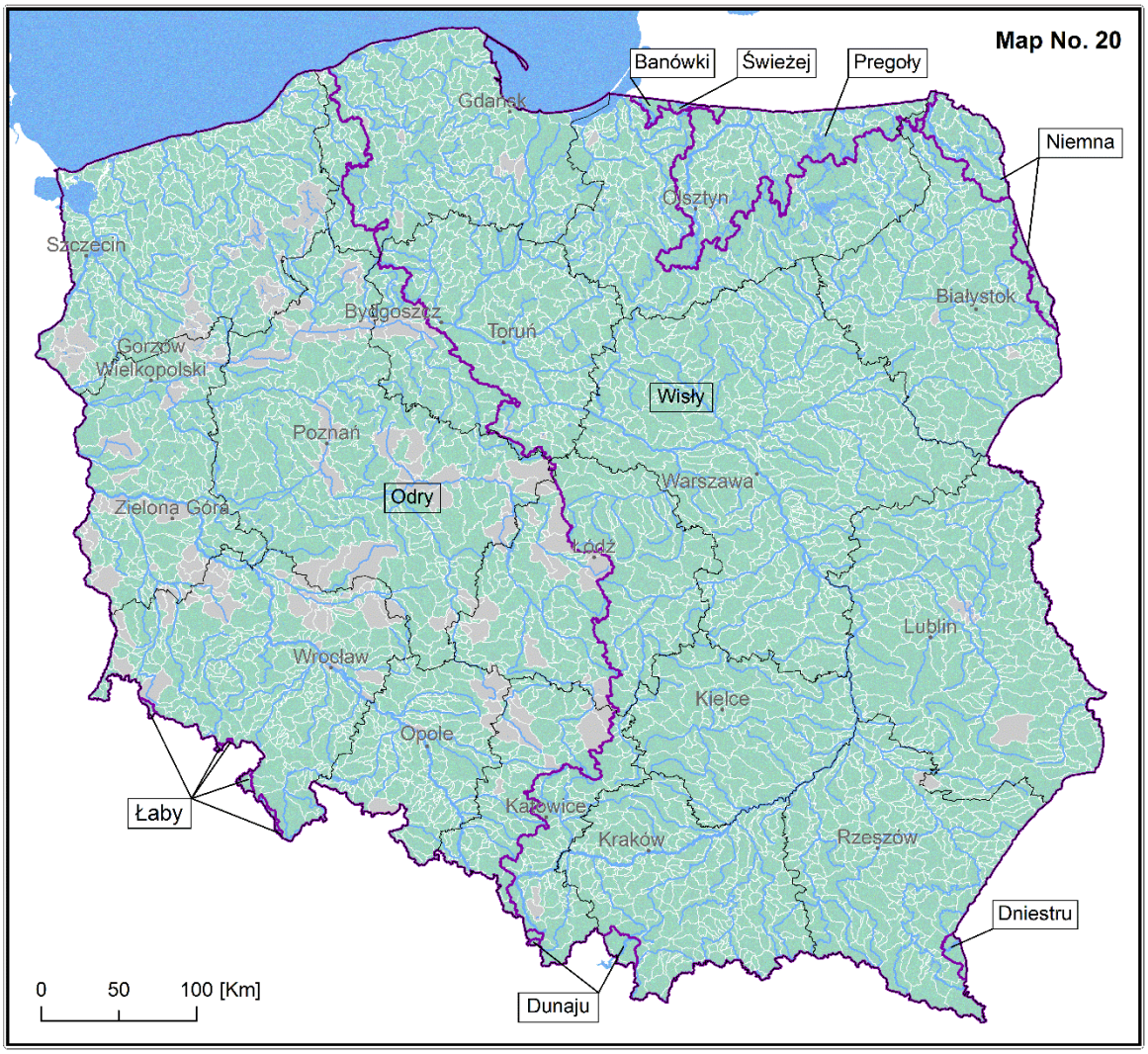


The Map of revised SWB with Action 10 as recommended for implementation:

The construction and reconstruction of groundwater intakes for agricultural irrigation, as well as construction and reconstruction of water-saving irrigation systems using groundwater resources (Action 10)

Legend

- aJCWP z rekomendacją dla realizacji działania
- aJCWP bez wskazania do realizacji działania lub wskazanie do realizacji po rozpatrzeniu uwarunkowań lokalnych
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities

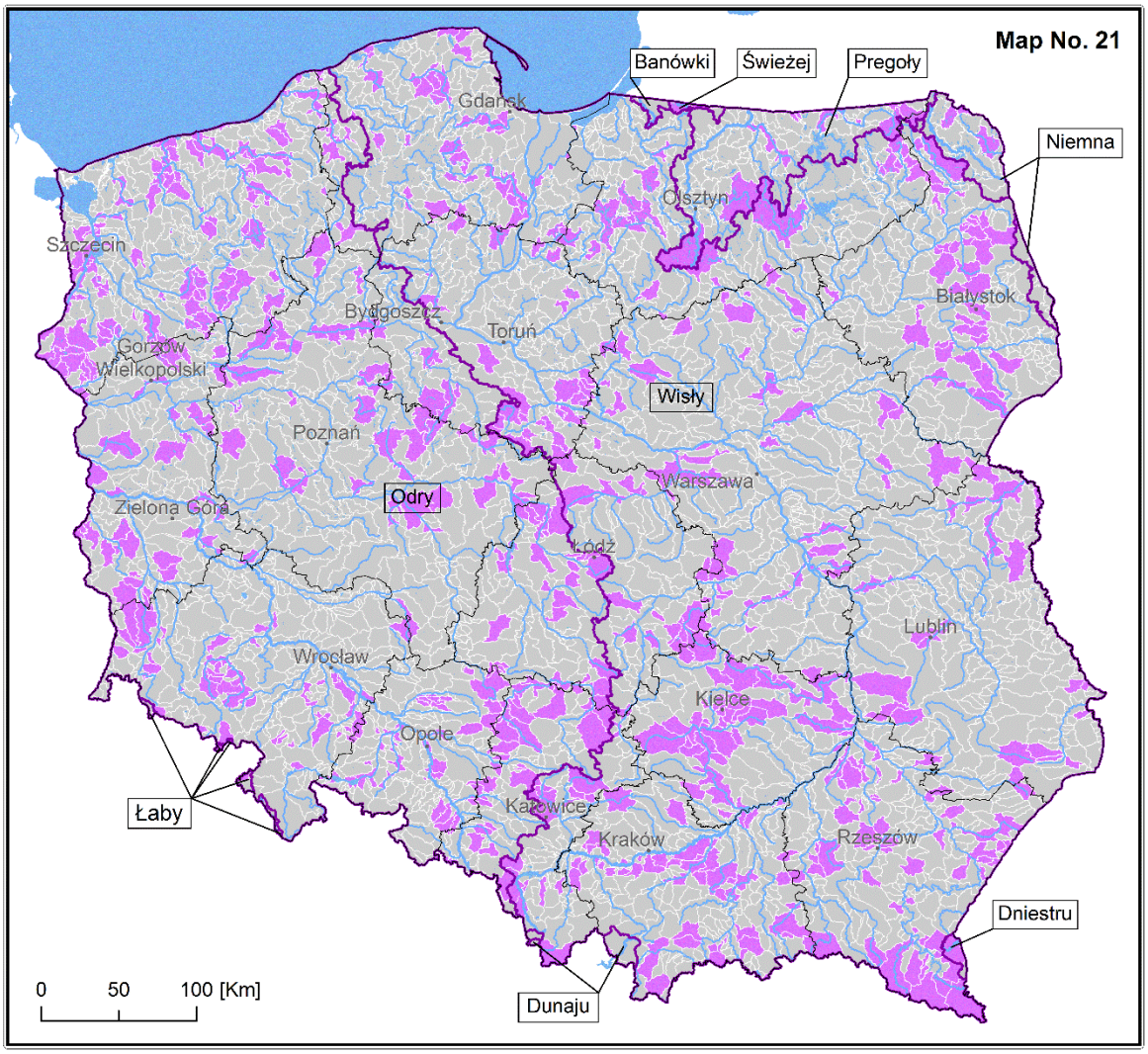


The Map of revised SWB with Action 24 as recommended for implementation:

Verification of the principles of water management in retention reservoirs (Action 24)

Legend

- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- revised SWB recommended for Action implementation
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities



The Map of revised SWB with Action 25 as recommended for implementation:

Review of water permits and integrated permits in areas of intensive and very intensive use of available water resources (Action 25)

Legend

- revised SWB with no recommendation for Action or indicated for Action implementation after considering local conditions
- revised SWB recommended for Action implementation
- Poland Boundary
- Voivodeship Boundary
- River Basin Areas Boundary in Poland (SWB v8)
- Selected Rivers (MHDP10 v8)
- Lakes and Water Reservoirs (MHDP10 v8)
- Voivodeship Cities