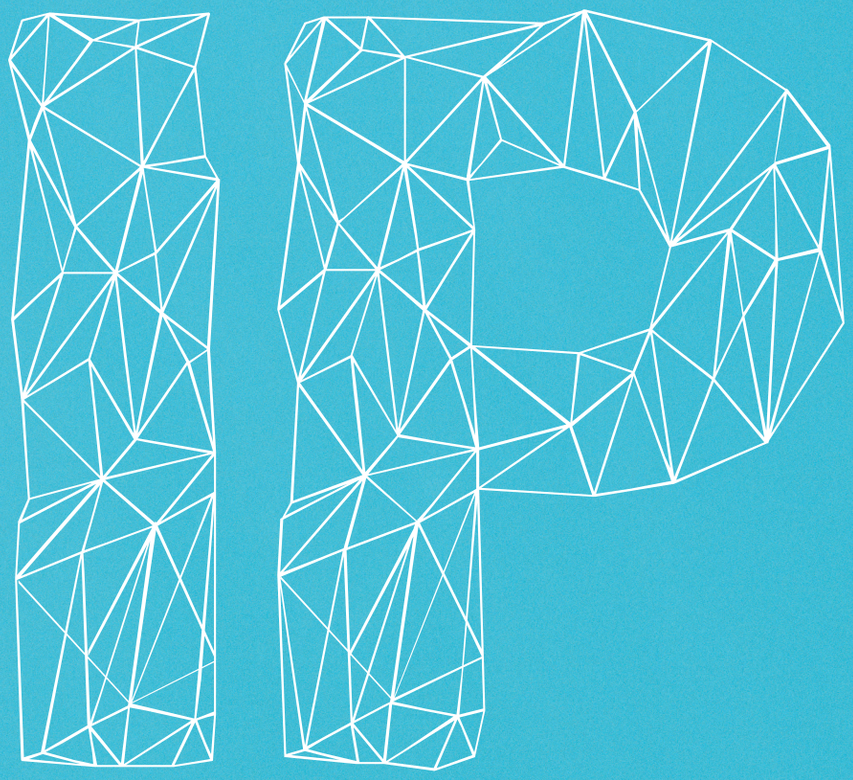

DRAFT REVIEW OF SIGNIFICANT WATER MANAGEMENT ISSUES FOR RIVER BASINS DISTRICTS

Material for public consultation

European Funds
Infrastructure and Environment

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Project: "Preparation of the second update to River Basin Management Plans together with the planning documents constituting the basis for their preparation", Project No.: POIS.02.01.00-00-0016/16

MGMiŻŚ
Ministry of Maritime Economy and Inland Navigation Secretary of State

DRAFT REVIEW OF SIGNIFICANT WATER MANAGEMENT ISSUES FOR RIVER BASINS

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Warsaw, 2019 r.

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DRAFT REVIEW OF SIGNIFICANT WATER MANAGEMENT ISSUES FOR RIVER BASINS

Material for Public Consultation

Warsaw 2019

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LIST OF ACRONYMS

RBMPu	River Basin Management Plan update
NWEPu	National Water and Environment Programme update
BOD_5	(5-day biochemical oxygen demand) – the oxygen quantity necessary for microorganisms to oxidise organic compounds
COD	(chemical oxygen demand) – the quantity of oxygen necessary for the oxidation of organic compounds and certain inorganic compounds in water.
Floods Directive	Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (OJ L 288, p. 27)
Dz.U.	Polish Journal of Laws
GUS	Central Statistical Office of Poland
SIs	significant issues
WB	water body
SWB	surface water body
GWB	groundwater body
EC	European Commission
M.P.	Monitor Polski
MGMiŻŚ	Ministry of Maritime Economy and Inland Navigation
FRM	Flood Risk Maps
FHM	Flood Hazard Maps
NIK	Supreme Audit Office
TOC	total organic compound
RBMP	River Basin Management Plan
PGW WP KZGW	National Water Management Authority – State Water Golding Polish Waters
PGW WP RZGW	Regional Water Management Board

SEM	State Environmental Monitoring
FRMP	Flood Risk Management Plan
GR	groundwater recharge
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 (OJ L 327, p. 1)
MD	mean annual discharge
EU	European Union
Polish Water Law	Act of 20 July 2017 – Water Law (Dz.U. of 2018, item 2268, as amended)
PAH	polycyclic aromatic hydrocarbons

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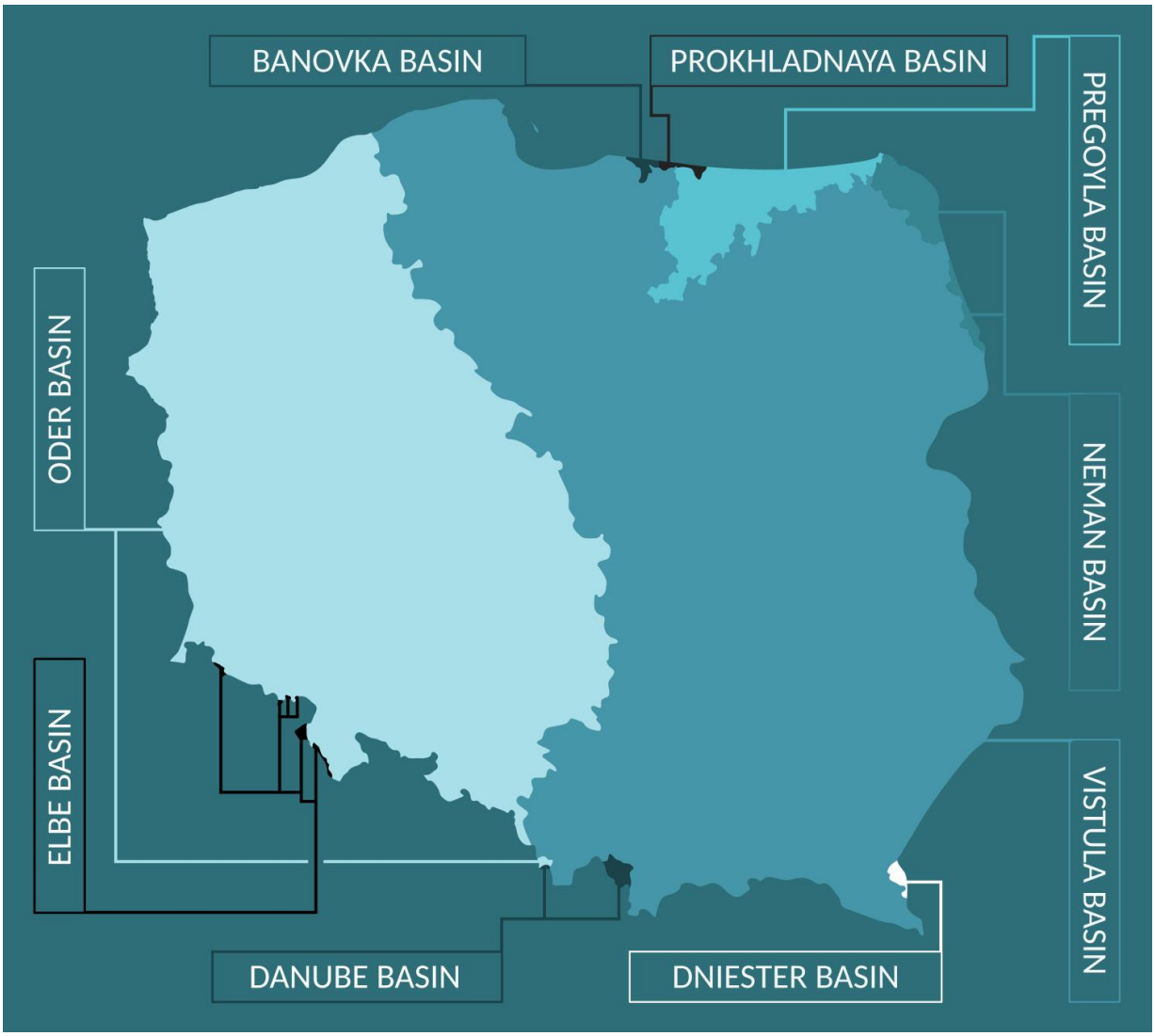
1 INTRODUCTION

The Water Framework Directive constitutes the basis underlying the system of protection of surface waters and groundwaters in the European Union. It obligates the Member States to produce and update the River Basin Management Plans (every six years). The aim of these plans is to achieve or maintain at least good status of surface waters and of the dependent ecosystems, improve the status of water resources, improve water use possibilities, reduce anthropogenic pressures and their impact on water status, and improve flood protection. Currently, work is in progress to prepare the second update to the RBMP. The review of significant water management issues in river basin districts, including public consultation, represents fulfilment of the requirements set forth in the applicable law in force, i.e. Article 14 of 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 (OJ L 327, p. 1) and Article 319(4) of the Act of 20 July 2017 – Polish Water Law (Dz.U. of 2018 item 2268, as amended).

The draft Review of Significant Water Management Issues is the subject of a 6-month public consultation, during which a digital form is made available for potential comments, and a nationwide consultation meeting will be held in Poland. In addition, a survey of local self-government entities and of the key entities responsible for supervision over the functioning of the individual water management areas will be conducted.

Environmental objectives are set for the following: 1) surface water bodies not designated as artificial or heavily modified; 2) artificial and heavily modified surface water bodies; 3) groundwater bodies; 4) protected areas. Articles 56 and 57 of the Water Law Act define the environmental objective in the following manner: "for surface water bodies not designated as artificial or heavily modified ones, it consists in protecting and improving their ecological and chemical status, so as to achieve at least good ecological and chemical status for surface waters, as well as in preventing deterioration of their ecological and chemical status", while "for artificial and heavily modified surface water bodies, it consists in protecting such waters and improving their ecological potential and chemical status, so as to achieve at least good ecological potential and good chemical status of surface waters, as well as in preventing deterioration of their ecological potential and chemical status". Pursuant to Article 55 of the Water Law Act, environmental objectives are also understood as: "achieving and maintaining good groundwater status, including good quantitative and chemical status of groundwaters, good status of surface waters, including good ecological status or good ecological potential and good chemical status of surface waters, or standards and objectives resulting from the legislation under which protected areas were established, and in preventing their deterioration, in particular with regard to aquatic ecosystems and other water-dependent ecosystems.

The aim of the Review of Significant Issues is to identify and classify both the most important water management issues hindering compliance with or achievement of environmental objectives, and the factors causing their occurrence. As part of this study, SIs have been identified separately for each river basin, in accordance with the current hydrographic division, i.e. the Vistula [Polish: Wisła], Oder [Odra], Elbe [Łaba], Banovka [Banówka], Prokhladnaya [Świeża], Neman [Niemen], Pregolya [Pregoła], Dniester [Dniestr] and Danube [Dunaj] basins (see Fig. 1).



Ryc. 1 River Basin Districts in Poland.

The aim of identifying significant issues is to determine the areas where corrective actions should be implemented as a matter of priority. The study presents a list of SIs with a detailed substantiation as to why the specific issue is important in the specific river basin district and why it has a negative impact on the achievement of or ongoing compliance with the assumed environmental objectives. In the course of analyses, within the individual problem areas (see Fig. 3), the problems were prioritised by classifying them as very significant, significant, moderately significant, or insignificant. The issues identified which it was impossible to classify due to insufficient data concerning their scale/scope, were included in the last category, i.e. data not available (see Fig. 2).

Ryc. 2 Classification of Water Management Issues by Significance Used in the Study for the Purpose of River Basin District SI Prioritisation.

The key aspects for each of the problem areas identified are specified below, and their importance and degree of significance will be analysed further on in the study, taking into account the specific conditions of the individual river basins.

Ryc. 3 Thematic Structure of the SI Review.

SURFACE WATER AND GROUNDWATER QUALITY

The 2018 report of the European Environment Agency indicates that the three most significant pressures on surface water bodies are hydromorphological pressures, diffuse sources (particularly from agriculture), and atmospheric deposition[1]. Point source pollution and water abstraction have less impact. For groundwaters, the same report identifies diffuse sources of pollution as the main pressure, and point sources as the second most important one.

The results of water monitoring in the previous planning cycle and the latest available monitoring results indicate that nutrients or biological elements of ecological status or ecological potential classification, vulnerable to this type of pressure, were the main factors responsible for the classification of surface water bodies as having below-good status. The situation looked much better in the case of groundwater bodies, the vast majority of which achieved good status, while in the case of other bodies of water, pollution with nutrients[2] was not the main pressure[3]. Deterioration of the ecological status or potential of surface waters results not only from exceeded standards, but also, in the case of rivers, from a wide range of monitoring of physicochemical parameters of water, which, combined with the *one-out all-out*[4] rule, increases the probability of a lower classification.

MORPHOLOGICAL CHANGES OF SURFACE WATERS

Changes in the natural hydromorphological status of surface waters introduced by hydraulic engineering developments on inland waters are the main aspects considered within this problem area. Hydraulic engineering investments are undertaken to pursue important economic or flood protection related objectives. Since they permanently change the morphological status of rivers and at the same time contribute to the achievement of the overarching objectives for the implementation of public policies of economic, social and financial importance, the derogation envisaged in Article 4(7) of the WFD. Most activities also require detailed environmental impact assessments to be performed and mitigation or compensation measures to be identified. Maintenance work is undertaken in order to ensure ongoing flood protection, proper operation and possibility of using water and drainage facilities, and maintenance of waterways, taking into account the need to achieve environmental objectives. Their environmental impact is therefore significantly lower and less permanent than that of hydraulic engineering works, so they are only subject to strategic assessment. In addition, good practice rules were developed for both categories of activities mentioned above in 2018, handed over by PGW Wody Polskie to the entities responsible for water administration as helpful material with regard to taking environmental aspects into account when planning and implementing maintenance and hydraulic works[5].

[1] Atmospheric deposition – movement and deposition of air pollutants on the surface of the earth.

[2] Nutrient pollutants – mainly nitrogen and phosphorus compounds responsible for water fertilisation.

[3] See Surface water monitoring [Monitoring wód powierzchniowych] at http://www.gios.gov.pl/pl/stan-srodowiska/monitoring-wod (accessed: 30 Sep 2019) and the groundwater body status map at http://mjwp.gios.gov.pl/mapa/mapa,172.html (accessed: 30 Sep 2019).

[4] *One-out all-out* – principle of assessment and classification of waters according to which the final classification is based on the indicator with the worst status.

[5] I. Biedroń, A. Dubel, M. Grygoruk, P. Pawlaczyk, P. Prus, K. Wybraniec, Catalogue of good practices with regard to hydraulic engineering and maintenance work, including the rules of their implementation [Katalog

An important aspect also involves the impact of transverse structures on the biological continuity of rivers and streams. The study identified actions taken to improve hydromorphological status, including implementation of non-technical methods of flood protection and restoration projects, as well as projects related to restoring the biological continuity of rivers and monitoring fish pass efficiency. In addition, analysing the current legislation in force, it should be pointed out that the impact of maintenance work on environmental objectives is minimised, among other things, by the Water Maintenance Plans developed within the water region system, which are subject to the strategic environmental impact assessment procedure.

The problem area involves the following aspects: 1) the scale of implementation of the derogation envisaged in Article 4(7) of the WFD related to the inability to achieve the environmental objectives, 2) the scale of implementation of non-technical methods of flood protection within the meaning of the instruments supporting the FRMP, and 3) assessment of the current passability of rivers in terms of the potential migration of bi-environmental fish species. The analysis takes into account the key planning documents, including the RBMPs currently in force[6] and the RBMPu database. Due to the general nature of the RBMPu planning documents, the study also draws on own PGW WP data provided by the Ordering Party concerning the scope of implementation of the investments envisaged in the RBMPu (progress as of February 2019). In addition, studies were used concerning problems occurring in individual river basins, including Reports of the International Commission for the Protection of the Odra River against Pollution[7] as well as earlier reviews of significant issues[8]. With regard to the problem areas identified in previous studies, the need to increase water retention in catchment areas and to improve passability of rivers for fish migration, as well as to implement a system of fish pass monitoring, have acquired particular importance. With regard to the impacts of the investments for which the derogation envisaged in Article 4(7) of the WFD was indicated, what

dobrych praktyk w zakresie robót hydrotechnicznych i prac utrzymaniowych wraz z ustaleniem zasad ich wdrażania], Kraków 2018.

[6] Water Management Plan for the Vistula River Basin, adopted by the Ordinance of the Council of Ministers of 18 October 2016 (Dz.U. item 1911, as amended); Water Management Plan for the Oder River Basin, adopted by the Ordinance of the Council of Ministers of 18 October 2016 (Dz.U. item 1967); Water Management Plan for the Dniester River Basin, adopted by the Regulation of the Council of Ministers of 18 October 2016 (Dz.U. item 1917); Water Management Plan for the Danube River Basin, adopted by an Regulation of the Council of Ministers of 18 October 2016. (Dz.U. item 1918); Water Management Plan for the Elbe River Basin, adopted by the Regulation of the Council of Ministers of 18 October 2016 (Dz.U. item 1929); Water Management Plan for the Neman River Basin, adopted by the Regulation of the Council of Ministers of 18 October 2016 (Dz.U. item 1915); Water Management Plan for the Pregolya River Basin, adopted by an Regulation of the Council of Ministers of 18 October 2016. (Dz.U. item 1959); Water Management Plan for the Prokhladnaya River Basin, adopted by the Regulation of the Council of Ministers of 18 October 2016 (Dz.U. item 1914); Water Management Plan for the Ücker River Basin, adopted by the Regulation of the Council of Ministers of 18 October 2016 (Dz.U. item 1818); Water Management Plan for the Jarft River Basin, adopted by the Regulation of the Council of Ministers of 18 October 2016 (Dz.U. item 1819).

[7] *Strategy for joint resolution of significant water management issues in the International Oder River Basin District [Strategia wspólnego rozwiązywania istotnych problemów gospodarki wodnej na Międzynarodowym Obszarze Dorzecza Odry]*, Wrocław 2013; *Strategy for joint resolution of significant water management issues in the International Oder River Basin District [Strategia wspólnego rozwiązywania istotnych problemów gospodarki wodnej na Międzynarodowym Obszarze Dorzecza Odry]*, Wrocław 2019.

[8] *Review of significant Water Management issues [Przegląd istotnych problemów Gospodarki Wodnej]*, Kraków 2008; *Review of significant Water Management issues [Przegląd istotnej problemów Gospodarki Wodnej]*, Warsaw 2012.

stands out is the limited degree of implementation of the investments planned in the RBMPu and thus their smaller effective impact compared to what was predicted in the planning documents.

QUANTITATIVE STATUS OF SURFACE WATERS AND GROUNDWATERS

The quantitative status of surface waters and groundwaters is influenced by a number of factors, both natural and related to human activity. The problems identified in the individual river basins in the context of the quantitative status of surface waters and groundwaters are conditioned, among other things, by the physical geographical location and by the distribution of annual precipitation totals in the individual regions. Poland, due to its location in a temperate transitional climate zone, is exposed to both excessive and insufficient precipitation. Average precipitation for Poland is approx. 600 mm[9]. The lowest precipitation total of approx. 450 mm is recorded in the Wielkopolska, Kujawy and north-west Mazowsze regions. These are areas with insufficient precipitation. In mountain areas, precipitation totals are higher, but both the nature of precipitation, i.e. an increase in heavy rainfall, and the steep slopes cause rapid runoff of water from the catchment area. As a consequence, the risk of both flooding and drought increases. The predicted air temperature increase, the high evaporation rate and the change of the nature of precipitation are the reasons for the decrease in its efficiency, and consequently lead to drought risk increase. At the same time, the number of snow cover days in mountain areas is decreasing, making it difficult to restore groundwater resources. Most rivers have a snow and rain regime, so the risk of drought in snowless winters already appears in early spring. Natural factors, including the predicted climate change, are accompanied by many years of anthropogenic pressure in the catchment areas. It is related to catchment area development, i.e. the share of forests, the share of agricultural land, the share of drained land, the percentage of sealed built-up areas, the degree of transformation of river valleys, and even the status of water courses. These elements will determine the retention potential of the catchment area, i.e. the ability to retain rainwater or meltwater (natural retention) and the runoff rate. Strongly transformed catchment areas will be characterised by low natural retention capacity. The final aspect having a direct impact on the quantitative status of waters is the pressure related to the use of water resources in the catchment area, i.e. for instance to abstraction, transfer of surface waters and groundwaters or wastewater/post-mining water discharge, as well as pond management and land drainage. Excessive use of water resources given the actual capacities offered by the specific water region, especially in times of drought, may cause negative environmental and social effects.

Quantitative changes of waters significantly determine their quality, influencing the chemical and ecological status of SWBs. This means that under certain environmental conditions when hydrological extremes occur, specific anthropogenic pressures have a significant impact on the possibility of achieving environmental objectives for surface water bodies, groundwater bodies and protected areas, including water-dependent habitats and ecosystems identified in the RBMPu.

LEGAL, ORGANISATIONAL AND SOCIAL ASPECTS

In the light of the WFD preamble, Community water policy requires a transparent, efficient and coherent legislative framework. This Directive is to set forth shared principles and a general

[9]Draft resolution of the Council of Ministers on the adoption of "Assumptions for the Retention Development Programme for the years 2021–2027 with an outlook to 2030" ["Założenia do Programu rozwoju retencji na lata 2021-2027 z perspektywą do roku 2030"] (ID231 on the list of legislative and programming works of the Council of Ministers) submitted for examination to the Standing Committee of the Council of Ministers – the Assumptions.

framework for action as well as to coordinate, integrate and, in the longer-term perspective, also further develop the general principles and structures for the protection and sustainable use of water in the EU.

Water management issues in terms of the legal, organisational and social aspects were not covered by wider analyses in the previous planning cycles. These aspects have gained importance in relation to the intensification of analytical work for the purpose of updating Water Management Plans, Flood Risk Management Plans and other studies related to the implementation of the WFD and of the Floods Directive. Apart from identification of significant issues within the framework of strategic documents, a wide range of problematic aspects justified the adoption of the new Water Law. The aim of this draft review of issues is to diagnose the legal, organisational and social conditions which constitute the key determinants for the pursuit of environmental objectives in the new planning and legal environment.

ECONOMIC AND FINANCIAL ASPECTS

Significant issues in the economic and financial area have been identified in the context of rational and sustainable water management, which is the basic objective of the Water Framework Directive, indicated in the preamble. The WFD also indicates that the purpose of one of the tools of water policy, i.e. fees for water use, is to achieve efficient use of water resources (Article 9 of the WFD).

In previous planning cycles, reference was made to issues in the economic and financial area only in 2009. Two significant issues were identified, referring to the water management financing system, namely the inadequate fee and subsidy system and the lack of sufficient financing for water management. Today, after the introduction of the new Water Law and water service fees, the issue in the financial area has been narrowed down. This document presents two significant issues in the economic and financial area, where the efficiency of water use has also been indicated, apart from the insufficient financing of water management.

2 NATIONWIDE PROBLEM AREAS

2.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS

2.1.1 IMPACT OF AGRICULTURAL EMISSIONS ON WATER STATUS

In recent years, technical infrastructure has been developing intensively in rural areas. For example, in the period 2005–2017, the percentage of users of the sewerage network increased by 21.8% (in towns and cities, the increase was by 5.7%). However, there is still a need for further construction of water and sewage management structures and facilities, as well as of waste management systems. This is hindered by the dispersed nature of developments in rural areas and by the high costs of investments in non-urbanised areas[10].

Pollution generated in farms varies in terms of its composition and nature. It includes mainly domestic wastewater, liquid animal excrement, leachate from natural fertiliser storage areas, succulent feed, and runoff from fields and farms[11]. Another issue may be related to polluted precipitation water – rainwater and meltwater, as well as infiltration and drainage water[12], constituting runoff from land where drainage was carried out. Dispersed developments account for as much as 60% of all developments in rural areas of Poland, with the distance between neighbouring properties exceeding 45m. This is an unfavourable situation for the construction of collective water supply and sewage systems[13].

[10] J. Sikora, *Level of satisfaction of rural population with life in rural areas in the light of empirical research [Poziom zadowolenia mieszkańców wsi z życia na wsi w świetle badań empirycznych]*, Studia Obszarów Wiejskich 2016/41, pp. 31–41;. *Municipal infrastructure in 2017. Statistical analyses [Infrastruktura komunalna w 2017 r.Analizy statystyczne]*, GUS 2018, 1–35.

[11] Z. Dymaczewski, M. Sozański, *Water supply and sewage systems in Poland: tradition and the present* [*Wodociągi i kanalizacja w Polsce: tradycja i współczesność*], Poznań-Bydgoszcz 2002, pp. 935−952; P. Gutry, J. Zajkowski, K. Wierzbicki, *Is cheaper waste treatment in rural areas possible?* [*Czy można taniej oczyszczać ścieki na obszarach wiejskich?*] Wiadomości Melioracyjne i Łąkarskie 2009/3, pp. 132–135; J.M. Kupiec, *Overview of the methods of* NPK macroelement balancing in agricultural *production* [*Przegląd metod balansowania macro składników NPK w produkcji rolnej]*, Inżynieria i Ochrona Środowiska 2015/18/3, pp. 323–342.

[12] Infiltration waters – precipitation water or surface water seeping into the ground and reaching groundwaters. Drainage waters – waters coming from land drainage.

[13] K. Wierzbicki, O. Gromada, *Relationship between village class and sewage system infrastructure [Związek między klasą wsi i jej infrastrukturą kanalizacyjną]*, Wiadomości Melioracyjne i Łąkarskie 2000/(43)2, pp. 79−83; E. Kaca, *Water and sewage infrastructure in rural areas at the turn of the centuries [Infrastruktura wodno-ściekowa na wsi na przełomie wieków]*, Problemy Inżynierii Rolniczej 2007, pp. 42−44.

A priority aspect resulting from the assumptions of the Nitrates Directive[14] involves protecting waters against pollution caused by nitrates from agricultural sources. The new Action Programme to reduce nitrate pollution of waters (2018–2022) covers the entire territory of Poland[15]. The main aim of the Action Programme is to prevent deterioration and to improve the status of waters whose status has already deteriorated.

Livestock rearing and farming, especially on a large industrial scale, is a dynamically developing sector in Poland and elsewhere in the world. In 2018, there were 1.4 million farms operating in Poland[16]. The vast majority of them operate in the field of livestock production, which involves the production of natural fertilisers. According to GUS data (2019), the number of livestock in Poland increased in 2018 to almost 10 million livestock standard units (LSUs). A similar number had last been recorded in 2010. The biggest change compared to the previous year was recorded in 2017, with an increase by over 700 thousand LSUs. This increase has involved, among other things, the production of a large amount of manure, which needs to be properly managed. With the development of livestock production, the use of highly concentrated industrial feed with a high nutrient content is also increasing.

[14] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (OJ L 375).

[15] Ordinance of the Council of Ministers of 5 June 2018 on the adoption of a "Programme of actions aimed at reducing pollution of waters with nitrates from agricultural sources and on preventing further pollution" (Dz.U. of 2018 item 1339).

[16] *Agriculture in 2018. Statistical analyses [Rolnictwo w 2018. Analizy statystyczne]*, www.stat.gov.pl (accessed: 30 Sep 2019).

Undigested ingredients are excreted with faeces, which causes their concentration in natural fertilisers to increase, posing a threat to water quality resulting from overfertilisation of soils.In 2005–2017, the consumption of feed in Poland increased significantly – in total by 83.6% for all livestock specialisations. Comparing 2017 to 2016, in a breakdown by specialisation, the highest increase was recorded for feed consumption in cattle rearing by 19.8%. The increase was by 16.8% in the case of pigs, and by 6.2% in the case of poultry[17].

In order to reduce the emission of nutrients to surface waters and groundwaters, it is recommended that the Collection of Good Agricultural Practice Recommendations[18] be followed. In addition, the Action Programme is being implemented across Poland[19]. Appropriate dosage and timing of fertilisation are of crucial importance here, among other things. A very important aspect, which is however often ignored or marginalised, involves the absence or the poor technical condition of structures in which natural fertilisers are stored. In accordance with the provisions of the ordinance on the adoption of the action programme of 2018, the storage conditions for natural fertilisers and the treatment of leachate are strictly defined.

Operators carrying out agricultural production and operators carrying out the activities referred to in Article 102(1) of the Water Law Act must adapt the surface or the capacity of their natural fertiliser storage facilities to the requirements set forth in the Action Programme. A study conducted for nearly two decades (2001–2018)[20] on a group of 1,222 farms with livestock production located in Poland within the administrative boundaries of 10 provinces (both in the Oder and of the Vistula river basins) shows that as many as 42% of farms do not have manure platforms and 24% do not have a storage tank for liquid manure. This research shows that in the pre-accession period only 25% of these farms had manure platforms (the oldest ones were built in 1950). After joining the EU, this percentage increased by a further 33%. However, there are still great needs in this respect. It is estimated that in the whole country, it is necessary to build platforms or storage tanks for manure in 543 thousand farms. The cost of this investment is estimated at approx. one billion Polish zlotys[21].

[17] *GUS 2019. https://stat.gov.pl/obszary-tematyczne/rolnictwo-lesnictwo/rolnictwo/srodki-produkcji-w-rolnictwie-w-roku-gospodarczym-20172018,6,15.html (accessed 03 Sept 2019).*

[18] Collection of *Good Agricultural Practice Recommendations for the protection of waters against nitrate pollution from agricultural sources [Zbiór Zaleceń Dobrej Praktyki Rolniczej mający na celu ochronę wód przed zanieczyszczeniem azotanami pochodzącymi ze źródeł rolniczych]*, ed. IUNG-PIB Puławy, Warsaw 2019, pp. 2–77.

[19] Ordinance of the Council of Ministers of 5 June 2018 on the adoption of a "Programme of actions aimed at reducing pollution of waters with nitrates from agricultural sources and on preventing further pollution" (Dz.U. item 1339).

[20] J.M. Kupiec, *Evaluation of infrastructure for storage of manures in selected farms of Poland, Conference Papers* [*Materiały konferencyjne*], Vinnica 2019.

[21] J.M. Kupiec, *Evaluation of infrastructure for storage of manures in selected farms of Poland, Conference Papers* [*Materiały konferencyjne*], Vinnica 2019.

Pesticides are another threat to surface waters and groundwaters. Due to the concentration and intensity of production, crops are threatened by multiple pathogens[22].

The use of pesticides is therefore a guarantee of an adequate level of agricultural production. Sales of plant protection products in Poland have been increasing systematically. In 2017, approx. 71.4 thousand tonnes of plant protection products were sold for agricultural purposes, i.e. 4.9% more than in 2016. The sales structure was dominated by herbicides (approx. 43 thousand tonnes), which accounted for 60.2% of all sales, and by fungicides (24.4%). Currently, 2,357 preparations are approved for use in Poland (as of 2019)[23].

In connection with the use of large quantities of chemical plant protection products and mineral fertilisers, there has been a clear deterioration in the status of groundwaters and of health conditions in rural areas. A significant number of rural wells in Poland contain water polluted with nitrates, phosphates, bacteria, but also pesticides[24].

One of the conditions for achieving good water status is the elimination or reduction of emissions of the most dangerous substances, including the group of priority hazardous substances which should be completely eliminated from the environment due to their highly toxic properties, susceptibility to bioaccumulation, and persistence. This group includes Polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) generated for instance as by-products of herbicide synthesis. Lowland storage lakes, most often located in the central or estuary parts of river basins, are ecosystems particularly vulnerable to pollution with such compounds[25].

[22] Pathogens – living and non-living agents responsible for causing diseases (e.g. bacteria, viruses, toxic substances).

[23] Register of Plant Protection Products [Rejestr Środków Ochrony Roślin], www.gov.pl (accessed: 30 Sep 2019).

[24] M. Bilek, K. Małek, S. Sosnowski, *Physicochemical parameters of potable water from wells dug in the Podkarpacie area* [*Parametry fizykochemiczne wody pitnej ze studni kopanych z terenu Podkarpacia*], Bromat. Chem. Toksykol. XLVIII, 2015/4, pp. 640–646; J. Raczuk, E. Królak, *Assessment of infant health risk related to exposure to nitrates and nitrates in potable water in agricultural areas* [*Ocena ryzyka zdrowotnego niemowląt związanego z narażeniem na azotany (V) i (III) w wodzie pitnej na terenach rolniczych*], Probl. Hig. Epidemiol. 2016/97(2), pp. 150–155; K. Bartkowski, *Are pesticides an environmental issue? [Czy pestycydy są problemem w środowisku naturalnym?]*, Tutoring Gedanensis 2016/1(1), pp. 7–10.

[25] *Reservoir limnology: Ecological Perspectives*, ed. K.W Thronton., B.L. Kimmer, F.E. Payne, New York – Chichester – Brisbane – Singapore 1990, p. 246.

2.1.2 IMPACT OF EMISSIONS FROM FISH REARING AND FARMING ON WATER STATUS

Intensive rearing and farming of fish may also constitute an important source of water pollution (high density is associated with excessive feeding and excrement).

At the same time, it may also contain toxic substances coming from veterinary products and may pose a threat to the health of fish living in water courses. Due to the lack of available data on the amount of water intake for pond facilities, it is impossible to prioritise the importance of the issue of the role of pond management in water management in river basins. However, it can be assumed that the problem is more significant in the main river basins of the Vistula and of the Oder, and less significant in small river basins, especially those in mountain areas, where the size and number of pond facilities are limited.

The Code of Good Practice in Fish Rearing and Farming, in accordance with its purpose, focuses on ensuring the well-being of farmed fish and on implementing advantageous solutions in fish production, and practically does not cover issues related to water management[26].

Good practice in water management involves the recommendation that fish farmers in smaller catchment areas agree on the time of discharging water from the ponds in order to minimise the risk of excessive increase of the water level and of local land flooding in the case of runoff accumulation. The document that obligates farmers to ensure that minimum flows are maintained is the water and wastewater management plan. In addition, fish farmers are obliged to make sure that the water facilities associated with the pond facilities are kept in an appropriate technical condition. The Code also describes the basic principles of keeping the ponds in good condition (fertilisation, mowing) and of feeding fish, with an indication of actions limiting eutrophication of waters and contributing to nature protection (e.g. removal of plants emerging from the ponds outside the bird breeding season). The Code also recommends that water quality should be systematically inspected in the pond production process. A significant issue for the quality of the natural environment is represented by fish (especially alien species), penetrating into a river which receives post-production waters, the effects of which have been recorded in studies of ichthyofauna as part of State Environmental Monitoring. The Code does not address this aspect, as it is included in the Nature Conservation Act[27].

[26] *Code of Good Fishery Practice in Fish Rearing and Farming [Kodeks Dobrej Praktyki Rybackiej w Chowie i Hodowli Ryb]*, www.mgm.gov.pl (accessed: 30 Sep 2019).

[27] Act of 16 April 2004 on nature conservation (Dz.U. of 2018 r. item 1614, as amended).

2.1.3 IMPACT OF MUNICIPAL EMISSIONS ON WATER STATUS, INCLUDING PROTECTION AGAINST WASTEWATER FROM HOUSEHOLDS, RECREATIONAL AREAS AND LANDFILLS

The impact of household wastewater treatment plants on the environment and on water quality is related mainly to the emission of suspensions and nutrients, which are the main indicators for the assessment of the efficient operation of such treatment plants, alongside BOD_5 and COD. Another problem may consist in the fact that household sewage treatment plants may fail to meet the relevant standards (which is caused by the high variability of pollutant concentrations, e.g. between summer and winter periods) and that they may be located on an inappropriate type of land.

Wastewater from landfills (leachate and process wastewater) usually needs treatment in order to be discharged to the sanitary sewage system. Different pre-treatment methods, including biological, physical and chemical ones and their combinations, are currently available. The solution applied must be appropriately selected to match the specific landfill, taking into account the quantity and quality of the wastewater and the fluctuations in its flow, and should guarantee compliance with the required standards[28].

Sewage sludge handling is also an important element that may affect water status. Appropriate handling of sewage sludge, due to the fact that it contains nutrients, including in particular phosphorus, is important for the quality of inland waters and ultimately for the status of the Baltic Sea, as emphasised in the Helsinki Commission's position on sewage sludge[29]. According to the regulations currently in force, it is prohibited to store sewage sludge in landfills, which means that the recovery process has to be applied. On this basis, sludge can be used after stabilisation mainly for agricultural purposes, to enhance crop production, for land reclamation[30] and for energy generation[31].

[28] S. Fundala-Książek, A. Łuczkiewicz, P. Kowal, M. Szopińska, *Optimisation of pre-treatment of leachates and sewage [Optymalizacja podczyszczanie odcieków i ścieków]*, Plus Komunalny 2019/8, pp. 12–16.

[29] Position of the Helsinki Commission (HELCOM) on sewage sludge of 15 March 2017 (recommendation (38/1).

[30] K. Chmielowski, *Sewage sludge supports plant cultivation [Osady ściekowe wspomagają uprawę roślin]*, Przegląd Komunalny 2018/11, pp. 42–42.

[31] W. Czekała, *Management of digestate from an agricultural biogas plant in line with the circular economy concept* [*Gospodarka pofermentem z biogazowni rolniczej w myśl GOZ-u*], Energia & Recykling 2018/7.

Over the last twenty years, a significant development has been observed in sewage systems, which may be considered the main element of water protection against pollution with sewage. In a dozen years (2005–2017), the percentage of people using the sewage system also increased, from 59.2% to 70.5%. In the same period, the length of the sewer network increased by 76.6 thousand km (by 95.7%), reaching 156.8 thousand km. In rural areas, the increase in the length of the network was higher by 55.2 thousand km (by 149.9%) than in towns and cities, where an increase by almost 21.5 thousand km (by 49.5%) was recorded[32].

Significant investment expenditures have also resulted in a significant increase in the number of municipal sewage treatment plants built both in rural areas and in small towns, as well as in the whole of Poland (from almost 2.5 thousand in 2000 to over 3.2 thousand in 2017), which has translated into a significant increase in the amount of sewage discharged using sewage systems. At present, substantial financial resources are also allocated to the development of the sewage system and to the construction and modernisation of sewage treatment plants. Despite the increase in the total number of sewer laterals and in the length of the sewer network in the consecutive years, the amount of sewage discharged using sewage systems in the whole of Poland and in towns and cities kept decreasing, while currently it is at a relatively stable level (approx. 2.2 million m^3). This is mainly due to reduced water consumption. There has also been a clear increase in the use of highly efficient treatment methods with increased nutrient removal compared to mechanical methods. Statistics show that the amount of sewage collected by vacuum tankers has remained essentially unchanged. In 2018, more than 2 million septic tanks were recorded (see graph below), from which approximately 46.2 hm^3 of liquid waste originated[33].

[32] *Municipal infrastructure 2017 [Infrastruktura komunalna 2017]*, www.stat.gov.pl (accessed: 18 Oct 2019).

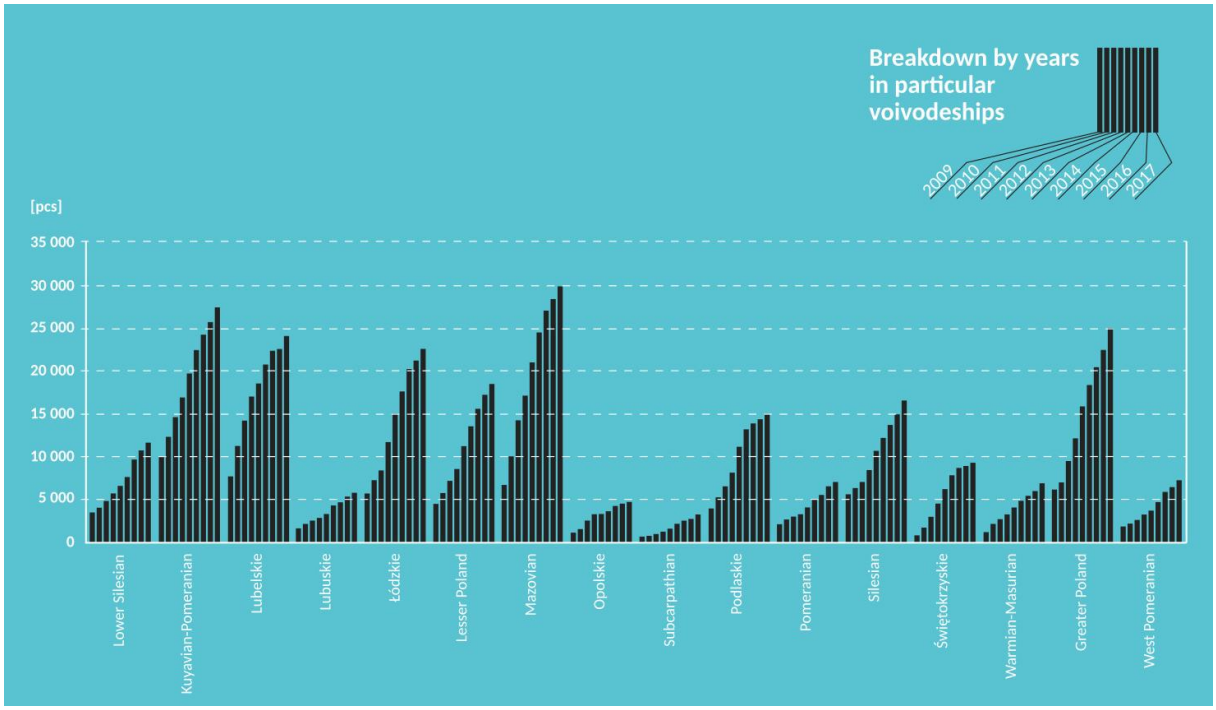
[33] *Environmental Protection 2018* [*Ochrona Środowiska 2018*], www.stat.gov.pl (accessed: 30 Sep 2019).

However, taking into account the number of people connected to the combined sewer system in villages, towns and cities (over 27 million) and taking into account household sewage treatment plants (almost 240 thousand), it can be estimated that the amount of sewage delivered to the sewage treatment plant is smaller than it should be. It is likely that the remaining amount is discharged directly and illegally into the environment. The solution should consist in further development of treatment systems through the construction of smaller sewer systems (for several dozen households), treatment of sewage in small sewage treatment plants, and construction of household sewage treatment plants[34]. Planning of the latter should, however, take into account problems related to compliance with the relevant treatment standards, the risk of groundwater pollution and the possibility of using state-of-the-art technologies.

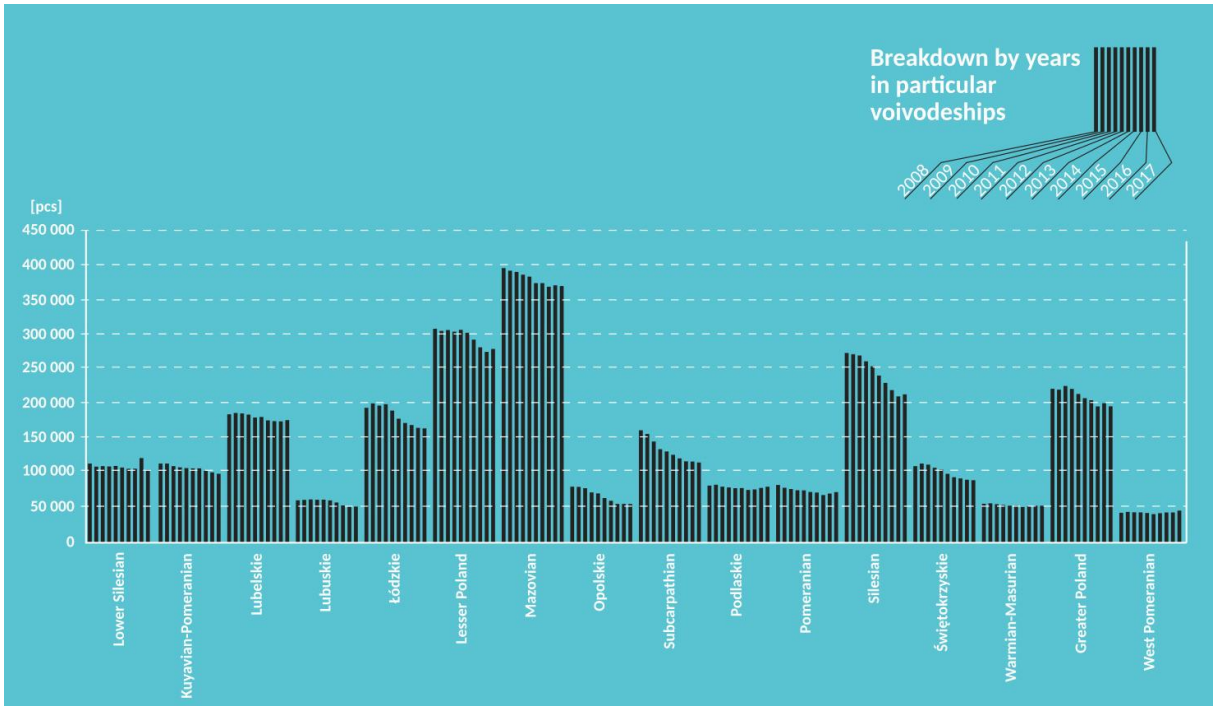
The development of sewage infrastructure has contributed to the reduction of concentrations of all pollutants in surface waters and to the improvement of the ecological potential or status of waters. Substance concentrations have been reduced to varying degrees. Over 20 years, the phosphorus load from treated sewage has decreased almost 5 times, just like BOD_5, but the nitrogen load has decreased by 60%, and COD by almost a half[35]. Despite the reduction in the amount of pollutants, including nitrogen, discharged from the territory of Poland into the Baltic Sea, further actions in this respect are necessary in order to protect the Baltic Sea waters against eutrophication.

[34] K. Chmielowski, *More and more sewer systems are being built* [*Powstaje coraz więcej systemów kanalizacji*], Przegląd Komunalny, 2017/10, pp. 48–52.

[35] *Environmental Protection 2018* [*Ochrona Środowiska 2018*], www.stat.gov.pl (accessed: 30 Sep 2019).



Ryc. 4 Number of Septic Tanks in 2009–2018 (source: GUS data, www.stat.gov.pl).



Ryc. 5 Number of Household Sewage Treatment Plants in 2009–2018 (source: GUS data, www.stat.gov.pl).

2.1.4 IMPACT OF INDUSTRIAL EMISSIONS ON WATER STATUS

Industrial emissions include wastewater other than domestic sewage, precipitation water or meltwater resulting from atmospheric precipitation, generated in relation to commercial, industrial, storage, transport or service-related activity pursued by an establishment or plant, as well as a mixture of such wastewater with another establishment's wastewater, discharged through the sewage facilities of that establishment[36]. This wastewater is characterised by a highly diversified chemical composition (wastewater with low pollutant concentrations such as cooling water and wastewater with high concentrations depending on the type of production)[37].

For example, wastewater from the dairy industry is characterised by a high fat content, a high concentration of organic pollutants, nutrient content and elevated temperature[38]. For the sake of comparison, wastewater from the paper industry contains highly persistent compounds with low biodegradability, such as: lignin, resin acids and organochlorine compounds[39].

Industrial wastewater accounts for the largest percentage of wastewater generated in Poland (approx. 85%). The amount of industrial wastewater discharged to waters or into the soil in recent years (since the year 2000) has remained each year at a similar level of 7,600–7,900 hm^3. In 2017, a significant decrease was recorded in the amount of that wastewater, to 7,240 hm^3. Of this amount, cooling waters and wastewater from cooling circuits represent the largest part, accounting for approx. 85–90% of the total industrial wastewater.

The vast majority of industrial wastewater is treated, while untreated sewage between 2000–2016 accounted for 5 to over 11% of the total amount. The treatment process that prevails is mechanical treatment, which is in fact rather pre-treatment of wastewater. In the years 2000–2016, around two-thirds of the total volume of industrial wastewater was treated in this manner. Biological and chemical treatment processes are used on a much smaller scale. The number of industrial establishments with wastewater treatment plants has been declining in recent years. For example, in 2000, out of 2,697 industrial establishments in operation, 1,238 (46%) had their own wastewater treatment plants. In 2016, the number of industrial establishments decreased to 2,083, of which 806 (39%) had wastewater treatment plants. This was caused by structural changes in industry and by the increasing possibilities of connecting to the combined sewer system. In 2016, of all industrial treatment plants, 736 had sufficient capacity, and the percentage of establishments whose wastewater treatment plants had insufficient capacity has been decreasing over the years. However,

[36] Act of 20 July 2017 – Water Law (Dz.U. item 1566).

[37] K. Chmielowski, *Preparation for the construction of industrial wastewater treatment plants [Przygotowanie do budowy oczyszczalni przemysłowych]*, Przegląd Komunalny 2018/4, pp. 45-47.

[38] K. Chmielowski, *The dairy industry and wastewater [Przemysł mleczarski a ścieki]*, Przegląd Komunalny 2018/7, pp. 43–45.

[39] K. Chmielowski, *Water and wastewater in the cellulose and paper industry [Woda i ścieki w przemyśle celulozowo-papierniczym]*, Przegląd Komunalny 2018/12, pp. 41–44.

modernisation measures should be taken with potential expansion in order to improve the capacity of such wastewater treatment plants. The vast majority of establishments without wastewater treatment plants discharge their wastewater to the sewer network, and the percentage of such establishments increased from 82.1% in 2000 to 88.2% in 2016. The number of industrial establishments discharging untreated wastewater into waters or into soil gradually decreased, from almost 18% in 2000 to almost 12% in 2016. This is certainly related to the increasingly developed wastewater treatment technologies on the one hand, and to the existing legal regulations on the other hand.

When analysing establishments discharging industrial wastewater into the sewer network, a downward trend can be observed in terms of the presence of pre-treatment systems in such facilities, which may pose a threat to the natural environment, especially the aquatic one. Even collective wastewater treatment plants, receiving wastewater that has not been pre-treated, may find it difficult to keep the treatment process at an appropriate level. Meanwhile, pre-treatment of industrial wastewater at its source may be a more economical solution than its treatment together with domestic sewage[40].

2.1.5 IMPACT OF ATMOSPHERIC DEPOSITION ON WATER STATUS

Atmospheric deposition is one of the main pressures affecting water status and the main pressure (after the discharge of wastewater from urban treatment plants) responsible for the failure to achieve good chemical status. The main pollutants contributed by atmospheric deposition are polycyclic aromatic hydrocarbons (PAHs) emitted from various sources, heavy metals, hydrogen ions as well as sulphur and nitrogen compounds. Acidification is also observed compared to normal rainfall pH. The pollutant load contributed by precipitation varies from region to region. The highest concentrations of various substances are recorded in the Małopolskie and Śląskie Provinces, and the lowest ones in the Dolnośląskie and Podlaskie Provinces. High concentrations of deposition were also recorded in urban and industrial centres. However, despite decreasing air pollution concentrations over the years, there have been situations involving a clear increase in pollution in some years. In addition, the observed trend is not sufficiently clear to make it possible to claim that the risk to the environment posed by the deposited atmospheric pollutants is decreasing. This is the result of actions taken to reduce emissions of pollutants into the atmosphere, including the implementation of technical and technological solutions (Best Available Techniques – BAT) and legal solutions (integrated permits)[41]. Pollutants contributed by atmospheric deposition should be taken into account in the overall balance of surface water pollution sources[42].

[40] *Environmental Protection 2018* [*Ochrona Środowiska 2018*], www.stat.gov.pl (accessed: 30 Sep 2019); K. Chmielowski, *Industrial wastewater and its treatment* [*Ścieki przemysłowe i ich oczyszczanie*], Przegląd Komunalny2018/5, pp. 54–57.

[41] *National Air Protection Programme until 2020 (with an outlook to 2030) [Krajowy Program Ochrony Powietrza do roku 2020 (z perspektywą do roku 2030)]*, Ministry of Environment, Warsaw 2015.

[42] *National Air Protection Programme until 2020 (with an outlook to 2030) [Krajowy Program Ochrony Powietrza do roku 2020 (z perspektywą do roku 2030)]*, Ministry of Environment, Warsaw 2015; P. Stepnowski, E. Synak, B. Szafranek, Z. Kaczyński, *Monitoring and analysis of environmental pollution [Monitoring i analityka zanieczyszczeń w środowisku]*, Gdańsk 2010.

2.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

2.2.1 IMPACT OF HYDROMORPHOLOGICAL EMISSIONS ON WATER STATUS

Article 4(7) of the WFD defines the situations and conditions in which it is permissible not to achieve the environmental objectives required by the Directive, i.e. at least good ecological status or ecological potential, and not to prevent its deterioration from high status to good status as a result of human development activities.

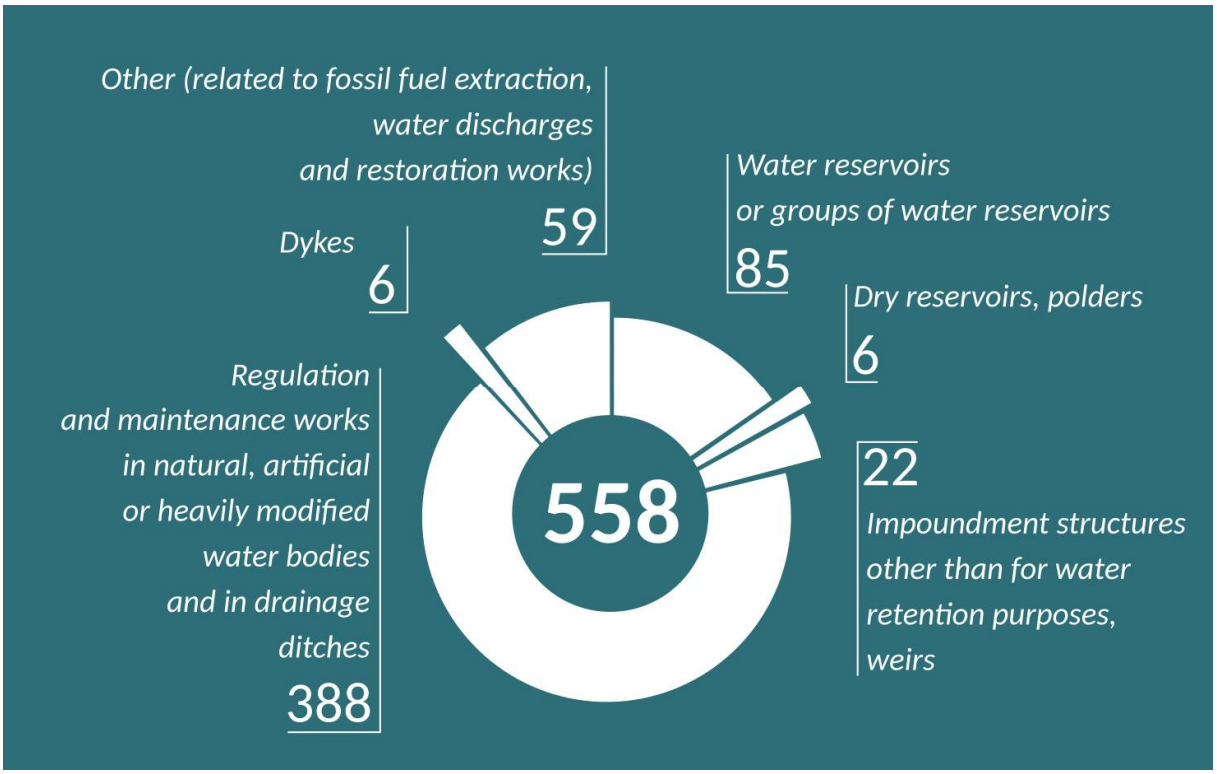
These conditions include the obligation to demonstrate that: (a) all practicable steps have been taken to mitigate the adverse impact on the status of the body of water; (b) the reasons for those modifications or alterations are specifically set out and explained in the RBMP; (c) the reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the environmental objectives are outweighed by the benefits of the new modifications or alterations to human health, to the maintenance of human safety or to sustainable development.

The analysis performed under the review covers the SWBs subject to the derogation under Article 4(7) of the WFD, as provided in the RBMPu for each river basin as well as the most common investment categories on account of which it was necessary to plan derogations for the water bodies. The scale of implementation of the investments indicated in the RBMPu for the current planning cycle has been taken into account.

What has been used is the results of parameterisation of the impact of specific categories of hydro-engineering projects on biological elements of water status assessment (phytoplankton, phytobenthos, macrophytes, macroinvertebrates, ichthyofauna) as well as supporting elements (hydomorphological elements – a method for assessing the morphology of rivers as per the HIR and physicochemical indices) against the context of differentiation in terms of the sensitivity of waters of different abiotic types[43]. The basic categories of projects identified for purposes of the parameterisation include 6 types of investments, of which 5 have been included in the provisions of the RBMPu: 1) construction or extension of the existing storage lake, 2) dry reservoirs, polders, 3) damming structures other than those built for purposes of water reservoirs, weirs, 4) regulatory and maintenance works in river channels, 5) flood control dykes. There are cases where the reasons referred to in the RBMPu as those which substantiate application of the derogation under Article 4(7) of the WFD include several categories of activity, however, for the sake of this analysis, they have been included in the category of the highest potential to affect river ecosystems as a consequence of

[43] *Retrospective assessment of the status of water bodies for purposes of an individual analysis of compliance with the Water Framework Directive of projects co-financed with EU funds [Ocena wsteczna stanu jednolitych części wód na potrzeby indywidualnej analizy zgodności z Ramową Dyrektywą Wodną projektów współfinansowanych z funduszy unijnych]*, M. Pchałek (ed.), Warsaw 2014; the abiotic types of rivers have been established with reference to geographical and geological conditions of river basins and the specificity of the plant and animal communities which inhabit rivers – source: *Verification of water typology and boundaries of surface water bodies [Weryfikacja typologii wód oraz granic jednolitych części wód powierzchniowych]*, Gliwice-Warsaw 2015.

parameterisation of impacts. What has also been identified in the RBMPu is such investment categories as those related to extraction of minerals, water abstraction and ecological restoration activities.



Ryc. 6 Scale of application of the derogation under Article 4(7) of the WFD in relation to the failure to achieve the environmental objectives due to hydromorphological alterations (with respect to the projects implemented in the current planning cycle, according to PGW WP's own data concerning the progress of implementation of investments).

An aggregate analysis of the RBMPu database implies that the derogation stemming from Article 4(7) of the WFD has been applied to investments performed in 558 river SWBs (12% of the total number of SWBs being rivers). Derogations under Article 4(7) of the WFD have also been envisaged for 19 lake SWBs – predominantly in relation to extraction of minerals (16 lake SWBs), stabilisation of the water level in lakes (2 lake SWBs), and redevelopment of the Elbląg Canal [Kanał Elbląski] (with an effect on 1 SWB, i.e. Lake Drużno [Jezioro Drużno]). Hard coal mining is the reason behind the derogation in the Vistula river basin (the Little Vistula and the Central and Upper Vistula water regions) and in the Oder river basin (the Upper Oder water region).Furthermore, in the Oder river basin, lignite is also extracted and water level is planned to be stabilised (in the Noteć water region). The number of derogations applied (19) is relatively small compared to the total number of 1,044 lake SWBs (2%). According to PGW WP's own data, only one of the investments planned to be implemented in a lake SWB is currently being performed (Lake Drużno – redevelopment of the Elbląg Canal).

This implies a much larger extent of the potential impact of investments on lotic waters than on lakes. In both river basins (of the Vistula and the Oder), the level of significance of this problem with regard to lakes should be considered as moderate.

As for transitional waters, on the other hand, the derogations under Article 4(7) of the WFD have been applied for 1 out of 5 SWBs in the Vistula river basin, i.e. the Vistula Lagoon [Zalew Wiślany], and 1 out of 4 SWBs in the Oder river basin, i.e. the Szczecin Lagoon [Zalew Szczeciński], in relation to the inland waterway development investments planned. The level of significance of the problem for this water category in both river basins can be considered as moderate. No derogation under Article 4(7) of the WFD has been envisaged in the RBMPu for any of the 10 coastal SWBs.

The actual scale of implementation of the investments planned with regard to river SWBs in the current planning cycle (as per PGW WP's own data, valid as of February 2019, submitted by the Ordering Party on 23 Sep 2019) is as follows: among the 558 SWBs for which derogations under Article 4(7) of the WFD have been established in the RBMPu, specific activities have been commenced or the need to perform them has been implied for the total number of 243 investments pertaining to 257 SWBs (46%), predominantly for the category of works related to regulation and maintenance of rivers (202 cases).

1) Water reservoirs or groups of water reservoirs – 85 river SWBs as per the RBMPu

Construction or extension of an existing storage lake is one of the factors which exerts a considerable impact on most species and ecological groups of fish, macroinvertebrates and macrophytes[44]. Sufficient planning and implementation of effective measures to mitigate these impacts (particularly by ensuring passability for fish migration via properly built fish passes) helps in reducing their intensity.

Both the construction of a dam and the preparation of a reservoir basin at the project implementation stage entail considerable long-term impact on the river ecosystem. Permanent transformation of the river ecosystem into the stagnant water of the reservoir triggers a number of changes to the living conditions of fish and invertebrates at the service stage. A fundamental consequence of a new dam being built within a reservoir, one which divides the river channel, is breaking the morphological continuity of the river system. This is of major importance to the

[44]W. Wiśniewolski, *Changes to the composition of ichthyofauna, its biomass and harvesting in selected storage lakes in Poland [Zmiany w składzie ichtiofauny, jej biomasa oraz odłowy w wybranych zbiornikach zaporowych Polski]*, Arch. Pol. Fish. 10 Suppl. 2002/2; Z. Kayak, *Hydrobiology - Limnology. Inland aquatic ecosystems [Hydrobiologia - Limnologia. Ekosystemy wód śródlądowych],* Warsaw 1998, p. 356; P. Prus, W. Wiśniewolski, *Diversity of forage for fish in mountain and lowland storage lakes and its consequences for the composition of ichthyofauna [Zróżnicowanie bazy pokarmowej ryb w górskim i nizinnym zbiorniku zaporowym i jego konsekwencje dla składu ichtiofauny]* [in:] Fishing in lakes, rivers and storage lakes in 2004 [Rybactwo w jeziorach, rzekach i zbiornikach zaporowych w 2004 roku], Mickiewicz, A. Wołos (eds.), Olsztyn 2005, pp. 87–106.

occurrence of bi-environmental fish, for which the capacity of free migration between the sea and rivers is prerequisite for the survival of the entire population.

Breaking the river's morphological continuity is also very important for fish migrating (for spawning, feeding, wintering purposes) within river systems. It should be stressed that even fitting a reservoir with a fish pass does not always reduce the effects of breaking the continuity of the river, especially if the fish pass parameters are not adapted to the requirements of the fish community[45]. Another problem may be triggered by further impacts exerted by the reservoir itself on migrating fish, such as those related to changes in the physical and chemical conditions of the water, increased predation (e.g. of birds) or mortality of fish migrating down the river via turbines of a hydroelectric power plant built at the dam. The species particularly vulnerable to these effects include young salmon and sea trout (smolts) as well as adult eels migrating towards the sea.

The key importance group which displays sensitivity to river damming is ichthyofauna,[46] and the requirements related to this group constitute the basis for the additional environmental objectives (on account of migration) defined in the RBMPu, which translate into the specific actions envisaged in the NWEPu. However, damming of a river channel is also relevant for the occurrence of invertebrates, especially those of the obligatorily aquatic group (particularly bivalve molluscs, but also snails, crustaceans, leeches, oligochaeta), which cannot migrate in the terrestrial environment at any stage of their ontogenesis. Although some organisms can migrate upstream along with the migrating individuals in the juvenile stage, spreading by means of the boundary layer of water or crevices, which enables them to pass even vertical walls of weirs and bars, yet they are incapable of passing higher ponding structures, while the scale of their migration in dammed water courses is limited. Consequently, the construction of a reservoir dam isolates local populations of these organisms in the upstream and downstream sections of the dammed river, since their capacity to migrate even through the existing conventional technical passes is limited[47]. An optimum solution to ensure the capacity for unconstrained migration of invertebrates is building passes formed into semi-natural by-passes as well as such technical passes where the granulation of the bottom substrate is diversified. This coincides to a large extent with the optimised solutions used for fish, and particularly the protected species, such as those of smaller body size (e.g.: Alpine bullhead, European bullhead, white-finned gudgeon, spined loach, golden spined loach, bitterling, brook lamprey). The length of

[45] *Fish passes – design, dimensions and monitoring [Przepławki dla ryb – projektowanie, wymiary i monitoring]*, P. Nawrocki (ed.), Warsaw 2016 (Polish translation and adaptation of the publication entitled *Deutscher Verband für Wasserwirtschaft und Kulturbau 1996 Fischaufstiegsanlagen – Bemessung, Gestaltung, Funktionskontrolle,* based on the English translation entitled Fish passes – design, dimensions and monitoring, Rome 2002).

[46] J. Błachuta et al., *Assessment of the needs for restoring morphological passability of rivers from the perspective of the pursuit of good status and potential of water bodies in Poland [Ocena potrzeb udrożnienia ciągłości morfologicznej rzek w kontekście osiągnięcia dobrego stanu i potencjału części wód w Polsce]*, Warsaw 2010.

[47] M. Alp, I. Keller, A.M. Westram, C.T. Robinson, *How river structure and biological traits influence gene flow: a population genetic study of two stream invertebrates with differing dispersal abilities*, Freshwater biology, 2012/57(5), pp. 969–981, Oxford: Blackwell Scientific Publications 10.1111/j.1365-2427.2012.02758.x.

non-dammed sections of rivers required for this group of fish species (10–15 km)[48] is also sufficient for the preservation of invertebrate communities.

A significant permanent effect of a new storage lake is the change to the natural hydrological regime in the downstream river, including reduction of freshets and low water periods. This affects the life cycles of fish and invertebrates, adapted to the natural variability of the flow.

Some major effects of storage lakes also include fundamental changes to the physicochemical parameters of the river ecosystem[49]. Their negative impact on the physicochemical conditions is particularly clear where cascade reservoir systems have been built, causing transformation of very long river sections. Moreover, the efficiency of the process of self-purification of water courses declines, while the rate of transport of load in non-dammed river sections between consecutive reservoirs is reduced. Proper design of the infrastructure, dredging in the reservoir basin and supplementation of the load (mainly bed load) downstream dams minimises the impact of river damming on the physicochemical conditions to a certain extent, yet some changes are inevitable. The consequences of these changes are particularly acute for the ichthyofauna and macroinvertebrates of mountain and upland rivers as well as of lowland rivers with coarse substrate. Lowland rivers with sandy substrate and large lowland rivers, on the other hand, are less vulnerable to the impact of storage lakes, since their ichthyofauna and invertebrates diverge from the reservoir inhabiting organisms to a lesser extent. The effects of the change to the physicochemical conditions are all the less drastic in the cases of alteration of fish and invertebrate communities in large lowland rivers as well as in organic and inter-lake rivers, where these communities differ very little from those to be found in still waters. Nevertheless, in reservoirs formed on such rivers, adverse phenomena such as cyanobacterial bloom can also occur, leading to deterioration of water quality and reduction in the ecological potential. Ponding in a reservoir always triggers the process of fish community succession, typically leading to the dominance of species with low habitat requirements, including small cyprinids, at the final stage[50].

[48] *Monitoring of animal species. Methodology guide. [Monitoring gatunków zwierząt. Przewodnik metodyczny]*. Part III., M. Makomaska-Juchiewicz, P. Baran (eds.), Warsaw, 2012, p. 748.

[49] This particularly pertains to such parameters as: oxygenation and temperature of water, content of nutrients, especially of phosphorus, nitrogen and organic carbon, biological and chemical oxygen demand, electrolytic conductivity, pH.

[50] W. Wiśniewolski, *Changes to the composition of ichthyofauna, its biomass and harvesting in selected storage lakes in Poland [Zmiany w składzie ichtiofauny, jej biomasa oraz odłowy w wybranych zbiornikach zaporowych Polski]*, Arch. Pol. Fish. 10 Suppl. 2002/2.

In lotic waters of all types, one can clearly observe the negative impact of such transformations, particularly with respect to the breaking of morphological continuity[51]. The absence of properly functioning fish passes or accumulation of the effects of consecutive ponding structures forming a cascade system can effectively reduce the occurrence of bi-environmental species. This decreases the rank of the D[52] indicator (being a measure of the passability of rivers for fish migration) used under the SEM with regard to the occurrence of bi-environmental fish, and not only in water bodies of large rivers, directly affected by the damming, but also in all water bodies of the upstream catchment area, where migratory species used to be historically present (consequently, maintaining passability for purposes of their migration on the route from and to the sea is required).

2) Dry reservoirs, polders – 6 river SWBs as per RBMPu

Construction of dry reservoirs and polders is significantly less risky to ichthyofauna and invertebrates than development of a regular reservoir within a river channel. If water is routed to the polder in the right way or the dry reservoir has been designed appropriately, the investment does not impede fish migration in the river.

Such investments trigger more permanent effects in the vegetation of river banks (tree felling), causing fish hiding places on river banks to disappear and reducing the river shading (increase in temperature). Moreover, once commissioned and maintained in service, such reservoirs reduce extreme flood phenomena, which affects the dynamics of the processes which condition the

[51] J. Błachuta et al., *Assessment of the needs for restoring morphological passability of rivers from the perspective of the pursuit of good status and potential of water bodies in Poland [Ocena potrzeb udrożnienia ciągłości morfologicznej rzek w kontekście osiągnięcia dobrego stanu i potencjału części wód w Polsce],* Warsaw 2010; W. Wiśniewolski, *Factors conducive and harmful to the development and maintenance of fish populations in lotic waters [Czynniki sprzyjające i szkodliwe dla rozwoju i utrzymania populacji ryb w wodach płynących],* Supplementa ad Acta Hydrobiologica 2002/3, pp. 1–28; *Fish passes – design, dimensions and monitoring [Przepławki dla ryb – projektowanie, wymiary i monitoring]*, P. Nawrocki (ed.), Warsaw 2016 (Polish translation and adaptation of the publication entitled *Deutscher Verband für Wasserwirtschaft und Kulturbau 1996 Fischaufstiegsanlagen – Bemessung, Gestaltung, Funktionskontrolle,* based on the English translation entitled *Fish passes – design, dimensions and monitoring,* Rome 2002).

[52] The D indicator for bi-environmental fish is a component of a method used to assess the ecological status or potential of rivers, as adopted in the SEM. It represents the ratio between the number of bi-environmental species currently present in the SWB subject to assessment and their historical number (values ranging from 0 to 1). If the indicator is lower than 0.5, the grade of the ecological status or potential based on the current status of the fish community, as determined by electrofishing (basic indicator being EFI+PL or IBI_EN, depending on the abiotic type of the river), is decreased by 1 class. If D ≥0.5, the grade of the basic indicator remains unaltered. The D indicator is also envisaged as an additional environmental objective for the migratory passability of rivers (under the project entitled "Setting environmental objectives for water bodies and developing a register of protected areas" [Ustalenie celów środowiskowych dla jednolitych części wód wraz z opracowaniem rejestru wykazów obszarów chronionych]).

morphology of river channels and slows down the restoration of natural hydromorphological structures.

Periodical flooding of the reservoir basin may also result in silting up of the river channel, inflow of a significant nutrient load and, consequently, deterioration of the living conditions of fish and invertebrates.

However, such phenomena occur at random, and often at intervals of several years, which enables the river ecosystem to regenerate. Transformations related to the construction of dry reservoirs exert a similar, moderate impact on upland and lowland rivers. It is only in extreme cases that they can reduce the class of ecological status/potential of the ichthyofauna or macrozoobenthos (e.g. in the case of small water bodies on which large dry reservoirs are built, covering a major section of the SWB).

3) Ponding structures other than for water retention purposes, weirs – 22 river SWBs as per RBMPu

Construction or elevation of existing weirs exert a very strong impact on most species and ecological groups of fish and macroinvertebrates, similarly to the construction of a storage lake, in which case one can observe morphological continuity disruption and changes to the physicochemical and morphological conditions (loss of habitats) in the section subject to ponding[53].

The impacts at the construction phase are generally less intense, since they are limited to earthworks in the immediate vicinity of the weir. Also in this case, the river ecosystem transformation into a ponded section of backwater upstream the weir entails a number of permanent changes to the living conditions of fish and aquatic invertebrates.

However, the spatial scale of these impacts at the service stage is more limited than in the case of construction of a storage lake. This is due to the limited scope of intervention in the zone directly adjacent to the weir, which typically extends over several dozen or several hundred metres of the backwater.

The main effect of the construction of a new weir is also the disruption of the morphological continuity of the river system. The consequences of such an impact have been discussed in the section pertaining to storage lakes (1), however, it should be additionally noted that developing a fish

[53]W. Wiśniewolski, *Changes to the composition of ichthyofauna, its biomass and harvesting in selected storage lakes in Poland [Zmiany w składzie ichtiofauny, jej biomasa oraz odłowy w wybranych zbiornikach zaporowych Polski]*, Arch. Pol. Fish. 10 Suppl. 2002/2; J. Błachuta et al., *Assessment of the needs for restoring morphological passability of rivers from the perspective of the pursuit of good status and potential of water bodies in Poland [Ocena potrzeb udrożnienia ciągłości morfologicznej rzek w kontekście osiągnięcia dobrego stanu i potencjału części wód w Polsce]*, Warsaw 2010.

pass in the weir poses another problem. Where the ponding is moderate in size, an efficient fish pass can itself reduce the negative impact of the river damming[54].

4) Regulation and maintenance works in channels of natural, artificial or heavily modified water bodies and in drainage ditches

Works which consist in altering the natural channels of streams and rivers have an essentially negative impact on the communities of fish and aquatic invertebrates dwelling in the respective water courses, especially when they are performed in an inappropriate manner, without taking good practices into account[55].

Mountain and upland rivers are most susceptible to the morphological changes of channels. However, the negative impact of regulation and other kinds of work performed in channels can be observed in all types of rivers. Its severity depends on the extent of disturbance caused by the given investment or maintenance work category to the river ecosystem as well as its spatial reach compared to the magnitude of the SWB. It should also be stressed that the negative impact of hydro-engineering and maintenance work mainly pertains to natural rivers, especially sections whose morphology has only slightly been altered, to be found in a part of landscape bearing natural features. The execution of such work in regulated rivers in urbanised, industrial or intensely used agricultural areas is not only justified by purposes of social and economic nature, but can also contribute to improving the morphological conditions and the status of river ecosystems, provided that good practices are applied. A separate category of facilities is that of drainage ditches and artificial channels, being hydro-engineering structures which can only exist and function properly when maintained on a regular basis.

The activity category in question comprises a number of works of diverse nature and degree of interference with the environment. The following two main categories should be distinguished:

1) Hydro-engineering works – investment activities leading to new and permanent transformations of morphological conditions, undertaken on account of important economic objectives, flood protection and water use. The works comprising this category include alteration in the river channel route, changes to the cross section and longitudinal section of rivers (dredging, river training structures, and structures which stabilise the river bed other than weirs and river barrages), river bank revetments, development and armouring of lake shores, or stabilisation and protection of sea shore against erosion. Changes in the environment caused by hydro-engineering are usually considerable, and so before the actual works can commence it is often necessary to prepare an environmental impact report in

[54] *Fish passes – design, dimensions and monitoring [Przepławki dla ryb – projektowanie, wymiary i monitoring]*, P. Nawrocki (ed.), Warsaw 2016 (Polish translation and adaptation of the publication entitled *Deutscher Verband für Wasserwirtschaft und Kulturbau 1996 Fischaufstiegsanlagen – Bemessung, Gestaltung, Funktionskontrolle,* based on the English translation entitled *Fish passes – design, dimensions and monitoring,* Rome 2002).

[55] I. Biedroń, A. Dubel, M. Grygoruk, P. Pawlaczyk, P. Prus, K. Wybraniec, *Catalogue of good practices with regard to hydraulic engineering and maintenance work, including the rules of their implementation [Katalog dobrych praktyk w zakresie robót hydrotechnicznych i prac utrzymaniowych wraz z ustaleniem zasad ich wdrażania]*, Kraków 2018.

which adequate remedying or compensating measures are defined, as well as to procure an official environmental decision.

2) Maintenance works – activities aimed at maintaining waters on an ongoing basis in order to ensure protection against floods, including ice floating, making it possible to use and maintain the waters, as well as to prevent degradation of the existing hydro-engineering structures and facilities. The catalogue of maintenance work[56] lists eight categories of work: mowing beds and banks/shores of water bodies, removing plants from river channels, felling of coastal trees, removing natural and man-made obstacles (woody debris, scree, and rubbish), developing breaches in river banks and beds, restoring passability of rivers by removing blockages (including removal of gravel and silt), repairing and maintaining hydro-engineering facilities, as well as removing and altering dams and burrows of beavers. The impact of maintenance work on the environment is essentially diversified, and therefore it is only subject to a strategic impact assessment and does not constitute grounds for the derogation under Article 4(7) of the WFD. Nevertheless, some categories of maintenance work can have a significant negative impact on river ecosystems, particularly if technical measures are used without implementing good practices, and where a considerable period of time has lapsed since the last maintenance work, causing development of new living conditions for organisms. For example, removing the substrate layer from the bed (through silt and gravel removal) disturbs the dynamics of the bed, causes fish to lose habitats, and reduces their forage by limiting the development of invertebrates, or even leads to mechanical destruction of fish and macroinvertebrates. Desilting and a number of other earthworks stir the bed substrate, thus contributing to the growth of trophy and increases the amount of suspended matter in the water. Such activities also trigger changes to the vegetation of river banks (tree felling), causing the hiding places of aquatic animals on river banks to disappear (due to under-washed roots, undercut banks) and reducing the river shading (increase in temperature, emergence of thermal barriers)[57]. However, it should be noted that systematic maintenance is justified provided that it continues to serve important economic or social purposes (e.g. flood protection or navigation). In the event of a permanent change in the way the given water body is used, and where the scope of the work performed to date is no longer substantiated, one should consider reducing it or even discontinuing further activity to allow for spontaneous river restoration. An example of such a mode of operation is abandoning maintenance of unused hydro-engineering structures, and instead, undertaking to dismantle or redevelop them (e.g. by converting unused weirs into rapids enabling fish migration).

[56] Article 227(3) of the Water Law Act of 20 July 2017 (Dz. U. 2017, item 1566).

[57] P. Prus, Z. Popek, P. Pawlaczyk, *Good practice in river maintenance [Dobre praktyki utrzymania rzek]*, Warsaw 2018.

Using good practices and adequately chosen measures of minimisation and compensation for investment activities may significantly reduce the negative impact of maintenance and hydro-engineering work, and even trigger additional benefits by introducing elements of river restoration[58].

5) Flood control dykes – 6 river SWBs as per the RBMPu

Felling trees on river banks in relation to construction or upgrading of flood control dykes causes fish hiding places to disappear, reduces river shading and increases water temperature (thermal barriers), all of them being permanent effects, lasting for many years following the completion of the construction or redevelopment of dykes. Preserving natural vegetation within the terrace area is only possible if the dykes are moved to a considerable distance from the river channel.

Such threats are particularly important from the perspective of mountain and upland rivers and streams of rocky bed, where they may result in deprivation of habitats of coldwater species, forming the very core of the ichthyofauna complexes of these rivers. The aforementioned impact is significantly smaller in lowland rivers, where dykes are usually erected at a certain distance from the river channel. However, for this group of rivers, prolonged adverse effects cause the flood plain along with the ox bow lakes which it contains to be cut off from the river current, which may contribute to a significant decline in the assessment grade of the ecological status/potential of large rivers as well as organic and inter-lake rivers.

6) Other – 59 river SWBs as per RBMPu

They are mainly related to extraction of minerals (53 SWBs), but also to water discharges (2 SWBs) and river restoration activities (4 SWBs). Since none of these investments has been indicated by the Ordering Party as pending or expected to be implemented in the nearest future, they have been excluded from further analysis and grouped under the other category.

The activities whose effect could potentially have been considered significant in this group would be the works related to adaptation of river channels to the requirements of mineral extraction, mine water discharge, etc., however, none of them has been approved for execution within the short time horizon covering the next planning cycle, and they have consequently been regarded as insignificant.

[58] W. Wiśniewolski, P. Prus, J. Ligięza, M. Adamczyk, K. Suska, P. Parasiewicz, *Possibilities of compensation for and minimisation of the effects of river training and maintenance [Możliwości kompensacji i minimalizacji oddziaływań prac regulacyjnych i utrzymaniowych w rzekach]* [in:] *Functioning and protection of flowing waters [Funkcjonowanie i ochrona wód płynących]*, ed. R. Czerniawski, P. Bilski (eds.), Szczecin 2017, pp. 9–30.

2.2.2 IMPACT OF INSUFFICIENT POTENTIAL OF NATURAL RETENTION AND RIVER RESTORATION, MAKING TECHNICAL METHODS OF FLOOD PROTECTION NECESSARY, ON WATER STATUS

The scale of implementation of non-technical methods of protection against flood in the understanding of the FRMP supporting instruments is currently insufficient. In the sphere of river restoration and natural retention restoration for flood protection purposes, two problems should be highlighted:

- restoration of rivers and river valleys is a measure aimed at fulfilment of the environmental objectives defined in the WFD,
- insufficient natural retention potential results in the necessity to implement hydro-engineering investments which interfere with the hydromorphology of rivers in a negative manner.

"Natural retention" mainly encompasses activities aimed at restoring ecosystems which had existed previously, before they were transformed by people. One can assume that the activities comprising natural water retention constitute the most fundamental part of the natural small water retention measures used in Poland[59]. In order to plan and implement effective restoration measures, five criteria are to be taken into account, which should be observed to ensure ecologically beneficial and sustainable outcomes of the efforts undertaken[60]:

- planning is based on the concept of restoration of a dynamic and healthy ecosystem, adequate to the given location,
- the ecological status of the given aquatic ecosystem should be permanently improved,
- following the restoration, an ecosystem is self-sustaining in nature as well as resistant to external impacts, enabling the scope of the potential maintenance[61] to be minimised,
- no long-term adverse effects (including on other ecosystems) should be triggered in the course of restoration activities, e.g. in connection with earthworks, alteration of the water circulation system, construction of hydro-engineering structures, etc.,
- the condition of the environment should be assessed before and after the implementation of individual measures in accordance with uniform procedures.

In order to meet these criteria in practice, one should define explicit and detailed restoration objectives as well as a catalogue of associated measures along with assessments of their efficiency in the pursuit of the pre-set objectives. What these objectives must account for is the hydromorphological and biological diversity of the river ecosystems, since only then is it possible to

[59] *Natural small water retention – Method for mitigating the effects of drought, limiting the flood risk and protecting biodiversity [Naturalna, mała retencja wodna – Metoda łagodzenia skutków suszy, ograniczania ryzyka powodziowego i ochrona różnorodności biologicznej]. Fundamentals of methodology [Podstawy Metodyczne]*, W. Mioduszewski, T. Okruszko (eds.), Poland 2016.

[60] M.A. Palmer, E.S. Bernhardt, J.D. Allan, P.S. Lake, G. Alexander, S. Brooks et al., *Standards for ecologically successful river restoration*, Journal of Applied Ecology 2005/42, pp. 208–217.

[61] Maintenance work pursuant to Article 227(3) of the Water Law Act includes: 1) mowing river banks and beds, 2) removing plants rooted in the bed, 3) felling of trees and bushes, 4) removing natural and man-made obstacles from the channel, 5) landfilling breaches in river banks, 6) dredging and desilting river channels, 7) repairing hydro-engineering structures, 8) removing or altering dams and burrows of beavers.

ensure lasting and good ecological status or potential of waters, which is the main requirement set forth in the Water Framework Directive, and which constitutes an environmental objective in itself.

Numerous measures are planned to be implemented to restore valley retention, however, their current state of advancement is insufficient. At present, there are 87 restoration measures planned[62]:

- restoring meanders – restoring river curvature (36 measures),
- removing dykes – valley widening (26 measures),
- connecting meanders and reclaiming ox bow lakes (16 measures),
- restoring wetlands in river valleys (3 measures),
- improving the condition of drainage infrastructure (restoring slide gates) (2 measures),
- developing polders (1 measure),
- restoring the anastomosing character of rivers (1 measure),
- maintaining the natural condition of valleys (1 measure),
- removing the concrete bed of streams (1 measure).

None of the aforementioned measures has been completed yet, which significantly limits the potential for retention of freshet water in river valleys. Moreover, it results in the necessity to perform hydro-engineering investments triggering negative disturbance in the river hydromorphology, including removal of trees and shrubs from the terrace, dredging and contour grading of the river channel cross-section, and straightening of the river channel route.

One should assume that the above problems will be minimised or eliminated to a large extent (in a long-term perspective) as a result of the completion of respective projects by the water management authority (State Water Holding Polish Water) under "Implementation of instruments supporting the execution of FRMP measures" (implementation period until 31 July 2020) and the "National programme for surface water restoration" (project completion by 29 Feb 2020).

[62] Flood Risk Management Plans – Supporting Instruments.

2.2.3 IMPACT OF THE RESTRICTED RIVER PASSABILITY (IN TERMS OF THE POTENTIAL FOR MIGRATION OF BI-ENVIRONMENTAL FISH) ON WATER STATUS

One of major problems related to river ecosystems is restoration of their ecological passability. This is of particular importance for bi-environmental fish and lampreys, which must migrate between fresh and sea waters throughout their life cycle.

The specific assumptions associated with the needs and priorities underlying restoration of river passability from the perspective of achieving good status and potential of water bodies in Poland were developed in 2010[63]. The problem of river passability within the main Polish river basins was also highlighted in previous reviews of significant water management issues[64]. The matter of river passability in the Oder river basin has also been identified as a problem of supra-regional relevance in the study concerning the International Oder River Basin District (IORBD)[65].

The main migration routes of bi-environmental fish coincide with the Vistula and the Oder, extending to their tributaries where spawning grounds are located. The progressing fragmentation of river systems, combined with the deteriorating water quality, the loss of spawning grounds in regulated river sections and the fishing pressure, have contributed to a considerable decline in the population size and, in several cases, caused extinction of individual migratory species (salmon, sturgeon). Maintaining the ecological continuity of rivers is one of the major conditions which, when satisfied, ensure that the condition of the environment improves and that migratory species are sustained or restored.

[63] J. Błachuta et al., *Assessment of the needs to unblock the morphological continuity of rivers in the context of achieving good status and potential of water bodies in Poland [Ocena potrzeb udrożnenia ciągłości morfologicznej rzek w kontekście osiągnięcia dobrych stanu i potencjału części wód w Polsce]*, Warsaw 2010.

[64] *Review of Significant Water Management Issues [Przegląd Istotnych Problemów Gospodarki Wodnej]*, Kraków 2008; *Review of Significant Water Management Issues [Przegląd Istotnych Problemów Gospodarki Wodnej]*, Warsaw 2012.

[65] *Strategy for joint resolution of significant water management issues in the International Oder River Basin District [Strategia wspólnego rozwiązywania istotnych problemów gospodarki wodnej na Międzynarodowym Obszarze Dorzecza Odry]*, Wrocław 2013; *Strategy for joint resolution of significant water management issues in the International Oder River Basin District [Strategia wspólnego rozwiązywania istotnych problemów gospodarki wodnej na Międzynarodowym Obszarze Dorzecza Odry]*, Wrocław 2019.

What proves particularly important is to enable fish to migrate in large rivers of the first order (flowing into the sea) and in their larger tributaries, since these rivers form the migration corridor for migratory fish between their feeding grounds and spawning grounds. There are programmes aimed to restore the passability of rivers already being implemented across individual catchment areas, this goal being pursued by building fish passes or restoring passability of river bars and weirs in order to enable fish migration[66].

A valuable source of data concerning both the historical and the current occurrence of bi-environmental fish is the report on the SEM outcomes collected since 2011 with respect to the assessment of the ecological status and ecological potential of rivers with regard to their ichthyofauna by application of the diadromous (D) index (the ratio between the number of bi-environmental species occurring at present and their historical number in the given river). The D indicator assessment affects the classification of the ecological status and potential of rivers with regard to the ichthyofauna, and consequently also the pursuit of the SWB related environmental objectives.

The level of confidence in the data used to assess the current passability of fish migration routes depends on whether or not one has the knowledge about both the existence and the efficiency of the migration facilitating structures at individual barriers along the fish migration route. The available data on ponding structures have been collected in the Database of Pressures. The data concerning the existence of migration facilitating structures (fish passes) are available for 7,092 dams (53%), 357 of which (5%) have been fitted with a fish pass, while the remaining ones are permanently or periodically blocked for passing of fish and other aquatic organisms.

Up till now, no uniform standards for monitoring of fish migration facilitating structures have been envisaged in the regulations in force in Poland. The requirement of five-year long monitoring of the newly erected fish passes financed using the EU funds is a means to obtain reliable information which is independent of seasonal variations, provided that the methods applied deliver the answer to the question about the efficiency of the given fish pass considered as a fish migration facility. The draft European standard for monitoring of fish passes using telemetry was published in January 2018[67], however, it has not yet been adopted by the European Committee for Standardisation. Consequently, none of the fish pass monitoring methods envisaged in the draft standard have yet been deployed. There are also no guidelines concerning this problem in Poland, while the results of the studies performed to date to investigate the efficiency of fish passes are based on disparate methods, which often precludes explicit conclusions on the actual functioning of migration facilitating structures to be formulated.

[66] *Analysis of the variants for restoring passability of ponding structures on water courses in the territory administered by the Regional Water Management Board in Kraków [Wariantowa analiza sposobu udrożnienia budowli piętrzących na ciekach w obszarze RZGW w Krakowie]*, Kraków 2017–2018.

[67] BS EN 17233. *Water quality. Guidance for assessing the efficiency and related metrics of fish passage solutions using telemetry [Jakość wody. Wytyczne w zakresie oceny efektywności i mierników rozwiązań dotyczących przepławek przy użyciu telemetrii.]*, 2018.

Only approx. 45% of the identified fish passes remain at least partially efficient in accordance with the Database of Pressures, and this result diverges significantly from the actual need for restoring passability of rivers for purposes of bi-environmental fish migrating within rivers as well as of protected species. Therefore, the problem of river passability for fish migration should be considered as a significant one whole country-wise. However, it has been systematically solved by numerous means, including through identification of water courses which are important and particularly important for maintaining morphological continuity and by identifying them in the respective water use conditions for water regions, and then by defining an additional environmental objective for these water courses in the applicable RBMPu, as well as through the assumed implementation of the measures pertaining to the chosen SWBs, as indicated in the NWEPu.

However, the Database of Pressures contains limited information on the efficiency of fish passes. In total, out of 357 structures identified in the database of fish passes, 121 (34%) have been identified as efficient, and 38 (11%) as partially efficient. For a significant number of ponding structures, there is no information about their respective facilities. Consequently, the problem of the quality of data identifying whether or not ponding structures feature fish passes should also be considered as significant country-wise.

It has recently been proposed that fish pass monitoring standards should be established in Poland by taking the aforementioned standard (BS EN 17233. *Water quality* into account, and that a uniform monitoring system should be deployed for migration facilitating structures. Implementation of such a system would make it possible to obtain reliable and comparable data on the efficiency of migration facilitating structures, and would contribute to increasing the level of confidence in the assessments based on the D indicator for bi-environmental fish, being an inherent component of the SEM methodology.

2.3 PROTECTION OF QUANTITAIVE SURFACE AND GROUNDWATER STATUS

2.3.1 IMPACT OF CLIMATE CHANGE ON WATER STATUS AND DROUGHT PROTECTION

The forecast climates changes may constitute a direct threat from the perspective of ensuring the required quantity of water of sufficient quality at a given place and time[68]. According to the Strategic adaptation plan (SPA 2020)[69], water management is considered to be a climate change-sensitive sector.

[68] *Management of water resources in Poland 2018 [Zarządzanie zasobami wodnymi w Polsce 2018]*[, ungc.org.pl (accessed: 30 Sep 2019).

[69] *Strategic adaptation plan for sectors and areas sensitive to climate change up to 2020 with prospects up to 2030 [Strategiczny plan adaptacji dla sektorów i obszarów wrażliwych na zmiany klimatu do roku 2020 z perspektywą do roku 2030]*, Warsaw 2013.

The temperature rise forecast for the entire territory of Poland as well as the change to the nature and magnitude of total annual precipitation for individual regions both pose a serious drought risk, with its effects to be intensified by the low retention potential of the catchment area[70]. On account of the urbanisation phenomenon, large parts of the catchment area have been either sealed or transformed, which has consequently reduced their retention potential. Additionally, the catchment area deforestation and reclamation of grassland and wetlands has increased the surface water runoff. Agriculture intensification has triggered a change of the landscape structure, as farmland roads and baulks have disappeared. Large-scale farming is particularly vulnerable to various environmental factors, including droughts. The absence of woods in farmland, which would otherwise reduce wind speed and evaporation, only adds to the sensitivity of the land in agricultural production to precipitation deficit. The forecast increase of rainstorm volume will favour water erosion of soil, since dry soil is more vulnerable to degradation[71].

With regard to this body of problems, much attention is attached to the potential occurrence of agricultural drought, as well as the risk of hydrological and hydrogeological drought[72]. The consequence of agricultural drought is growing demand for water to be used for irrigation of crops. The problems of susceptibility of individual areas to drought were analysed along with the identification of specific actions aimed at limiting its effects. Improving the potential water retention conditions through retention in the biotic and abiotic environment is an optimum strategy of adaptation to the effects of climate change, one which limits the consequences of drought. The application of various forms of retention, including artificial and natural retention (by diverse means aimed at protecting water resources by restoring or maintaining natural ecosystems), will significantly contribute to reducing the sensitivity of the environment, society and economy to the effects of climate change. Securing sufficient quantities of water under conditions of high climate uncertainty through its reasonable utilisation will enable the water needs of all users to be satisfied.

[70]The capacity of individual elements of the structure of the environment to retain rainwater and meltwater is conditional to decreasing the rate of runoff of these waters as well as water retention in the landscape, soil, underground, in reservoirs, water courses, trenches, and plants (bioretention). A decline in this potential entails catchment area deforestation, catchment area development and soil drainage.

[71]S. Horska-Schwarz et al., *Drought or flood? How to adapt to climate changes through small retention and protection of biodiversity [Susza czy powódź? Poradnik adaptacji do zmian klimatu poprzez małą retencję i ochronę bioróżnorodności]*, Legnica 2018.

[72]Drought – a natural phenomenon, i.e. temporary decrease in water availability due to such factors as lack of precipitation, among others. Atmospheric drought – deficit of precipitation. Agricultural drought – water deficit for plants. Hydrological drought – changes to the water discharge in a river. Hydrogeological drought – drop of groundwater level.

Significant problems caused by the limited water resources in Poland, identified against the background of climate changes (including an increase in the frequency and duration of droughts), pertain to the following sectors[73]:

- water transport: low retention capacity of catchment areas and high risk of drought make it difficult to ensure optimum conditions for inland navigation;
- power engineering: hydroelectric power plants with a capacity of less than 5 MW, classified as small hydropower plants (SHP), are generally considered to be clean, safe and predictable energy sources[74], but even they have been reporting problems due to water shortage in water courses since 2015. Hence the limited energy production from renewable sources, e.g. at hydroelectric power plants, and one can observe problems with cooling of conventional coal-fired power plants (due to lack of water and high water temperature), which may cause their operation to be discontinued or reduced. This proves to be particularly problematic on high energy demand for cooling in summer, which applies to both the private sector (air conditioning) and agriculture, i.e. farms or cattle breeding facilities;
- agriculture: crop loss, soil erosion (susceptibility to surface runoff and deflation), shortage of water for irrigation;
- water management: wells running dry, lack of water in municipal intakes, limited water intake for private and business entities;
- forestry: drying out of forest stands, susceptibility to fire;
- protected areas and biodiversity: wetlands and peat bogs running dry, incapacity to maintain biological flow in watercourses.

A prolonged drought can cause the level of surface water or groundwater to drop, which may lead to restrictions being introduced in respect of water use, access to water related services or agricultural and forest production[75].

In 2019, the Council of Ministers adopted a resolution on the adoption of "Assumptions for the Retention Development Programme for the years 2021–2027 with an outlook to 2030"[76]. The programme is expected to produce the following outcomes:

- increased water retention volume,

[73]Sectors listed in SPA 2020.

[74]M. Wilkowski, *Small hydropower plants matching the needs of the 21st century* [Małe elektrownie wodne na miarę XXI], [in:] Czysta Energia 2011/4, pp. 38–39; J. Steller, Hydropower engineering in Poland – a challenge beyond comprehension [Energetyka Wodna w Polsce – niepojęte wyzwanie], conference papers, 2009, pp. 69–84.

[75]*Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy]*, Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

[76]It is assumed to be adopted in the 4th quarter of 2020 or in the 1st quarter of 2021. An appendix to the adopted assumptions for the programme contains a list of 94 investments to be completed by 2027, their total cost amounting to ca. PLN 10 billion.

- increased capacity of small-scale water retention facilities,
- capacity to mitigate the effects of drought, with particular regard to rural and forest areas,
- reduction of the flood risk, including floods associated with what is commonly referred to as flash floods[77] in urban areas,
- restoration or improvement of conditions for energy-efficient use of water,
- increased share of local and regional undertakings in the creation of water retention potential,
- increased public awareness of the issue of dwindling water resources and of the need for water retention,
- improved conditions for utilisation of water for agricultural purposes,
- support for ecosystems created or sustained through water retention,
- improved class and navigation stability of inland waterways,
- improved visual appeal of landscape of areas with water bodies[78].

2.3.2 IMPACT OF EXCESSIVE SURFACE WATER AND GROUNDWATER INTAKE ON THEIR STATUS

In the event that any problems related to water abstraction are identified, one first consider the water resources available for utilisation. By definition, it is the amount of water that can be used for economic purposes on a permanent basis without violating the principle of sustainable development[79].

When identifying them, a certain reserve is assumed in relation to the need to maintain inviolable flows in rivers, both under the current hydrological conditions and by taking global changes into account. Excessive abstraction of surface water or groundwater exerts a significant impact on the hydrology of catchment areas. It disturbs the natural conditions of water flow in water courses, increases the soil susceptibility to drought, and lowers the groundwater table. Excessive surface water abstraction may lead to disturbance in the inviolable flow, which in the long-term perspective is the cause of permanent degradation of aquatic ecosystems as well as those dependent on water. The risk of the inviolable flow not being attained may potentially occur during prolonged low water periods, prolonged drought, and under the conditions of groundwater recharge, on the maximum permissible water abstraction taking place simultaneously[80].

[77]Flash flood – flooding caused e.g. by surface runoff, inefficient stormwater drainage system, or water rise in rivers following heavy short-term rainfall.

[78]Information available on the following website: www.premier.gov.pl (accessed: 30 Sep 2019).

[79]Groundwater resources available for use in quantities causing neither deterioration of the status of surface water associated with the groundwater nor any major damage to terrestrial ecosystems dependent on groundwater, see E. Przytuła, S. Filar, G. Mordzonek, *Groundwater management balance including interactions with the surface waters in the Polish part of the Oder basin [Bilans wodnogospodarczy wód podziemnych z uwzględnieniem oddziaływań z wodami powierzchniowymi w polskiej części dorzecza Odry]*, Warsaw 2013.

[80]E. Przytuła, S. Filar, G. Mordzonek, *Groundwater management balance including interactions with the surface waters in the Polish part of the Oder basin [Bilans wodnogospodarczy wód podziemnych z uwzględnieniem oddziaływań z wodami powierzchniowymi w polskiej części dorzecza Odry]*, Warsaw 2013.

Excessive abstraction of groundwater may lead to formation of regional depression craters. Moreover, groundwater abstraction entails a high risk of ascension or ingress of saline waters[81] (mine water, sea water), leading to deterioration of their quality and preventing them from being used.
The problem of excessively high water abstraction with reference to specific available resources pertains to both large agglomerations and areas of intensive raw material extraction and mine drainage.
Excessive groundwater abstraction may intensify the negative effects of climate change within a given territory, posing a threat to the sectors considered particularly sensitive, such as agriculture (increased susceptibility to agricultural drought), water management (reduced discharge in water courses, reduced groundwater table – shortage of drinking water, compromised navigation targets), biodiversity (eutrophication of water – algal blooms, reduced biodiversity, increased fish mortality), protected areas (drainage of protected water-dependent habitats), and developed areas (depression craters, land subsidence, construction damage).

The growing demand for water of good quality makes people draw groundwater resources with increasing intensity. This pertains to the areas under significant anthropogenic pressure, including large industrial regions with high water demand for technological purposes. Drainage performed in areas where mineral deposits are extracted (underground and surface mines) has disturbed their hydrology and caused depression craters to develop, having deleterious impact on the groundwater and surface water status, frequently within a radius of many kilometres. The high water abstraction in urban areas, conducted for municipal and industrial purposes, has caused the static water table to be significantly lowered and triggered formation of depression craters (water table lowering by up to ca. 70 m, as in the case of the Kalisz region; one can additionally observe deterioration of water quality, which involves the necessity to build water treatment plants). Excessive abstraction of water from the given aquifer may lead to depletion of resources of the same level and pose the threat of water pollution (e.g. with humus compounds from subsurface levels or due to salinity in the aftermath of ascension of saline water from lower levels, this being the case of e.g. Poznań, where the local authorities have limited the issuance of water permits in that area)[82].

As a consequence of anthropopressure, which manifests itself in the catchment area deforestation, development of river valleys and declining channel retention in watercourses, as well as the high degree of soil sealing, one could observe the capacity to redevelop groundwater resources to dwindle significantly. According to the literature of the subject, on the average, 70–90% of rainwater

[81] Upward influx of water from other aquifers, influx of saline water of high mineralisation from the sea or from deeper aquifers to fresh groundwater, [in:] *Dictionary of Hydrogeology [Słownik hydrogeologiczny]*, ed. J. Dowgiałło, A.S. Kleczkowski, T. Macioszczyk, A. Różkowski, Warsaw 2002.

[82] Characterisation of the Warta water region including identification of significant water management issues.

in urban areas is collected by the sewage disposal system, only to be discharged to rivers[83]. The average ratio for Poland's entire territory is ca. 18% of precipitation water infiltrating into aquifers (they are referred to as renewable resources)[84]. Given the excessive exploitation of groundwater, the groundwater table shows a tendency to gradually decline. The groundwater restoration capacity is inextricably linked with the amount of precipitation within the given water region. Therefore, the change in the nature of precipitation combined with high evaporation, also in winter, as well as the decreasing number of days with snow over the recent years make the water resource restoration capacity considerably limited. Consequently, the variety of pressures in play to date may be expected to exert a significantly higher impact on the quantitative status of waters compared to the situation observed a few or a dozen or so years ago. Due to abstraction and drainage, the water circulation conditions in water regions have been heavily disturbed.

The following major issues have been identified as the consequences of excessive abstraction of surface and groundwater with regard to river basins and water regions:

- disturbed inviolable flow in surface watercourses as a result of excessive abstraction of surface water which constitutes a significant problem for the condition and ecological potential of flowing waters as well as a threat to the pursuit of environmental goals defined for the SWB and protected areas in accordance with the WFD,
- formation of depression craters in main usable aquifers of regional range – problem related to excessive groundwater abstraction for municipal and industrial purposes,
- lowering the groundwater table as a result of excessive water abstraction or mine drainage,
- lowering the groundwater table within protected areas,
- increasing the susceptibility of agricultural land to drought,
- ascension or ingress of saline water, causing a change in the quality of water in usable aquifers.

2.3.3 LACK OF IMPLEMENTATION OF EFFECTIVE REGULATION REGARDING THE IMPACT OF ENVIRONMENTAL FLOWS ON WATER STATUS

The environmental flow, both in and out of channel,[85] is intended to provide the sufficient amount of water as required by natural environment, taking the conditions of growth and life of organisms into

[83] W. Bartnik, J. Bonenberg, J. Florek, *Effect of a catchment area losing its natural soil retention capacity on the morphological characteristics of the catchment area and of water courses [Wpływ utraty naturalnej retencji zlewni na charakterystykę morfologiczną zlewni i cieku]*, Polish Academy of Sciences (PAN), Countryside Infrastructure Committee, Kraków 2009.

[84] P. Herbich, *Groundwater resources – current state of exploration [Zasoby wód podziemnych – aktualny stan rozpoznania]*, www.pgi.gov.pl (accessed: 30 Sep 2019).

[85] Environmental in-channel flow (equivalent of inviolable flow, according to contemporary nomenclature) is the kind of flow which determines the good condition (or potential) of the biological elements affecting the

account[86]. In other words, the environmental flow makes it possible to maintain a minimum level of flow in the river throughout the entire year, as well as the out-of-channel flow for a certain number of days, thus ensuring conditions sufficient enough to attain a good status of waters and water-dependent ecosystems. Ensuring the cyclic nature of inundation is particularly important for riverside phytocoenoses and habitats requiring periodic flooding (waterlogged meadows, riparian forests). Environmental flows constitute an important component of water resource management. In order to develop environmental flows required to maintain good condition of the environment, one must verify the patterns of water use currently functioning in catchment areas. On account of the climate changes and prolonged periods of drought, it may not be possible to maintain conditions favourable of the environmental flows in catchment areas subject to high pressure (where surface water and groundwater abstraction is high), which will require re-estimation of the available resources. The plans to counteract the effects of drought comprise an analysis of the possibility to expand the available resources as well as specific suggestions as to the necessary changes in terms of utilisation of water resources, introduced by improving natural and artificial retention. From the perspective of the capacity to develop environmental flows in the catchment areas with limited available resources or altered hydrology, the most optimum actions are those which aim at increasing natural retention. Improving the retention capacity, particularly in agricultural lands, forests and developed areas, as well as landscape, soil and surface retention by application of nature-friendly methods in a long-term horizon significantly increases the catchment area's potential to redevelop water resources.

The capacity to ensure sufficient conditions to attain a good quantitative status of water (environmental flow) while providing water to consumers at the same time is one of the most important and difficult problems related to updating of river basin management plans.

In conclusion, it should be noted that overestimation of environmental flows may lead to reduction of the water resources available to other water consumers. In light of the efforts aimed at developing environmental flows, it is necessary not only to improve the hydromorphological status of SWBs, but also to restore optimum hydrology across the entire catchment areas.

water status; environmental out-of-channel flow determines the good condition of water-dependent habitats and species.

[86]Implementation of a method for estimating environmental flows in Poland is one of the elements taken into account while developing the second update to the National Water and Environment Programme as well as to the River Basin Management Plan. The project is co-financed by the European Union under the Cohesion Fund within the framework of the 2014–2020 Infrastructure and Environment Operational Programme.

2.4 LEGAL, ORGANISATIONAL AND SOCIAL ASPECTS

2.4.1 ENSURING THE EFFECTIVENESS OF THE NEW INSTITUTIONAL SYSTEM FOR THE IMPLEMENTATION OF WFD ENVIRONMENTAL OBJECTIVES

One of the main obstacles hindering the achievement of WFD environmental objectives included the "disintegration of the Polish water management system", with its main symptoms involving the "dilution of state authority competences", leading to an "integrative spaghetti"[87]. As a result, the main objective of the new Water Law concerning the principles of water management was to change the legal and organisational structure of public administration bodies competent in matters of water management.

The system in force until 31.12.2017 was considered ineffective, which had a major impact on the difficult situation in the water management sector[88]. The explanatory memorandum to the bill indicates, among other things, that the division of competences between the President of the National Water Management Authority and the minister in charge of water management, introduced under the Water Law Act of 18.07.2001 (Dz.U. 2017, item 1121, as amended), hindered effective and efficient intervention in cases requiring it, due to the implementation of the policy of the Council of Ministers, including in the area of investment activities in water management[89]. In the opinion of the project initiator, the legal and organisational structure in force at that time did not guarantee that the process of preparing and implementing projects would be conducted in a planned, timely and reliable fashion.

The new Water Law established the PGW WP as the main entity responsible for national water management. PGW WP is a state legal entity (within the meaning of the Act on public finances (Dz.U. of 2016, item 1870, as amended)) consisting of the following organisational units: KZGW, RZGW (11), management boards of catchment areas (50), water management boards (330).

In light of the current regulations, the National Water Management Authority (PGW WP KZGW) supervises the planning of water management investments and their implementation. Meanwhile, the role of the Regional Water Management Board (PGW WP RZGW) is to coordinate these investments in water regions. Activities in the field of preparation and implementation of investment projects and objectives in the water management sector are the focus of management boards of catchment areas. As indicated in Article 240(4)(6) of the Water Law, these organisational units of PGW WP plan and carry out investments, including fulfilling the role of investor or substitute investor. It should be noted that under the previous regulation these competences were executed by RZGWs and voivodeship marshals. Therefore, in light of the binding provisions the legislator decided to lower the administrative location of the investor's function from the regional (voivodeship) level to the supra-local (sub-regional) level.

[87] Janusz Żelaziński defined "integrative spaghetti" as "a seemingly integrated system, however practically impossible to control due to the extreme entanglement of relations between elements", [in:] J. Żelaziński, *Changes in Polish Water Law necessary for full transposition of the Water Framework Directive [Zmiany polskiego prawa Wodnego niezbędne dla pełnej transpozycji Ramowej dyrektywy Wodnej]*, Warsaw 2004.

[88] This was pointed out by the initiator (Council of Ministers) [in:] *Government bill on Water Law*, Sejm of the 8th term, document no. 1529, Warsaw 2017.

[89] *Government bill on Water Law*, Sejm of the 8th term, document no. 1529, Warsaw 2017.

In the context of the execution of the WFD environmental objectives, the new institutional system framework creates the need to ensure adequate human and substantive resources of the new institutions, both the PGW WP RZGW and the management boards of catchment areas in the scope of tasks assigned by way of the new Water Law, according to which, based on the planning works carried out at the RZGW level, the management boards:

- implement and cooperate in the implementation of measures aimed at sustainable water management and achievement of environmental objectives in catchment areas;
- conduct projects related to the reconstruction of ecosystems degraded by the exploitation of water resources and cooperate with the relevant authorities and entities in this respect.

Based on the Water Law, it can be concluded that, as investors, the management boards of catchment areas operate at various levels in terms of the ways of achieving WFD environmental objectives, i.e. at the planning, decision-making and executive level.

As per the Rules of Organisation of PGW WP[90], the aforementioned tasks specified in the Water Law are the responsibility of the catchment board's Environmental Management Department which conducts sustainable water management, such as the execution and cooperation in the implementation of activities aimed at sustainable water management, including the achievement of environmental objectives specified for surface and groundwater bodies.

Meanwhile, through the decision it issues, the Department of Water Law Permits ensures that the planned investments do not violate the PGW provisions or protection plans and tasks for protected areas (Article 396(1) of the Water Law Act) or conducts proceedings to determine whether certain permits interfere with environmental objectives for water (Article 80 of the Water Law Act).

As regards water maintenance, the tasks performed under the WFD are performed by the Water Investment and Sustainability Departments in cooperation with water supervisors. Under the Rules of Organisation, these departments cooperate by "developing or updating planning documents, implementing conservation tasks for WB in accordance with the provisions of plans for Natura 2000 areas and by planning, programming and implementing tasks in the field of water and water structure maintenance", which should be consistent with the environmental objectives for the WB.

The above legislation and statutory solutions provide a wide range of possibilities at the catchment area level towards implementing measures aimed at achieving the environmental objectives set by the WFD. The potential of the catchment area management boards lies in issues such as:

- catchment area management pertains to a smaller area with a lower number of WBs, which facilitates good understanding of the land, environmental qualities and problems in the catchment area and their control in the field;
- the management boards of catchment act as intermediaries between the senior units, i.e. PGW WP RZGW (which control and supervise the planning documents and their implementation in the field) and the subsidiary units - water supervisory units which,

[90] *Rules of Organisation of the National Water Management Authority of 26.03.2019 [Regulamin organizacyjny Państwowego Gospodarstwa Wodnego Wody Polskie z 26.03.2019r.].*, www.wody.gov.pl (accessed: 30 Sep 2019).

assuming proper effectiveness of the board, makes it possible to introduce WFD-related plans consistent with the tasks of PGW WP at all levels of activity;

- as field units of PGW WP, catchment area boards and supervisory units have direct contact with current and future water users through field visits, issuing opinions and decisions, thus impacting the sustainable use of water;
- in the case of infringements of environmental objectives identified in the field, the management boards of catchment areas can report potential users for water management inspection.

2.4.2 REDUCING THE DEVELOPMENT PRESSURE ON FLOOD RISK AREAS (PRESERVING AND RESTORING NATURAL RETENTION AREAS)

Failure to implement effective instruments to prevent anthropopressure on river valleys (floodplains) not only leads to deterioration of the quality of aqueous and flowing water-dependent ecosystems, but also significantly contributes to increasing the flood risk[91].

On the one hand, the reasons for such state of affairs should stem from the fact that the development of floodplains interferes with the natural regulation mechanisms of flowing waters, increasing the probability of flooding of increased intensity. On the other hand, the size and value of material damage caused by flooding is always a function of the degree and nature of floodplain land development. Understanding these relations, or rather the empirical confirmation of their "absolute consistency" has lead to a situation in which the idea of "returning the rivers to their environment"[92] has become a central direction of water conservation and flood protection policies in most EU countries, as well as one of the pillars of the Floods Directive.

The issue of transposition of flood hazard maps (FHM) and flood risk maps (FRM) into spatial planning illustrates a significant problem of water management in connection with the issue of regulating liability for damages for restricting the use of real estate.

The new Water Law upheld the obligation to include FHMs and FRMs in spatial development documents. At the same time, the new Water Law excluded the municipalities' liability for damages for the transposition of the FHMs into local spatial development plans.

Section 1a was added to In Article 36 of the Act on spatial planning and development[93]; under the section, a municipality's liability is excluded if the content of the local plan resulting in the limitation of the possibility of using the property does not constitute a municipality's independent

[91]As per Article 2(2) of the Floods Directive, "flood risk means the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event." Under this definition, flooding is an event causing serious environmental damage; hence, protection against flooding should be treated as one of the "integrated legal measures for environmental protection."

[92]The statement was formulated by German Chancellor H. Kohl after the tragic floods on the Mississippi and Rhine rivers in the early nineties of the last century, [in:] J. Żelaziński, *The role of floodplain maps in flood protection planning [Rola map terenów zalewowych w planowaniu ochrony przeciwpowodziowej]* [in:] *Safe commune on the Oder [Bezpieczna gmina nad Odrą]* , ed. P. Nieznański, Wrocław 2007.

[93]Act of 27 March 2003 on spatial planning and development (Dz.U. of 2018 r. item 1945, as amended).

determination of the socio-economic purpose of the area and the manner of its use, but stems from hydrological, geological, geomorphological or natural conditions, among others, concerning the occurrence of floods and related restrictions, determined on the basis of separate provisions.

The absence of specific provisions regulating the potential responsibility for the implementation of the FHMs into local plans may be considered a significant social problem. Nevertheless, it should be pointed out that a complete exclusion of liability may be based on the judicial practice of the Constitutional Tribunal[94].

2.4.3 ENSURING EFFECTIVE MECHANISMS FOR OBTAINING RIGHTS TO REAL ESTATE FOR THE PURPOSE OF RIVER RESTORATION AND RECREATION OF NATURAL RETENTION FOR FLOOD PREVENTION PURPOSES.

As regards effective mechanisms of acquiring rights to real estate for restoration purposes and recreation of natural retention for flood protection purposes, two issues should be pointed out:

- restoration of rivers and river valleys is a measure to achieve the environmental objectives of the WFD,
- insufficient potential for natural retention results in the necessity to carry out hydrotechnical investments interfering negatively with the hydromorphology of rivers.

In the current legal system, the acquisition of real estate for the purpose of river restoration and recreation of natural retention has to be carried out pursuant to the Act on real estate management[95], which significantly hinders the implementation of such projects and often makes them even impossible to implement. In the course of works on the FRMP, a proposal was made for this type of investment to be covered by the regime of the Act on specific rules for the preparation for implementing investments in the field of flood control structures[96].

In the aforementioned context, the soon-to-start project of Polish Waters. titled "Implementation of instruments supporting the execution of FRMP measures" should be mentioned. This project will cover a wide range of legal aspects pertaining to the implementation of Flood Risk Management Plans (the implementation period until 31 July 2020).

The following tasks are planned to be performed within the framework of the indicated project:

[94] Sentence of the Constitutional Tribunal of 16 Oct 2007, K 28/06, Lex No 322149.

[95] Act of 21 August 1997 on real estate management (Dz.U. of 2018, item 2204, as amended).

[96] Act of 8 July 2010 on specific rules for the preparation for implementing investments in the field of flood control structures (Dz.U. 2019, item 933, as amended).

- preparation of legal, inspection and investment solutions based on the "Guidelines on non-technical methods of flood risk management",
- preparation of legal, inspection and investment solutions based on the "Guidelines for location and technical aspects of development in flood hazard areas",
- analysis of conditions for the implementation of programmes and projects aimed at relocating buildings from areas of particular risk of flooding,
- analysis of conditions provided for under the Act on specific rules for the preparation for implementing investments in the field of flood control structures[97].

Important legal solutions in this problem area should be proposed also within the "National programme for surface water restoration" project (project completion by 29.02.2020).

The national programme of surface water restoration should include at least a national-level action plan, involving:

- identification of threats and causes of hydromorphological changes in watercourses and reservoirs,
- a catalogue of remedial measures that will enable the achievement of environmental objectives for surface waters,
- legal and administrative solutions facilitating the implementation of restoration activities.

Moreover, the planned action programme for Priority Areas indicated for restoration assumes that each identified task should be considered in terms of legal, administrative, inspection, financial, educational and investment solutions.

2.4.4 IMPLEMENTATION OF EFFECTIVE LEGAL REGULATIONS CONCERNING THE METHOD OF ESTIMATING ENVIRONMENTAL FLOWS

In accordance with the EC guidelines, the implementation of the WFD objectives requires the establishment of effective mechanisms at the national level for the preservation of environmental flows in a broader perspective than the institution of inviolable flow[98] functioning in Poland. The role of the environmental flow instrument is to ensure the proper quantitative state of water in surface watercourses, as well as to maintain regular flooding of water-dependent ecosystems. In the last few years, State Water Holding Polish Waters has carried out two research and development projects to determine the method for estimating environmental flows. The results of these projects should receive final approval by water authorities and water users and then should be reflected in the relevant Water Law regulations.

[97] Act of 8 July 2010 on specific rules for the preparation for implementing investments in the field of flood control structures (Dz.U. 2019, item 933, as amended).

[98] *Ecological flows in the implementation of the Water Framework Directive Guidance Document* No. 31; Technical Report - 2015 – 086, European Union 2015.

The implementation of an instrument for estimating environmental flows requires effective legal regulation, binding in the following areas:

- definitions,
- administrative procedures regarding individual projects, including control provisions for monitoring flow behaviour.

In light of the regulations currently in force in Poland, there is no definition of "environmental flows". Moreover, while the Water Law of 20 July 2017 uses the concept of inviolable flow in relation to biological elements of water status, there is no regulation concerning out-of-channel habitats and species.

The following definition of the flow estimation process was adopted within the first research project of KZGW[99]: "A process of estimating environmental flows is understood as a process involving:

- the determination of ecological indicators for the achievement of environmental objectives for the biological elements of water status and water-dependent habitats and species;
- the determination of the method of converting ratios into flow values;
- the determination, in the context of anthropogenic pressure, of flow values guaranteeing the achievement of environmental objectives, which could be unfulfilled only in case of meeting the conditions provided for in provisions on environmental protection, in particular:
    - of the Water Framework Directive,
    - of the Habitats Directive[100],
    - of other Community and national regulations on nature conservation (regulations on species conservation / regulations on national area forms of nature conservation)."

As for the proper definition of out-of-channel environmental flows, the following wording was proposed: "out-of-channel environmental flow is understood as a flow determining the proper condition of water-dependent habitats and species within the meaning of the Act of 16 April 2004 on nature protection, and its value should correspond to the minimum flow necessary to maintain the proper status of habitats and species[101]."

As part of the second research and development project to establish a method for estimating environmental flows[102], the following definitions of environmental flows were proposed:

"*Environmental flow* is a natural flow modified in such a way that these modifications, stemming from the need to ensure access to water at a level necessary for securing living and development conditions, provide sufficient water to maintain habitats and biotopes in water and water-dependent

[99] *Establishment of a method for estimating environmental flows*, National Water Management Authority, Warsaw 2015.

[100] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ EU L 206, p. 7).

[101] *Establishment of a method for estimating environmental flows in Poland, Stage II of the final report [Ustalenie metody szacowania przepływów środowiskowych w Polsce, Etap II raport końcowy]*, Warsaw 2015.

[102] Implementation of a method for estimating environmental flows in Poland. Stage II. Verification and calibration of the method for estimating environmental flows – analysis part (including completion of field studies) and development of tools for implementing the method. National Water Management Authority, Warsaw 2015.

ecosystems. Good status should be understood as defined in the Water Framework Directive and the Habitats Directive. In heavily modified watercourses, good status is replaced with good potential.

For practical purposes, the above definition is brought down to the notions of *channel environmental flow* (the equivalent of the current inviolable flow), i.e. a restriction aimed at leaving a river flow which determines the good status (or potential) of biological elements of water status and *out-of-channel environmental flow* which determines the good condition of water-dependent habitats and species dependent.

The material contained in the study, referring to the requirements of water-dependent ecosystems, was adopted as an element to be used in the expert determination of the out-of-channel environmental flow.

From a legal perspective, the key issue related to the application of the above definition is to develop a methodology for considering the value of flows guaranteeing the achievement of environmental objectives in proceedings regarding:

- environmental decisions,
- water permits for the construction of water facilities, special use of water and water services (in particular groundwater or surface water abstraction),
- decisions approving water management instructions.

2.4.5 EFFECTIVE ENFORCEMENT OF NEW REGULATIONS CONCERNING THE IMPLEMENTATION OF THE PRINCIPLE OF COST RECOVERY FOR WATER SERVICES

The economic instruments regulated by the Water Law of 2001 related to water service fees were criticised for their fundamental ineffectiveness, which justified the need to develop new solutions that would ensure the implementation of the WFD provisions: "In the course of works on the preparation of water management planning documents, an economic analysis was performed which showed that the reimbursement of incurred costs of water services was executed at the level of 22% to 24% in Poland, which indicates a very low level of implementation of this requirement[103]."

The Water Law[104] of 18 July 2001 provided for numerous exemptions from the obligation to pay fees for the use of water services. This solution itself was not incompatible with the WFD, as the obligation to reimburse the costs of water services is not absolute and fully proportional to the scope of using these services, but Polish solutions in this respect were questioned by the EC as being too broad, which especially concerned the energy sector.

[103] Reply to parliamentary question no. 18075 on the effects of introducing a water price regulator, delivered by Undersecretary of State at the Ministry of Maritime Economy and Inland Navigation, Anna Moskwa, 2.02.2018, www.sejm.gov.pl (accessed: 30 Sep 2019).

[104] Act of 18 July 2001 – Water Law (Dz.U. item 1229).

Eventually, a number of exemptions from the obligation to pay for water services, provided for in the Water Law of 2001, were repealed in the Water Law of 2017.[105], replacing the previous law of the same name. The new regulations maintained, albeit to a lesser extent, certain derogations which covered selected types of activities and certain subject categories[106]; a quota limitation was also introduced, under which no fee is paid for water services if their amount does not exceed PLN 20[107].

In essence, the development of new solutions was an *ex-ante* conditionality: 6.1 water management''[108], without which EU support for investments in the water sector would be significantly hampered, if not impossible, to reach for.

Implementation of the principle of water service cost recovery should encourage rational management of water resources, which is of "particular importance in the case of Poland, i.e. a country with low water resource volume per citizen"[109]. The Regulation Impact Assessment of the new Water Law indicates that "the new water management model will entail the introduction of a complete system of economic instruments, which will primarily aim at more efficient management of water resources"[110].

The establishment and implementation of a new system of fees for water services also required introduction of organisational changes to the water management structures. As a result, the new Water Law established the National Water Management Polish Waters (PGW WP), which is a state legal entity within the meaning of the Article 9(14)t 14 Public Finance Act[111].

2.5 ECONOMIC AND FINANCIAL ASPECTS

2.5.1 EFFICIENCY OF WATER RESOURCES USAGE, ESPECIALLY IN TERMS OF WATER UTILISATION FOR INDUSTRIAL AND MUNICIPAL PURPOSES

One of the basic economic tasks is to determine the way of allocating resources to ensure their best use. Water is a unique commodity. It is impossible to survive without it, hence its management is defined in a specific way in legislation, both at the national and international level. Currently, many studies stress the importance of access to clean freshwater. Moreover, it is pointed out that water resources can become a source of human conflict. From this point of view, as well as given the

[105]Act of 20 July 2017 – Water Law (Dz.U. item 1566).

[106]Cf. Article 269(2)–(4), Article 270(2) and Article 279(3) of the Water Law Act 2017.

[107]Article 279a of the Water Law Act.

[108]Cf. reply to parliamentary question no. 21887 on EU funding of water investments in Końskie and Radoszyce, delivered by Undersecretary of State at the Ministry of Maritime Economy and Inland Navigation, Anna Moskwa, 30.05.2018, www.sejm.gov.pl (accessed: 30 Sep 2019).

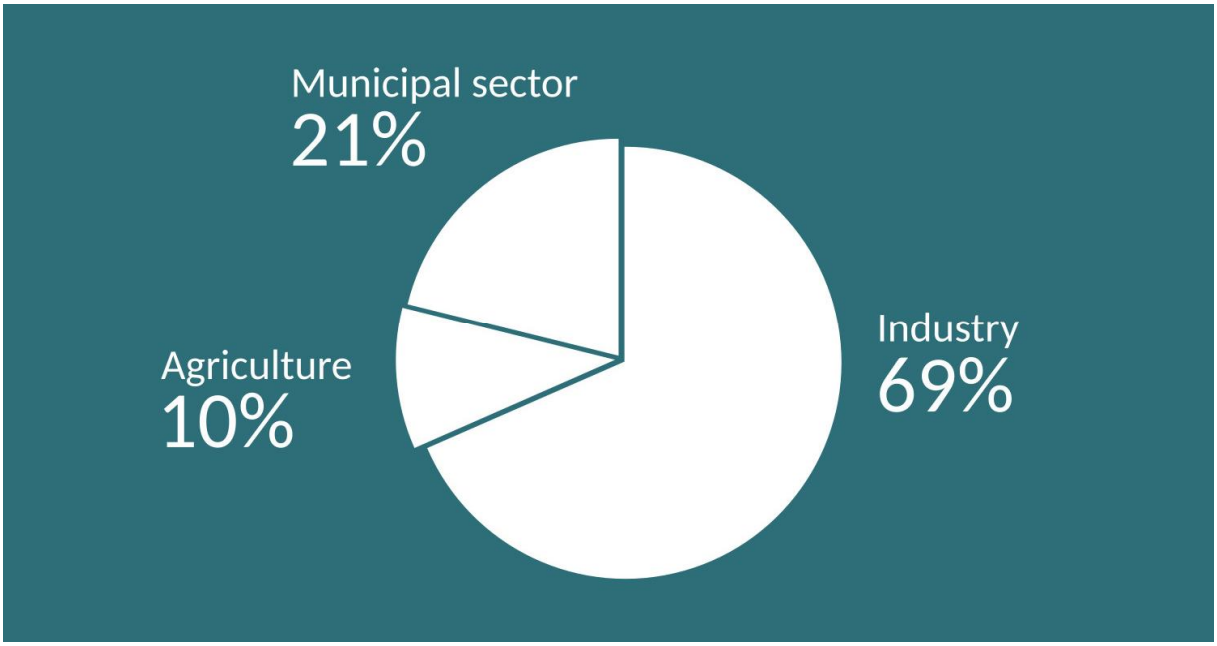
[109]Reply to a parliamentary question regarding the increase in water service fees, granted by the Undersecretary of State at the Ministry of the Environment, Mr Mariusz Gajda, 12.07.2017, ref. no. DZW-I.070.48.2017.SW, www.sejm.gov.pl (accessed: 30 Sep 2019).

[110]Regulation Impact Assessment, [in:] *Government bill on Water Law*, Sejm of the 8th term, document no. 1529, Warsaw 2017.

[111]Public Finance Act of 27 August 2009 (Dz.U. 2019, item 869).

regional demand for water services, the efficient use of water resources is crucial for society and the economy.

The insufficient effectiveness of water resources usage in Poland is noticeable. This problem was one of the reasons behind the introduction of the new Water Law[112], which reforms water management. Provisions on the need to improve the efficiency of water resources use are also included in the National Water and Environmental Programme update (NWEPu). EU programmes are also working towards increasing the efficiency of water resources use[113].



Ryc. 7 Water Abstraction Share in Poland for National Economy and Population Needs in 2018. (source: Environmental Protection in 2018, Central Statistical Office of Poland, Warsaw 2019, p. 1).

The problem of low efficiency of water resources usage leads to their excessive use compared to the demand, which is particularly evident in issues related to the amount of water abstracted and its transfers. Excessive use of water may lead to failure to maintain the quality parameters, while failure to effectively treat wastewater may have a negative impact on the achievement of environmental objectives.
Water in Poland is used (collected) mainly by industry (ca. 70%), for municipal purposes and for agriculture[114].

[112] *Statement of grounds for the government bill on Water Law*, Sejm of the 8th term, document no. 1529 pt. 1, Warsaw 2017, p. 2.

[113] See description of possible use of financial resources in the NWEPu [in:] *Update of the National Water and Environmental Programme [Aktualizacja Progrmau Wodno-Środowiskowego Kraju]*, Warsaw 2016, pp. 43–61.

[114] Source: GUS data.

Most water services in Poland are related to providing access to water for these three groups of users, as well as directly to abstraction for electricity generation purposes. The problem of efficiency of water resources usage was analysed in these three areas, with special consideration of energy in the industrial sector (i.e. demand for electric and thermal energy, as this is responsible for nearly 90% of abstraction for industrial purposes[115]) and land reclamation in agriculture.

In the case of water supply for municipal purposes, there are losses in the water supply network at the level of 16% to 25% (according to various sources[116]) for rural areas and for over 10% for cities. This leads to an increased level of water services for municipal water abstraction.

This situation results from the insufficient level of investments in the modernisation of the water supply system. In 2018, the Minister of Maritime Economy and Inland Navigation addressed the issue of water supply for the population by setting up an advisory team on the collective water supply and discharge of wastewater[117].

When introducing changes in the Act on the collective water supply and discharge of wastewater[118], a new price regulator was established for water and collective wastewater discharge – the director of the regional water management board of State Water Holding Polish Waters. As a result, the functions of communes and cities in the area of water and sewage pricing (owner, regulator and representative of service users) were separated. As a consequence, the prices of services in the local monopoly market were verified. This should result in more rational spending of funds concerning water supply and sewage disposal. It may be assumed that the low efficiency of water supply systems will improve.

As for water use by the population, Poland is ranked among the European average. However, it may be pointed out that low environmental awareness leads to irrational water consumption[119]. In drought periods, this is reflected in the appeals of water suppliers (municipal companies) for rational water usage.

Analysing industry efficiency, including energy efficiency, which is the economic area with the highest demand for water, it can be pointed out that inadequate efficiency of operations leads to increased demand for water services. In its Strategy for Responsible Development[120], the Polish government presented the main problems related to national economy. One of them pertains to electric energy

[115]Data for 2017 [in:] *Environmental Protection 2018 [Ochrona Środowiska 2018]*, www.stat.gov.pl (accessed: 30 Sep 2019), p. 59.

[116] Information about inspection results: *Implementation of collective water supply for the inhabitants of rural communes*, NIK 2018, Registration No. 186/2017/P/17/107/LZG, p. 26.

[117] Order No. 30 of the Minister of Maritime Economy and Inland Navigation of 5.09.2018 on the establishment of an advisory team for collective water supply and discharge of wastewater (Dz.Urz. MGMiŻŚ item 30).

[118] Act of 27 October 2017 amending the Act on the collective water supply and discharge of wastewater and certain other acts (Dz. U. 2017 item 2180).

[119] The problem of low environmental awareness was raised in the 2008 IP Review.

[120]Strategy for Responsible Development until 2020 (with a perspective until 2030), Warsaw 2017, pp. 321–324.

supply. The document states that the efficiency of energy production and transmission is insufficient and that action is needed to improve the situation.

Both indicated areas concern mainly surface water abstraction. Groundwater is also collected by water supply companies. Insufficient effectiveness of company operations and individual customers of water supply services may impact the volume of water resources. However, improvement in this area requires investment outlays.

Reclamation facilities, i.e. infrastructure which enables water management for agricultural purposes, also requires a lot of investment. Its effectiveness is incompatible with increased agricultural production and challenges the farmers who benefit from it.

There are many reasons for the inadequate efficiency of water resources use, however the following should be indicated in particular:

- low level of investment in the national economy,
- low awareness of possible technical solutions for improving operational efficiency.

It may be expected that the introduction of water service fees can provide an incentive for investment and modernisation of infrastructure and water usage systems to match the consumption to actual demand, thereby improving the efficiency of water usage.

2.5.2 PROBLEM OF FINANCING SOURCES

As a rule, water management is publicly funded. There are virtually no private investments in this area. Moreover, there is a multitude of potential financing sources for activities in the area of water protection and achievement of environmental objectives.
Water management plans and programmes tie activities to very different, often unrelated, sources of funding.

In addition, investments in this respect compete for financing sources with activities from other environmental areas, which are more aimed at achieving environmental objectives. Due to the achievement of effects in various areas (e.g. flood protection, transport, drought prevention, water supply, natural retention, etc.), water management programmes have difficult access to financing under EU programmes which are aimed at achieving effects in one sector. There are no sources of financing (apart from budgetary resources) which would directly and comprehensively concern the protection of the water environment.

The analysis of the progress in the implementation of measures to improve the water environment in Poland[121] revealed that one of the significant reasons for ineffective implementation of measures is the lack of financial resources or shortage of resources allocated to investments. This is of great importance, especially since the value of investment activities is increasing and the demand is not dropping. As a consequence, delays in the implementation of measures occur, and consequently, the improvement of water quality is slower. Investment and expenditure needs (e.g. for maintenance), defined in subsequent updates of planning documents, are constantly growing. The increasing costs

[121] *Assessment of progress in the implementation of action programmes for SWBs and GWBs resulting from the NWEPu [Ocena postępu we wdrażaniu programów działań dla JCWP i JCWPd wynikających z aPWŚK]*, Gliwice 2018, p. 78.

of maintaining the facilities themselves should also be added to the demand for funding. This results in an increasing demand, and it should be pointed out that the problem of funding was raised also in the previous IP review. Some improvement in this area should be sought in the functioning of water service charges.

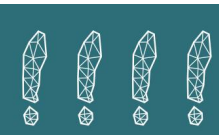
As regards the causes of the discussed problems of financing water management, the following should be indicated:

- low rate of return on investments;
- the previous low value of activities and investments in water management – long-term deficiencies;
- low level of public awareness regarding the necessity of incurring expenses on the protection of water, water environment and water-dependent environment;
- inadequate water charges for services.

3 SIGNIFICANT PROBLEMS IN INDIVIDUAL RIVER BASIN DISTRICTS

3.1 THE VISTULA RIVER BASIN DISTRICT

3.1.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS



Atmospheric deposition

VERY SIGNIFICANT

Exceeding the limit values of environmental quality standards for PAHs in a significant number of SWBs and for heavy metals in a large number of SWBs (lead, mercury, cadmium, nickel) monitored in the current planning cycle (no improvement compared to the previous cycle), caused by fossil fuel combustion, low emissions[122], transport, industrial emissions, the existence of large industrial centres[123] (e.g. Upper Silesian Industrial Region, Lublin Industrial Region, Warsaw Industrial Region). Industrial plants from the mining, metallurgy, power, machinery and chemical sectors are located within the basin area. Exceeding of limit values is noted for pollutants from atmospheric deposition in individual GWBs (e.g. benzo(a)pyrene) which, however, do not contribute to deterioration and risk of failing to achieve good status. Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in a large number of SWBs (in the previous planning cycle – insufficient data in the new cycle). Low level of biological elements sensitive to eutrophication.

[122] Airborne pollutants discharged up to 40 m high from domestic stoves and local boiler plants as a result of inefficient combustion of coal, poor quality of fuels, sometimes also waste incineration and vehicle traffic.

[123] M. Kubiak, *Polycyclic aromatic hydrocarbons (PAHs) – their occurrence in the environment and in food [Wielopierścieniowe węglowodory aromatyczne (WWA) – ich występowanie w środowisku i w żywności]*, Problemy Higieny i Epidemiologii, 2013/94(1), pp. 31–36.

In the Little Vistula water region, the limit values for heavy metals (lead, mercury, cadmium, nickel) and PAHs have been exceeded in a significant number of SWBs monitored in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport, industrial emissions, and the presence of large industrial centres (Upper Silesian Industrial Region). Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in a large number of SWBs (in the previous planning cycle – insufficient data in the new cycle). Low level of biological elements sensitive to eutrophication.

In the Upper-Western Vistula region, the limit values of heavy metals and PAHs have been exceeded in a significant number of SWBs monitored in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport, and industrial emissions.

In the Upper-Eastern Vistula water region, the limit values of PAHs (mainly benzo(a)pyrene) have been exceeded in a significant number of SWBs monitored in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport and industrial emissions. Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) – the limit values of various indicators have been exceeded in a large number of SWBs.

In the Central Vistula water region, the limit values for PAHs (mainly benzo(a)pyrene and fluoranthene) have been exceeded in a significant number of SWBs monitored in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport, and industrial emissions. Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in a large number of SWBs.

In the Bug water region, the limit values for PAHs (mainly benzo(a)pyrene) have been exceeded in a significant number of SWBs monitored in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport and industrial emissions. Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen), whose limit values have been exceeded for part of the SWBs.

In the Narew water region, the limit values for PAHs (benzo(a)pyrene, fluoranthene), among others, have been exceeded in a significant number of SWBs monitored in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport and industrial emission.

In the Lower Vistula water region, the limit values for PAHs, among others, have been exceeded (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport, and industrial emissions. Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in part of SWBs.

SIGNIFICANT

Industrial wastewater (over 2,000 discharge points) discharged to nearly 1,000 SWBs.

Exceeding of concentration limits for substances particularly harmful to the aquatic environment in most of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which can be released into the environment also from landfill leachates (more than 330 landfills in the river basin, including at least 140 industrial waste landfills and almost 800 illegal

landfills and wild landfills). The discharge of saline waters resulted in a low evaluation of the parameters associated with this type of pollution in part of the SWBs.

In the Little Vistula water region, the concentration limits of particularly hazardous substances were exceeded in most of the SWBs monitored mainly in the previous planning cycle (lack of sufficient data in the new cycle). A considerable part of SWBs were characterised by low assessment of parameters related to salinity, caused by the discharge of saline waters.

In the Upper-Western Vistula and Upper-Eastern Vistula water regions, concentration limits of particularly hazardous substances were exceeded in most of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment also from landfill leachates. A large number of SWBs was characterised by low assessment of parameters related to salinity, caused by the discharge of saline waters.

In the Central Vistula water region, concentration limits of particularly hazardous substances were exceeded in most of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment also from landfill leachates. The discharge of saline waters resulted in a low evaluation of the parameters associated with this type of pollution.

In the Bug and Lower Vistula water regions, concentration limits of particularly hazardous substances were exceeded in most of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment also from landfill leachates. A considerable part of SWBs were characterised by low assessment of parameters related to salinity, caused by the discharge of saline waters.

In the Narew water region, concentration limits of hazardous substances, particularly brominated diphenyl ethers, were exceeded in most of the river SWBs monitored in the current planning cycle. These compounds may be released into the environment also from landfill leachates.

SIGNIFICANT

Domestic wastewater (over 1,500 discharge points) discharged to over 700 SWBs and municipal wastewater (over 1,600 points) discharged to over 950 SWBs.

A large number of wastewater discharge points. Current exceeding of concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC), among others. Wastewater may also be an important source of nutrients, whose limit values were exceeded in more than half of the monitored SWBs. Low level of biological elements susceptible to eutrophication (especially in lakes). The impact of domestic and municipal wastewater causes poor chemical status in one of the GWBs studied in the current planning cycle, at risk of failure to achieve good status. In addition, pollution from wastewater is recorded in a large number of GWBs which, however, does not affect the reduction of the status and the risk of failure to achieve good status.

The Little Vistula water region contains a large number of wastewater discharge points. Current exceeding of concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC), among others. Wastewater may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication.

The Upper-Western Vistula water region contains a large number of wastewater discharge points which, however, do not translate into significant exceeding of pollutant concentrations of parameters indicating significant wastewater impact.

The Upper-Eastern Vistula, Central Vistula, Bug, Narew and Lower Vistula water regions contain a large number of wastewater discharge points and experience exceeding of concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC), among others. Wastewater may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs in these water regions.

SIGNIFICANT

Agriculture – agricultural land occupies more than 60% of the river basin district (of which more than 70% is arable land).

Area with a large share of arable land and intensive agriculture. Large number of breeding farms. Agriculture emission may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs. Low level of biological elements susceptible to eutrophication (especially in lakes). Agriculture-related pollution is recorded in a large number of GWBs which, however, does not affect the reduction of the status and the risk of failure to achieve good status.

The Little Vistula water region is characterised by a small share of areas used for agricultural purposes. Agricultural emission may have some influence on the concentration of nutrients in the water.

The Upper-Western Vistula water region is characterised by a high share of agricultural areas, including arable land. However, such use does not translate into significant emissions of pollutant concentrations of parameters indicating agricultural origin (e.g. nutrients).

The Upper-Eastern Vistula water region is an area with a relatively small share of agricultural areas. Agricultural emission may, however, contribute to exceeding the limit values in a large number of SWBs.

The Central Vistula water region is an area with a large share of arable land and intensive agriculture. Agricultural emission may also be an important source of nutrients (mainly nitrates) whose limit values were exceeded in a large number of SWBs.

The Bug water region is an area with a large share of agricultural land, including arable land. Agricultural emission may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs.

The Narew water region is an area with a large share of arable land and intensive agriculture. However, this does not translate into significant exceeding of nutrient levels. However, the concentration limits of environmental quality standards of heptachlor, belonging to the group of organochlorine insecticides commonly used in agriculture, were exceeded.

The Lower Vistula water region is an area with a large share of arable land and intensive agriculture. Agriculture emission may also be an important source of nutrients whose limit values were exceeded in a number of SWBs.

MODERATELY SIGNIFICANT

Rearing and farming discharge (over 1,300 discharge points) into almost 600 SWBs.

Numerous instances of exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming (TOC, organic nitrogen, COD), among other things, and poor status of certain SWBs based on the ichthyofauna, which may be due to contamination associated with farming (e.g. pathogens).

The Little Vistula water region is characterised by a very large number of discharge points. Numerous instances of exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming, among other things.

The Upper-Western Vistula water region contains a large number of discharge points which, however, do not translate into significant exceeding of pollutant concentrations of parameters indicating significant wastewater impact. However, low evaluation based on the condition of the ichthyofauna may indicate another type of impact related to farming (e.g. pathogens).

The Upper-Eastern Vistula water region contains a large number of discharge points. Numerous instances are noted of exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming, among other things.

The Central Vistula water region has a large number of discharge points. Instances of exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming (TOC, organic nitrogen), among other things, are noted in the region. Emission from fish rearing and farming may also be an important source of other nutrients (including nitrates, phosphates) whose limit values were exceeded in a large number of SWBs.

The Bug water region has a large number of discharge points. Instances of exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming (TOC, organic nitrogen), among other things, as well as poor status based on the ichthyofauna, are noted in the region.

The Narew water region contains a large number of discharge points. Numerous instances are noted of exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming (TOC, COD), among other things.

The Lower Vistula water region contains a large number of discharge points which does not translate into significant exceeding of concentration limits for physicochemical indicators that could indicate fish rearing and farming (TOC, COD), among other things.

3.1.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

VERY SIGNIFICANT

Evaluation of the current passability of rivers in terms of the potential migration of bi-environmental fish species.

The Vistula river basin is a habitat for all bi-environmental fish and lamprey species recorded in Poland. The gorge sections of lower and central Vistula, Narew and Bug, lower sections of the larger upland tributaries, such as Drwęca, San z Wisłokiem, Wisłoka, Dunajec, Raba, Soła and Skawa, are historical spawning grounds of sturgeons. The higher located sections of the Vistula river with its gravel bed Subcarpathian tributaries of lower order, as well as Drwęca, Wierzyca, Wda and Brda are salmon, sea trout and vimba spawning grounds. Vimbas also spawned in the Bug, Narew and Pilica basins and in their tributaries. An important spawning ground for salmon and sea trout include also rivers flowing directly into the Baltic Sea or the Vistula Lagoon: Pasłęka, Bauda, Łeba, and Słupia. These rivers also include spawning grounds for the river lamprey, which historically also occurred in other rivers of the lower and central Vistula river basin. The spawning of the sea lamprey, on the other hand, took place in the lower sections of the coastal rivers, the Vistula and the tributaries of the Vistula Lagoon. Meanwhile, the river basins and lakes of the Mazurian Lake District [Pojezierze Mazurskie], as well as the entire systems of lowland and upland rivers of central and south-eastern Poland served as feeding and growth grounds for eels, which reached those places through a river network connecting to the sea and which used those rivers to travel to the sea for spawning as adults.

Currently, the state of the watercourse damming in the Vistula river basin is significant – 8,861 barriers higher than 1 m (5 dams per one SWB) have been identified in total in the Presja Database, whereas the number of weirs and thresholds is much higher. This has a hindering impact on fish migration in the Vistula system – 4,668 out of the total number of barriers lack information regarding fish passes; such information is available for 4,193 barriers (47%), out of which only 125 impoundments (3%) have been fitted with a fish pass, while the remaining ones are permanently or periodically blocked for passing of fish and other aquatic organisms. For this reason, the insufficient knowledge about the condition of river bulkheads in the Vistula system and the low share of bulkheads made passable by fish passes should be considered a serious problem.

The Włocławek barrage plays a crucial role in the preservation of passability in the Vistula river system. The modernisation of the barrage pass, conducted in 2011–2014, allowed for partial passability of the central and upper Vistula system for the salmon, sea trout, vimba and probably for the river lamprey; however, sturgeon migration through is still impossible through the existing fish pass due to its technical parameters. Therefore, it is necessary to build a semi-natural fish pass in the form of a bypass of the Wloclawek barrage, which would meet the migration requirements for sturgeon, as well as to adapt the navigation lock for fish migration. Such a comprehensive solution, combined with the already modernised vertical-slot fish pass, may ensure sufficient passability of the Włocławek dam for all bi-environmental fish species for which linear continuity in this section of the Vistula is required[124]. Restoring full passability of the Vistula river in Włocławek and ensuring such

[124] J. Błachuta et al., *Assessment of the needs for restoring morphological passability of rivers from the perspective of the pursuit of good status and potential of water bodies in Poland [Ocena potrzeb udrożnienia*

passability for the planned barrage below Włocławek (construction of two fish passes and a semi-natural bypass adapted to sturgeon migration is projected) constitutes a very important problem in the area of restoring migration paths for bi-environmental fish in the central and upper Vistula river basin (migration corridor of crucial importance).

SIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

Like in the whole country, most of the RBMPu investments planned in the Vistula river basin, covered by the derogation under Article 4(7) of the WFD, are classified as "Regulation and maintenance works" (224 SWB). An area with significant accumulation of investments in this category is the Little Vistula water region (23 SWB), where regulation or reconstruction of the riverbed is planned along significant sections. Therefore, the scale of the planned works in this region may lead to the accumulation of impacts on the entire river network, hence the assessment of the problem as very significant. Meanwhile, in the much larger Upper Vistula and Central Vistula water regions 69 and 92 SWBs were indicated respectively, with derogations due to regulation works, which indicates that the problem in these areas is of a moderately significant nature. In the Lower Vistula water region, the concentration of works in this category is even lower (43 SWB), which indicates that the problem is insignificant. This is due to the nature of lowland rivers, which pose less risk of flooding and, therefore, less need for interference with river systems. In the Vistula river basin, regulation or maintenance works are in progress or planned to be carried out in 106 SWBs (47% of the planned ones), as indicated above, mainly in the Little Vistula and Central Vistula water region. This indicates that the problem in the overall river basin is significant. However, it should be stressed that the implementation of works in accordance with the principles of good practice may limit their negative effects or even contribute to the implementation of positive pro-environmental measures in already regulated rivers.

The construction of reservoirs requires more individual analysis due to the different parameters of the planned facilities. In this respect, derogations under Article 4(7) of the WFD are projected for 57 SWBs in the Vistula river basin, including: 1 for Little Vistula, 21 for Upper Vistula, 32 for Central Vistula and 3 for Lower Vistula. Taking into account the concentration of the planned investments and the significant scale of river ecosystems transformation through the construction of reservoirs, it may be pointed out that the problem is of a significant nature in the Upper and Central Vistula water regions, whereas in other regions it is insignificant. This stems from the cumulative impact of reservoirs on migrating fish. This impact is related to changes in physicochemical conditions of water, increased predation (e.g. birds) or mortality rate of fish flowing downstream through turbines of a hydroelectric power plant installed on the ponding. The problem of migration passability of the Vistula river in Włocławek is of supra-regional importance due to the role of the river as a key migratory corridor for bi-environmental fish. The Wisłoka reservoir (Kąty-Myscowa) may also be deemed a significant problem due to the importance of the upper course of the river for bi-environmental fish and local populations of protected species. The construction of reservoirs in the Vistula river basin is ongoing or planned for 23 SWBs (40% of the planned ones), mainly in the Upper

ciągłości morfologicznej rzek w kontekście osiągnięcia dobrego stanu i potencjału części wód w Polsce], Warsaw 2010.

Vistula and Central Vistula water regions. Considerable environmental interference during the construction of reservoirs indicates the significance of this problem within the river basin.

Weir construction is provided for in 14 SWBs, mostly on less important watercourses. The problem is not significant due to the low number of objects in the catchment area. Exceptions include two weirs ponding water for power engineering purposes (on the Vistula and Narew), for which the problem is of a significant nature due to the importance of large rivers as fish migration routes. Overall, weirs are planned for 8 SWBs (57% of the planned ones), which justifies classifying the problem as moderately significant to the Vistula river basin.

The construction of dry reservoirs and polders has little impact on the habitat conditions of ichthyofauna and invertebrate fauna. A properly designed dry reservoir dam does not create a migration obstacle except for occasional periods of filling the reservoir after freshets; however, some morphological changes are introduced in the river bed within the reservoir basin (deforestation of banks) and downstream (reinforcement of bank sections). In the Vistula river basin, derogation under Article 4(7) of the WFD was indicated only for 2 polders which, however, were not planned for implementation – the problem should be considered as insignificant.

In 4 SWBs in the Vistula river basin, derogations for the construction of small dyke sections were indicated – the problem should be considered as insignificant.

Problems in general: The following categories of measures were indicated as significant problems in the Vistula river basin: "Regulation and maintenance work" and "Reservoir construction". The construction of weirs is of moderate significance, with other categories being insignificant. Therefore, the problem of implementation of projects requiring derogation under Art. 4(7) WFD should be recognised as significant in the Vistula river basin.

Insufficient potential for natural retention.

SIGNIFICANT

Insufficient potential for natural retention results in the necessity to carry out hydrotechnical investments interfering negatively with the hydromorphology of rivers; planned restoration investments: Upper Vistula – 32, Central Vistula – 28, Lower Vistula – 3; 73 tasks in total. Environmentally beneficial solutions improving the natural retention in river valleys include also proper maintenance or modernisation of water reclamation facilities (ditches) for controlling water runoff and slowing it down in dry periods (countering droughts), as well as water retention in periods of intense rainfall (limiting flood risk). Żuławy, where the reclamation system is of key significance for maintaining proper hydrographic conditions, is a particularly problematic area in this respect within the Lower Vistula water region.

3.1.3 PROTECTION OF QUALITATIVE SURFACE AND GROUNDWATER STATUS

SIGNIFICANT

Uncontrolled groundwater abstraction for irrigation of arable crops.

Due to the prolonged drought and forecast climate changes – increase in the frequency of droughts throughout the country – the risk of unregistered water abstraction from private wells for irrigation purposes significantly increases. The problem is particularly relevant for catchment areas with low rainfall and high risk of agricultural drought. It is argued that abstraction for irrigation of agricultural crops may, in periods of drought, constitute a significant share of total groundwater abstraction in a balance area.

SIGNIFICANT

Impact of excessive groundwater abstraction on average river flow SQ.

The Little Vistula water region is heavily modified in anthropogenic terms, with numerous hard coal, zinc and lead ore mines, as well as open sand and gravel pits. Runoff from the river catchments in the region is very high (e.g. Rawa, Pogoria), characterised by a high share (over 70%) of industrial and municipal wastewater and pit water from mines.

In the Lower Vistula water region, the problem is assessed as significant. Lowering of the groundwater table of the first level and the main aquifer results from the pressure associated with intensive reclamation of Żuławy Wiślane and the creation of cones of depression within large agglomerations. When river flows are shaped by underground supply, pressures accumulate which, even in conditions of non-returnable, acceptable abstraction, may result in the disappearance of sectional river flow. This risk will not take place with a large return of the collected waters.

SIGNIFICANT

Impact of maximum abstraction from guaranteed resources on inviolable flows.

In the case of a maximum allowable non-returnable groundwater abstraction, the average annual groundwater flow may fall below the inviolable flow.

In the Little Vistula water region, the problem is assessed as significant. The influence of groundwater abstraction on the inviolable flow of surface water reveals a strong dependency on the degree of return of used water to the hydrographic system of the catchment area. The risk of failure to achieve the inviolable flow may occur in low-water conditions, when rivers are supplied by groundwater, as well as during maximum allowable non-return flow when <25% of used water is discharged into the system.

In the Upper Vistula water region, the problem is assessed as moderately significant. In the case of non-returnable maximum abstraction during droughts, the seasonal inviolable flow will not be able to be maintained by underground water supply to rivers in areas with identified water deficits. Deficits in water supply of land ecosystems dependent on groundwater may occur in the northern part of the Upper Vistula water region[125].

In the Central Vistula water region, the problem is assessed as significant. The maximum allowable non-return abstraction of groundwater may result in the loss of river flow in periods of significant low-water levels during drought. Three areas with the longest lasting hydrogeological low water are located in the region, which qualifies them as areas with the highest risk of negative effects of potential changes in the groundwater table location.

In the Lower Vistula water region, the problem is assessed as significant. Lowering of the groundwater table of the first level and the main aquifer results from the pressure associated with intensive reclamation of Żuławy Wiślane and the creation of cones of depression within large agglomerations. When river flows are shaped by underground supply, pressures accumulate which, even in conditions of non-returnable, acceptable abstraction, may result in the disappearance of sectional river flow. This risk will not take place with a large return of the collected waters.

SIGNIFICANT

Impact of excessive surface water abstraction for crop irrigation on inviolable flow during long-term low water levels.

Excessive abstraction of surface waters from watercourses for agricultural purposes, often unregistered , carried out by local ponding of water, may pose a significant threat to inviolable flows in SWBs, especially during hydrological drought.

SIGNIFICANT

Formation of depression cones in main usable aquifers groundwater of regional span.

Decreasing the permeable surface of the catchment areas within large agglomerations means that 70–90% of rainwater runs off[126] without supplying groundwater, while excessive water abstraction leads to the lowering of the water table

[125] *Characteristics of the Upper Vistula water region [Charakterystyka regionu wodnego Górna Wisła]*, www.krakow.rzgw.gov.pl (accessed: 14 Oct, 2019).

[126] W. Bartnik, J. Bonenberg, J. Florek, *Effect of a catchment area losing its natural soil retention capacity on the morphological characteristics of the catchment area and of water courses [Wpływ utraty naturalnej retencji zlewni na charakterystykę morfologiczną zlewni i cieku]*, Polish Academy of Sciences (PAN), Countryside Infrastructure Committee, Kraków 2009.

Significant in the Little Vistula water region. The occurrence of regional depression cones was documented, resulting from excessive utilisation of groundwater resources – over 75%. The problem concerns in particular the Upper Silesian urban and industrial agglomeration.

Significant in the Upper Vistula water region; high groundwater abstraction for municipal purposes, intensive groundwater abstraction related to drainage of mining excavations – numerous opencast mines of rock raw materials, changes in the location of the groundwater table in the protected areas.

Significant in the Central Vistula water region; three areas with the longest lasting hydrogeological low water are located in the region, which qualifies them as areas with the highest risk of negative effects of potential changes in the groundwater table location; documented depression cones in main usable aquifers caused by excessive water abstraction for municipal and industrial purposes.

Significant in the Lower Vistula water region; lowering of the groundwater table of the first level and the main aquifer in Żuławy Wiślane as a result of accumulative pressure (reclamation and water abstraction); depression cones caused by excessive water abstraction for municipal and industrial purposes within large agglomerations.

SIGNIFICANT

Risk of 4 types of drought (atmospheric, agricultural, hydrological and hydrogeological).

Intensive and very intensive use of surface waters occurs in 36% of the Vistula river basin. For 25.36% of the area, intensive use of available surface water resources was determined , i.e with a clear pressure on the sustainability of resources, which means water exploitation at the level of maximum resource availability. For 11.5% of the river basin district, exploitation exceeds the quantity of water resources[127].

In 13.21% of the river basin, it was impossible to meet the needs of users, including ecosystemic ones, during hydrological drought[128].

Moreover, a very high and high percentage of areas at risk of various types of drought has been identified in the river basin. 37% of the river basin district was identified as significantly and extremely at risk of agricultural drought. 36.1% of the areas are significantly and extremely at risk of hydrological drought, with 62% at moderate risk. More than 28% of the river basin district is moderately threatened by hydrogeological drought.

Areas with significant risk of hydrological drought cover 77% of the Lower Vistula water region, with 14.5% of the area[129]at highest risk of hydrological drought.

[127]*Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy]*, Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

[128]*Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy]*, Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

[129]*Development of a draft Plan for drought prevention in the Lower Vistula water region, including the indication of the areas most exposed to its effects [Opracowanie projektu Planu przeciwdziałania skutkom suszy w regionie wodnym Dolnej Wisły wraz ze wskazaniem obszarów najbardziej narażonych na jej skutki]*, Mędłów 2015, www.rzgw.gda.pl (accessed: 14 Oct 2019).

Risk of drought resulting from climate change.

SIGNIFICANT

When assessing the risk of climate change-related drought, available materials were analysed related to the phenomenon of drought and the assessment of drought risk in particular water regions in the context of projected precipitation changes. For a large part of Poland, a decreasing trend of annual precipitation sums with a simultaneous increase in air temperature is predicted, which constitutes an increase in the risk of agricultural and hydrological drought. Due to the projected increase in average air temperature and the increase in the frequency of heat waves in spring and autumn, as well as changes in the nature of precipitation (> torrential rains), the frequency of droughts and their duration in Poland will increase significantly. Currently, a drought occurs every 2–3 years, while the hydrological drought has been intensifying since 2015. However, drought effects are more acute in regions under strong pressure[130].

More than 69% of the river basin district is moderately threatened by hydrological drought, with 21% including areas with significant threat by this type of drought[131].

In the Little Vistula water region, the problem has been assessed as significant. Zones at risk of drought occur within the entire described area.

Areas at risk of drought occur in almost the entire described area in the Upper Vistula water region, with the Precarpathian Foredeep being most at risk[132]. During the 2011 drought in the Kraków PGW WP RZGW, a decrease in watercourse levels or the total disappearance of smaller watercourses were observed in 76% of the region, i.e. in 361 communes, with total decline (course with no water) reported in 57 communes (12%), significant lowering (no possibility of water abstraction) noted in 87 communes (18%) and noticeable decrease (limited water abstraction possibility) recorded in 274 communes (57%). 70% of communes experienced considerable decrease in groundwater level (necessity to limit water abstraction), with total decline observed in 26 communes, i.e. 6% (water decline in farmstead wells). As for the remaining communes (116 communes, i.e. 24%), no lowering of groundwater table was observed[133].

The risk of drought occurs in nearly the entire discussed area within the Central Vistula water region.

The risk is significant in the Lower Vistula water region. Zones at risk of drought occur within the entire described area. Extreme precipitation deficits were recorded in almost all areas of the PGW

[130]S. Horska-Schwarz et al., *Drought or flood? How to adapt to climate changes through small retention and protection of biodiversity [Susza czy powódź? Poradnik adaptacji do zmian klimatu poprzez małą retencję i ochronę bioróżnorodności]*, Legnica 2018.

[131]*Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy]*, Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

[132]*Characteristics of the Upper Vistula water region [Charakterystyka regionu wodnego Górna Wisła]*, www.krakow.rzgw.gov.pl (accessed: 14 Oct, 2019).

[133]*The phenomenon of drought in the area of activity of the Regional Water Management Board in Kraków in 2011 [Zjawisko suszy na obszarze działania RZGW w Krakowie w 2011 r.]*, Kraków 2012, www.krakow.rzgw.gov.pl (accessed: 14 Oct 2019).

WP RZGW in Gdańsk. 15.6% of the entire Lower Vistula water region includes areas at high risk of atmospheric droughts. The dominant share (65.6%) is held by areas at very high risk of drought, with 18.8% of the region at moderate risk of atmospheric drought. Atmospheric drought of the highest intensity occurs in the north-western and north-eastern parts of the area. The largest precipitation deficits in the past were recorded in the areas of the Koszalin Coastal Region [Pobrzeże Koszalińskie] (Słowińskie Coast [Wybrzeże Słowińskie], Żarnowiec Upland [Wysoczyzna Żarnowiecka] , Reda-Łeba Ice-Marginal Valley [Pradolina Redy-Łeby], Damnica Upland [Wysoczyzna Damnicka], Polanowska Upland [Wysoczyzna Polanowska]), in the northern part of the Kashubian Lakeland [Pojezierze Kaszubskie], the Hel Peninsula [Mierzeja Helska], the northern part of the Kashubian Coastal Region [Pobrzeże Kaszubskie], parts of: the Staropruskie Coast [Wybrzeże Staropruskie], the Górowski Hills [Wzniesienie Górowskie], Warmińska Plain [Równina Warmińska], Elbląg Upland [Wysoczyzna Elbląska]. The most extreme precipitation deficits were recorded in the balance catchment areas of: Wierzyca, Słupia, Łupawa, Reda and Piaśnica, Pasłęka and Bauda. Based on multiannual data, it was indicated that the biggest atmospheric droughts occurred in the balance catchments of: Vistula from the tributary from Bogucin to Wda, Słupia, Łupawa, Łeba.

Exposure to drought effects in the navigation industry.

SIGNIFICANT

River flows reflect hydrological drought, which is a consequence of prolonged atmospheric drought and soil drought. In conditions of prolonged drought, sub-transit depths may occur in all waterways. In order for water transportation to function properly, it is necessary not only to maintain suitable infrastructure, but also to maintain a specified water status, decrease the rate of water runoff from agricultural and urban catchment areas, improve the retention of catchment areas in mountain, agricultural and built-up areas.

Exposure to drought effects in the agricultural sector.

SIGNIFICANT

A considerable part of the river basin is located in an area with significant risk of atmospheric and hydrological drought. Low water levels in the Vistula river basin occur usually in early spring (January, February, March) and autumn (September-November). The emergence of low-level flows may hinder the abstraction of surface water for agricultural purposes.

In the Upper Vistula water region, the problem has been assessed as significant. The phenomenon of atmospheric and hydrological drought is intensified by pressure related to excessive groundwater abstraction: depression cones most frequently formed as a result of intensive exploitation of groundwater for municipal purposes (1 GWB), mine drainage (4 GWBs).

In the Lower Vistula water region, the problem has been assessed as significant. A large share of areas which react to rainfall deficits the strongest and are susceptible to agricultural losses. 26 communes covering more than 75% of the Lower Vistula water region is at high risk of atmospheric drought, out of which 15 are completely (100%) within reach of the strongest threat. Approximately

70% of arable land within the Lower Vistula water region is under the influence of high and strong drought risk. Negative effects of atmospheric drought are recorded in the balance catchment areas of: Wda, Reda, Wierzyca, Łeba.

SIGNIFICANT

Exposure to drought in the natural environment and biodiversity.

The extensive share of years with drought experienced in the Vistula river basin as well as the hydrological drought extended since 2015, create a big risk for the achievement of environmental objectives for SWBs. The negative impact of low flows in watercourses on the ecological status of rivers and water-dependent habitats is significant, and the situation is aggravated by the high demand for water in drought periods. Water abstraction for agricultural purposes, especially unregistered abstraction from surface waters, poses a threat to inviolable flow. Water-dependent ecosystems and areas under conservation are most vulnerable to hydrological drought. The occurrence of low-water levels in courses supplied by groundwater poses a threat to inviolable flow in a significant part of the river basin. In water regions with high anthropogenic pressure associated with groundwater and surface water abstraction, the negative effects of drought will accumulate.

In the Lower Vistula water region, the problem has been assessed as significant. Particularly vulnerable water-dependent areas are located in the northern and central-western part of this water region, in balance catchment areas of: Łeba, Wierzyca, Reda and Piaśnica, Radunia and Motława, Vistula from the tributary from Bogucin to Wda, Elbląg and Żuławy Elbląskie.

SIGNIFICANT

Water abstraction and drainage of mining areas.

The phenomenon of water transfers between catchment areas as a result of mine activity, drainage abstraction of waters and discharge of mine water and wastewater into rivers, often within other catchment areas. The problem is that the available resources are exceeded on an annual scale due to drainage abstraction.

MODERATELY SIGNIFICANT

Degree of utilisation of groundwater resources.

In the Little Vistula water region, the problem is assessed as significant. A deficit of guaranteed resources has been identified here. The degree of current resource utilisation >100% includes the balancing area: GLIII, a very high resource utilisation rate of 90–100% covers the area: GL II.

Considering the projected abstraction for the region, 45% of the area will be affected by lack of reserves (deficit), with 22% at risk of deficit.

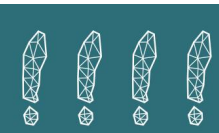
In the Upper Vistula water region, the problem is assessed as moderately significant. The utilisation rate of guaranteed resources is 50–60%. Given the current abstraction, two water economy regions (K03/E, K05/E) are at risk of a deficit of guaranteed resources. Considering the projected abstraction for the region, 3% of the area will be affected by lack of reserves (deficit), with 1% at risk of deficit.

In the Central Vistula water region, the problem is assessed as moderately significant. Actual groundwater abstraction amounts to ca. 17.5% of the region's guaranteed resources. The abstraction is forecast at ca. 20%. The highest groundwater abstraction – equal to or exceeding the guaranteed resources – were recorded in the Bzura catchment area, the Bystrzyca catchment area, the lower Kurówka catchment area and the Sulejów reservoir. High water abstraction for municipal and industrial purposes.

In the Lower Vistula water region, the problem is assessed as significant. Current (actual) groundwater abstraction amounts to ca. 17% of the region's guaranteed resources. A deficit of groundwater resources may occur in the G-18 balance area (the Reda, Piaśnica Zagórska Struga, Płutnica and Kacza catchment areas), covering part of the groundwater intakes supplying the Tri-City, in the G-18/E area (the Kacza and Potok Oliwskiego catchment areas), where the current abstraction makes full use of the long-standing groundwater resources.

3.2 THE ODER RIVER BASIN DISTRICT

3.2.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS



Atmospheric deposition.

VERY SIGNIFICANT

Exceeding the limit values for heavy metals (including mercury, lead) and PAHs (including benzo(a)pyrene) in a significant number of SWBs studied in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport, industrial emissions (presence of large industrial centres, including the Kędzierzyn-Koźle region, the Upper Silesian Indistrual Region, the Rybnik Coal Area, the Piotrków-Bełchatów Industrial Area, the Konin Mining and Power District, the Poznań Industrial Region, the Legnica-Głogów Copper District, mining plants: Lubin, Rudna, Polkowice-Sieroszewice). Exceeding of limit values is noted for pollutants from atmospheric deposition in individual GWBs (e.g. benzo(a)pyrene) which, however, do not contribute to deterioration and risk of failing to achieve good status. Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication in SWBs (especially in lakes).

Upper Oder water region: exceeding the limit values for heavy metals and PAHs in a large number of SWBs studied in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport, industrial emissions (concentration of environmentally burdensome sectors in the area of Kędzierzyn-Koźle, the Upper Silesian Indistrual Region, the Rybnik Coal Area). Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in a large number of SWBs.

In the Central Vistula water region: the limit values for heavy metals and PAHs have been exceeded in a significant number of SWBs monitored in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport, industrial emissions, and the presence of large industrial centres (Legnica-Głogów Copper District, mining plants: Lubin, Rudna, Polkowice-Sieroszewice). Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication.

Warta water region: exceeding the limit values for heavy metals and PAHs in a large number of SWBs monitored in the current planning cycle (no improvement compared to the previous cycle) due to fossil fuel combustion, low emissions, transport, industrial emissions, the presence of three large industrial areas (Piotrków-Bełchatów Industrial Area, Konin Mining and Power District, Poznań Industrial Area). Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication.

Noteć water region: exceeding the limit values of PAHs (mainly benzo(a)pyrene) in a significant number of SWBs monitored in the current planning cycle due to fossil fuel combustion, low emissions, transport, industrial emissions. Individual exceeding of other hazardous substances. Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in part of SWBs. Low level of biological elements sensitive to eutrophication.

Lower Oder and West Przymorze water region: exceeding the limit values (mainly PAHs, mercury) in a significant number of SWBs monitored in the current planning cycle due to fossil fuel combustion, low emissions, transport, industrial emissions. Atmospheric deposition may also be an additional source of nutrients (mainly nitrogen) whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication.

VERY SIGNIFICANT

Domestic wastewater (over 1,500 discharge points) discharged to over 550 SWBs and municipal wastewater (over 800 points) discharged to over 600 SWBs.

A large number of wastewater discharge points. Numerous instances of exceeding concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC, organic nitrogen, phosphorus). Wastewater may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs. Low level of biological elements susceptible to eutrophication (especially in lakes). The impact of domestic and municipal wastewater causes poor chemical status in one of the GWBs studied in the current planning cycle, at risk of failure to achieve good status. In addition, pollution from wastewater is recorded in a large number of GWBs which, however, does not affect the reduction of the status and the risk of failure to achieve good status.

Upper Oder water region: large number of wastewater discharge points. Exceeding of concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC), among others. Wastewater may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs.

Central Oder water region: a large number of discharge points. Exceeding of concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC, ammonia nitrogen), among others. Wastewater may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs.

Warta water region: large number of wastewater discharge points. Numerous instances of exceeding concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC), among others. Wastewater may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication (especially in lakes).

Noteć water region: a large number of wastewater discharge points. Numerous instances of exceeding concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC), among others. Wastewater may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication (especially in lakes).

The Lower Oder and West Przymorze water region: a large number of wastewater discharge points. Numerous instances of exceeding concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC), among others. Atmospheric deposition may also be an important source of nutrients whose limit values were exceeded in part of SWBs. Low level of biological elements sensitive to eutrophication (especially in lakes).

SIGNIFICANT

Industrial wastewater (over 1,200 discharge points) discharged to over 700 SWBs.

Exceeding of the concentration limits of particularly hazardous substances in most of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment also from industry and from landfill leachates (more than 940 landfills in the river basin, including at least 170 industrial waste landfills and almost 5,000 illegal landfills and wild landfills). Discharge of saline waters in some regions resulted in exceeding the salinity indicators in a SWB.

Upper Oder water region: exceeding of the concentration limits of particularly hazardous substances in most of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment also from landfill leachates. The discharge of saline waters resulted in a low evaluation of the parameters associated with this type of pollution in a considerable number of SWBs.

Central Oder water region: a large number of wastewater discharge points. Exceeding of the concentration limits of particularly hazardous substances in all of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment from industry and from landfill leachates. Discharge of saline water by industrial plants, leading to the exceeding of concentration limits in some of the SWBS. Probable impact on the failure to meet the standards for water pH.

Warta water region:exceeding of the concentration limits of particularly hazardous substances in most of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment from the industry and from landfill leachates. Discharge of saline waters which, however, did not cause significant exceeding in SWBs.

Noteć water region: A large number of wastewater discharge points. Exceeding of the concentration limits of particularly hazardous substances in most of the river SWBs monitored in the current

planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment from industry and from landfill leachates.

Lower Oder and West Przymorze water region: A large number of wastewater discharge points. Exceeding of the concentration limits of particularly hazardous substances in most of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment from industry and from landfill leachates.

SIGNIFICANT

Agriculture – agricultural land occupies nearly 60% of the river basin district (of which more than 80% is arable land).

Area with a large share of arable land and intensive agriculture. Large number of breeding farms. Agriculture emission may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication.

The Upper Oder water region: an area with a large share of arable land and intensive agriculture. Agriculture emission may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs. Agriculture-related pollution is recorded in a large number of GWBs which, however, does not affect the reduction of the status and the risk of failure to achieve good status.

Central Oder, Warta, Noteć, Lower Oder and West Przymorze water region: an area with a high share of arable land and intensive agriculture. Agriculture emission may also be an important source of nutrients whose limit values were exceeded in a large number of SWBs. Low level of biological elements sensitive to eutrophication.

MODERATELY SIGNIFICANT

Rearing and farming discharge (2,100 discharge points) into 600 SWBs.

A large number of discharge points. Numerous instances of exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming (TOC, organic nitrogen, COD), among other things, and poor status of certain SWBs based on the ichthyofauna, which may be due to contamination associated with farming (e.g. pathogens).

The Upper Oder water region: a large number of discharge points. Exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming (TOC, organic nitrogen), among other things, and poor status of certain SWBs based on the ichthyofauna, which may be due to contamination associated with farming (e.g. pathogens).

Remaining water regions: numerous instances of exceeding the concentration limits of physicochemical indicators which may come from fish rearing and farming, among other things, pertain to the Central Oder, Warta, Noteć, Lower Oder and West Przymorze water regions.

3.2.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

VERY SIGNIFICANT

Evaluation of the current passability of rivers in terms of the potential migration of bi-environmental fish species.

Like in the Vistula river basin, the Oder river basin is a place where all bi-environmental species recorded in Poland occur. The central and partly upper Oder river course, the lower sections of the larger gravel-bed tributaries (Lusatian Neisse [Nysa Łużycka], Eastern Neisse [Nysa Kłodzka]), as well as the Warta river with Noteć and Drawa constitute potential sturgeon spawning grounds. The migration route of salmon and sea trout has a much larger range: the Oder with Warta, Noteć, Drawa and Gwda, large sections of numerous tributaries (Lusatian Neisse, Ina, Bóbr, Kaczawa, Eastern Neisse, Olza) together with larger gravel bed tributaries of lower order. Pomeranian rivers flowing into the Baltic Sea (Rega, Parsęta, Wieprza) may also serve as spawning grounds for these species. Meanwhile, the vimba, apart from the lower sections of the aforementioned rivers, migrate also into the Barycz. The range of the river lamprey in the Oder system is similar to that of the vimba, while the sea lamprey is sporadically recorded in the coastal floodplains and their tributaries. Eels migrate to all rivers of a more lowland character – up to the upper Oder river and its tributaries, as well as to the Warta system and the Pomeranian lakes connected to the rivers. Due to a smaller degree of damming of main migration routes downstream, the Oder and the Warta rivers are of great importance for the preservation of the eel population in Poland, and adults flowing into the sea contribute to the maintenance of this species' global population.

In the case of the Oder river basin, the key problem is to ensure migration passability for numerous pondings in the middle and upper course: starting from the Malczyce barrage, through the Brzeg Dolny barrage and the Wrocław Floodway System, up to the cascade of more than 20 steps to the mouth of the Olza river, further reservoirs and steps on the tributaries. The fish passes installed on these ponding structures have to be highly efficient in order to ensure that at least part of the fish population can migrate to upstream tributaries where spawning grounds are preserved (e.g. the Kłodzko Valley river). The Lusatian Neisse is also an important route of bi-environmental fish migration; however, currently a smaller historical range of salmon and sea trout is indicated in this river. An important field of activity includes also the maintenance or restoration of the passability of the Warta system with the Noteć and Drawa rivers as key spawning areas for sturgeon, salmon, sea trout and river lamprey in the Warta and Noteć water regions. The passability of the Warta River up to the mouth of the Oder River to the Jeziorsko reservoir dam for fish migration has been confirmed. It is also important to make the ponding on coastal rivers in the water region of the Lower Oder and Western Coast passable – an important measure for the preservation of the salmon, sea trout and river lamprey populations. Therefore, the problem of restoring river passability should be considered as very important in the Oder river basin.

SIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

Like in the whole country, most of the RBMPu investments planned in the Oder river basin, covered by the derogation under Article 4(7) of the WFD, are classified as "Regulation and maintenance works" (224 SWBs). An area with significant accumulation of investments in this category includes the Upper Vistula and Central Vistula water regions (a total of 96 SWBs in which regulation or reconstruction of the riverbed is planned along significant sections). Therefore, the problem in these regions should be indicated as significant. It should be noted that the number of such activities in this water region is correlated with the considerable degree of watercourse transformation (necessity of intervention), and the implementation of works in accordance with the principles of good practice may limit their negative effects or even contribute to the introduction of positive pro-environmental solutions in already regulated rivers. Meanwhile, 39 SWBs with derogations due to regulation works were indicated in a considerable area of the Warta water region, which indicates that the problem in these areas is moderately significant. In the Lower Oder and West Przymorze water region, the concentration of works in this category is even lower (5 SWBs), which shows that the problem is insignificant. However, maintenance work on the border section of the Oder and the Oder river from Parnica to the mouth could be significant as it covers 3 Oder SWBs with a significant length. The minimisation and compensation projected in course of compiling an environmental impact assessment for this investment allowed for eliminating the significant impact of the planned works on 2 of the included SWBs (the Oder from the Lusatian Neisse to Warta and the Oder from Warta to Western Oder) and for abandoning the use of derogations under Article 4(7) WFD. For this reason, the problem in this area may be considered insignificant. In the Oder river basin, regulation or maintenance works are in progress or planned to be carried out in 87 SWBs (62% of the planned ones), mainly in the Upper Oder and Warta water regions. This indicates that the problem is significant in the catchment area.

The construction of reservoirs in the Oder river basin and the resulting derogations under Article 4(7) of the WFD are projected for 23 SWBs, including: no activities in the Upper Oder, 15 in the Central Oder, and 7 in Warta, 1 in the Lower Oder and West Przymorze. Taking into account the concentration of the planned investments and the significant scale of river ecosystems transformation through the construction of reservoirs, it may be pointed out that the problem is insignificant in the Upper Oder, Warta and Lower Oder and West Przymorze, whereas in the Central Oder region it is moderately significant.

Weir construction is provided for in 8 SWBs, mostly on less important watercourses. Out of the above, 2 structures are planned for construction or are in progress (25%); therefore, generally it should be assumed, that the problem is insignificant due to the small number of structures in the Oder river basin. Only 4 dry reservoirs were projected for construction in the Oder river basin, out of which 3 have been indicated for implementation (75%). Due to the moderate or low impact of these categories on river ecosystems and the small number of implemented projects, the problem has been deemed as insignificant. Derogations were indicated also for the construction of small dyke sections in 4 SWBs (planned for implementation).

Insufficient potential for natural retention.

SIGNIFICANT

Insufficient potential for natural retention results in the necessity to carry out hydrotechnical investments interfering negatively with the hydromorphology of rivers; restoration investments are planned: Upper Oder (3), Central Oder (11). Environmentally beneficial solutions improving the natural retention in river valleys include also proper maintenance or modernisation of water reclamation facilities (ditches) for controlling water runoff and slowing it down in dry periods (countering droughts), as well as water retention in periods of intense rainfall (limiting flood risk). This problem is of special importance in the Warta water region, due to the high risk of drought.

3.2.3 PROTECTION OF QUANTITATIVE SURFACE AND GROUNDWATER STATUS

Uncontrolled groundwater abstraction for irrigation of arable crops.

SIGNIFICANT

Due to the prolonged drought and forecast climate changes – increase in the frequency of droughts throughout the country – the risk of unregistered water abstraction from private wells for irrigation purposes significantly increases. The problem is particularly relevant for catchment areas with low rainfall and high risk of agricultural drought. It is argued that abstraction for irrigation of agricultural crops may, in periods of drought, constitute a significant share of total groundwater abstraction in a balance area.

Water abstraction and drainage of mining areas.

SIGNIFICANT

The problem is significant in the Upper Oder water region. The phenomenon of water transfers is observed between catchment areas as a result of mine activity, drainage abstraction of waters and discharge of mine water and wastewater into rivers, often within other catchment areas in the Upper Silesian Region (GOP).

In the Central Oder water region, the problem is assessed as significant. The problem is that the available resources are exceeded on an annual scale due to drainage abstraction (Turoszów Coal District).

In the Warta and Noteć water region, the problem is assessed as significant. As a result of deep draining and operations of brown coal mines in the areas of Bełchatow, Turek and Konin, the hydrology has changed – depression cone[134].

In the Lower Oder and West Przymorze regions, the problem is assessed as moderately significant due to excessive mining abstraction or drainage in compared to the available groundwater resources.

SIGNIFICANT

Impact of excessive surface water abstraction for crop irrigation on inviolable flows during low water levels.

Excessive abstraction of surface waters from watercourses for agricultural purposes, often unregistered, carried out by local ponding of water, may pose a significant threat to inviolable flows in SWBs, especially to ecosystems during hydrological drought. Moderate or very high risk of hydrological drought affects 90% of the river basin, with moderate or significant risk of hydrological drought affecting over 35%[135].

Upper Oder water region – moderate problem. There are areas with high risk in the northern and western part, which is associated with the occurrence of areas with the longest lasting hydrogeological low waters (western part of the region). Occurrence of arable land beyond the reach of irrigation structures and unfavourable ratio of available or prospective groundwater resources to their abstraction (north-eastern area of the region).

The Central Oder, Warta and Noteć water regions – significant problem due to the susceptibility of river flows to prolonged drought, large area at risk of four types of drought. An additional problem involves accumulating pressure with abstraction and drainage of mine areas. As a consequence, considerable lowering of courses is observed sectionally.

The Lower Oder and West Przymorze water region – significant problem due to the big susceptibility of river flows to prolonged drought.

SIGNIFICANT

Formation of depression cones in main usable aquifers groundwater of regional span.

Decreasing the permeable surface of the catchment areas within large agglomerations means that 70–90% of rainwater runs off without supplying groundwater, while excessive water abstraction leads to the lowering of the water table.

[134] Characterisation of the Warta water region including identification of significant water management issues in PGW WP RZGW Poznań.

[135] *Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy]*, Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

In the Upper Oder water region, the problem was assessed as moderate on a regional scale; exceeding of available resources during the year because of drainage abstraction and abstraction from intakes for supplying the population.

In the Central Oder river, the problem was assessed as significant. The changes in the groundwater table level are mainly caused by the volume of mining abstraction or drainage in relation to the available groundwater resources, documented depression cones in the main usable aquifers, as well as a long-term downward trend regarding the groundwater table level.

In the Warta and Noteć water region, the problem was assessed as significant. There are documented depression cones in main usable aquifers, as well as a long-term downward trend in the groundwater table level.

In the Lower Oder and West Przymorze water regions, the problem was assessed as significant, with documented depression cones in the main usable aquifers and a long-term downward trend in the groundwater table level.

SIGNIFICANT

Risk of 4 types of drought (atmospheric, agricultural, hydrological and hydrogeological).

Approximately 52% of the river basin is at extreme risk of agricultural drought. Intensive and very intensive surface water usage occurs in more than 20% of the Oder river basin. 11.39% of the area has an intensive use of available surface water resources, i.e with a clear pressure on the sustainability of resources, which means water usage at the level of maximum resource availability. For 10.95% of the river basin district, exploitation exceeds the quantity of water resources[136].

In 8.92% of the river basin, it was impossible to meet the needs of users, including ecosystemic ones, during hydrological drought[137].

Moreover, a very high and high percentage of areas at risk of all four types of drought has been identified in the river basin. High share of years affected by drought in a multiannual period. In 2019, all voivodeships of the river basin experienced agricultural drought[138].

Very high threat was indicated for 13.6%, high threat for 34.8%, and significant for 36.8% of the Central Oder water region.

The balancing catchment area deemed most at risk of all four types of drought is Barycz, where very high threat pertains to as much as 37% of the area and high threat pertaining to 29% of the area.

[136] *Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy]*, Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

[137] *Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy]*, Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

[138] *Announcement regarding the occurrence of drought conditions in Poland*, www.susza.iung.pulawy.pl (access: 14 Oct 2019).

In the water region of Warta and Noteć, the problem has been assessed as significant. A very high and high percentage of areas at risk of all four types of drought has been identified in the river basin. High share of years affected by drought in a multiannual period.

Risk of drought resulting from climate change.

SIGNIFICANT

Due to the projected increase in average air temperature and the increase in the frequency of heat waves in spring and autumn, as well as changes in the nature of precipitation (> torrential rains), the frequency of droughts and their duration in Poland will increase significantly. Currently, a drought occurs every 2–3 years, while the hydrological drought has been intensifying since 2015. However, the effects of drought are more acute in regions under strong pressure. In 2019, agricultural drought has been stated in all voivodeships within the river basin district[139].

The problem is significant in the Central Oder water region, where a high percentage of years with drought is observed in a multiannual period.

The highest percentage of dry years occurred in the catchment areas of Eastern Neisse, Bystrzyca, Osobłoga and the southern part of the Bóbr and Przyodrze catchment areas. The highest share of very and extremely dry years was observed in the western part of the Barycz catchment area and in the southern part of the Bóbr and Kaczawa catchment areas. The average share of months experiencing moderate drought in a multiannual period is 29 months. The maximum percentage share (above 42%) is found in the catchment areas of Bóbr, Eastern Neisse, Widawa and Barycz.

Class IV atmospheric drought hazard class IV exists in the Central Oder water region, while moderate and highly endangered areas have been identified in other water regions.

The problem is significant in the Warta and Noteć water region, where a high percentage of years with drought is observed in a multiannual period.

Exposure to drought effects in the navigation industry.

SIGNIFICANT

Despite the well-developed, dense river network, the surface water resources, the retention capacity in the Oder water region is low, which is conditioned by the shape of the terrain, geological construction and transformation of the river basin. In case of a dry year, sub-transit depths may occur in all waterways in the region. The biggest problem is diagnosed in the freely flowing Oder downstream Brzeg Dolny. Due to drought, navigation conditions (compliance with the required transit parameters) may be unfulfilled.

[139] *Announcement regarding the occurrence of drought conditions in Poland*, www.susza.iung.pulawy.pl (access: 14 Oct 2019).

Retention reservoirs have an ecosystem function, therefore the supply of inland waterways is limited by factors resulting from the protection plan.

In case of a dry year, sub-transit depths may occur in all waterways in the Warta water region. In 2015, water levels below the limit were found at 11 gauging stations. The biggest problem is diagnosed on waterway E70; failure to maintain the transit depth may amount to 8.7% and more for the navigation period. Due to drought, navigation conditions (compliance with the required transit parameters) may be unfulfilled in Noteć and Warta.

Exposure to drought effects in the agricultural sector.

SIGNIFICANT

High share of soil susceptible to drought in agricultural use. High share of years affected by drought in a multiannual period. In July 2019, agricultural drought was recorded in all the voivodeships of the river basin.

Extreme agricultural drought was caused by low precipitation and extremely low availability of water for plants. In the case of agricultural drought, an important factor affecting the condition of plants is the period when water deficit occurs. The most sensitive part of the growing season of arable crops is the intensive growth phase in April and May.

Exposure to drought effects in the natural environment and biodiversity.

SIGNIFICANT

High susceptibility of the natural environment to prolonged drought. High share of years affected by drought in a multiannual period. In case of prolonged drought, the negative impact on the SWB status and water-dependent habitats is significant. This poses a threat to the environmental objectives of a SWB, and results from a decrease in watercourse flows and a threat to inviolable flows.

In the Central Oder water region, the problem has been assessed as significant.

Catchment areas threatened by agricultural and hydrological drought are particularly vulnerable. Lowering the groundwater level threatens the environmental objectives of water-dependent protected areas and water-related objects under protection, e.g. the catchments of the Bóbr and Barycz rivers are exposed to 4 types of drought.

In the Warta and Noteć water region, the problem has been assessed as significant. A balancing catchment area where the share of SWBs at risk of hydrological drought is 100% and pertains to balancing catchment areas: Upper Warta, Liswarta without Kocinka, Warta from Liswarta to Widawka, Widawka, Warta from Widawka to Ner, Ner, Warta from Ner to Prosna, Prosna, Warta from Prosna to the Mosiński channel, the Poznań basin of Warta, Wełna, Warta from Obrzycko to Noteć, Obr, Upper Noteć, Noteć of the Toruń-Eberswald Ice-marginal valley, Gwda, Drawa, Lower Warta. As a result of accumulated pressures related to non-returnable water abstraction, post-mining drainage and depression cones, the vulnerability of SWBs and protected areas to the effects

of droughts, which aggravate the negative impacts, is increasing. In many areas, a local decline in water flows in courses can be observed, together with a decrease of the water level in lakes by even 4 m. The situation poses a serious threat to protected areas (e.g. the Powidz Landscape Park, the Gopło Landscape Park Millenium Park Wielkopolska and Kuyavian-Pomeranian with NATURA 2000 areas: Jezioro Gopło PLH040007, Ostoja Nadgoplańska PLB 040004).

MODERATELY SIGNIFICANT

Impact of excessive groundwater abstraction on average river flow SQ.

In the Upper Oder water region, the problem has been assessed as significant. The Upper Silesian agglomeration is largely supplied with potable water from surface water intakes; after their use, these waters are discharged in the form of wastewater to the nearest surface watercourses often located in other catchment areas – water transfers.

The problem is moderately significant in the Upper Oder water region. Moderate influence of groundwater abstraction on changes in the average annual flow of rivers SQ, documented depression cones in the main usable aquifers, long-term downward trend in groundwater table level, annual excess of available resources due to drainage (Turoszów Coal District).

In the Warta water region, the problem has been assessed as significant. As a result of deep drainage of brown coal mines in the areas of Belchatow, Turek and Konin, the hydrology has changed, leading to a change in the surface water network. In the P-XIV balancing area (Upper Noteć), the water system of the Upper Noteć is completely unnatural: the Warta-Gopło channel, the Bachorze Duże i Małe channel, the Noteć channel and the Bydgoszcz channel. In other areas, the maximum allowable abstraction from groundwater intakes, without returning the water to the system, may reduce the SQ average annual flow.

In the Lower Oder and West Przymorze water region, the problem has been assessed as moderately significant. Changes in the level of the groundwater table caused by excessive abstraction compared to the available groundwater resources, documented depression cones in the main usable aquifers, as well as exceeding renewable resources on an annual basis due to abstraction for population supply purposes.

MODERATELY SIGNIFICANT

Degree of utilisation of groundwater resources.

In the Upper Oder water region, the problem has been assessed as significant. The guaranteed groundwater resources in the region are lower or similar to those available. The current abstraction represents 80% of the established guaranteed resources, while the abstraction forecast up to 2030 is estimated at approximately 90.8% of determined guaranteed resources. Considering the projected abstraction for the water region, 38% of the area will be affected by water deficit, with low reserves estimated for 12%. A deficit of resources has been stated in the GL-IV/D and GL-V/A - GOP regions;

strongly anthropogenically modified areas (Gliwice region), with numerous hard coal mines. Long-term water exploitation occurs at a level exceeding the possibilities of natural groundwater resources recovery.

In the Central Oder water region, the problem has been assessed as insignificant. Current groundwater abstraction in the region equals on average 17.6% of the established guaranteed resources. Considering the current and projected abstraction, 4% of the area will be affected by water deficit, with low reserves estimated for 2%.

In the Warta water region, the problem has been assessed as moderately significant. Current groundwater abstraction in the region equals on average 35.4% of the established guaranteed resources, with an estimation at 40.7%. Considering the current and projected abstraction, 7% of the area will be affected by water deficit, with a risk of lack of reserves estimated for 1%. The highest abstractions, exceeding the guaranteed resources in the balancing areas Widawka and Warta from Ner to Prosna.

In the Lower Oder and West Przymorze water region, the problem is assessed as significant. Current groundwater abstraction in the region equals on average 9% of the established guaranteed resources. Considering the current abstraction, 2% of the area will be affected by water deficit. Highest water abstraction within municipal intakes: Szczecin, Koszalin and Kolobrzeg. The utilisation rate of guaranteed resources equals from 3% to 45%. The highest level of resource utilisation (45.5%) was stated in the coastal area of Uznam.

MODERATELY SIGNIFICANT

Impact of maximum abstraction from guaranteed resources on inviolable flows.

In the case of a maximum allowable non-returnable groundwater abstraction, the average annual groundwater flow may fall below the inviolable flow. Resource deficit in the GOP.

Upper Oder water region – significant problem. The influence of groundwater abstraction on the inviolable flow of surface water reveals a strong dependency on the degree of return of used water to the hydrographic system of the catchment area.

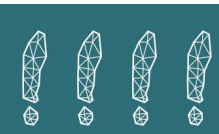
Central Oder water region – moderately significant problem. The risk of failure to achieve the inviolable flow may occur in low-water conditions, when rivers are supplied by groundwater, as well as during maximum allowable non-return flow.

Warta water region – significant problem. The network of surface waters, which are largely supplied by groundwater in the area of depression cones, has changed as a result of water abstraction, drainage, and brown coal mining activities.

Lower Oder and West Przymorze water region – moderately significant problem. The risk of failure to achieve the inviolable flow may occur in low-water conditions, when rivers are supplied by groundwater, as well as during maximum allowable non-return flow when <25% of used water is discharged into the system.

3.3 THE ELBE RIVER BASIN DISTRICT

3.3.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS



VERY SIGNIFICANT

Atmospheric deposition.

Exceeding the limit values for heavy metals and PAHs, among other things, due to fossil fuel combustion and low emissions. A deterioration of the chemical status in relation to the previous planning cycle was noted.

SIGNIFICANT

Rearing and farming discharge (17 discharge points) into 4 SWBs.

A large number of points draining water from ponds may be the cause of assessing the ecological status as below good (indication of biological elements susceptible to atrophy).

MODERATELY SIGNIFICANT

Municipal and household sewage (including sewage coming from people who do not use the sanitary sewage system).

The introduction of biogenic pollutants from treatment plants may have an impact (accumulation of pollutants from treatment plants and ponds) on assessing the ecological status of certain water bodies as below good (indication of biological elements sensitive to atrophy).

INSIGNIFICANT

Agriculture – agricultural land occupies less than 30% of the river basin area (including a large part of grasslands), forest areas dominate.

Agriculture may be a source of biogenic pollution, but the structure of use and the small number of animals has probably little influence on the water status.

3.3.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

INSIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

No derogation under Article 4(7) of the WFD has been identified in the river basin district; hence, the problem is insignificant.

INSIGNIFICANT

Insufficient potential for natural retention.

No need of restoration works is anticipated in the river basin; hence, the problem is insignificant.

INSIGNIFICANT

Evaluation of the current passability of rivers in terms of the potential migration of bi-environmental fish species.

The Elbe river basin includes rivers that have not been identified as priorities for restoring passability due to the location of the lower course of the main rivers outside Poland and the significant degree of their damming. For this reason, the analysed problem should be considered insignificant in the river basin scale.

3.3.3 PROTECTION OF QUANTITATIVE SURFACE AND GROUNDWATER STATUS

SIGNIFICANT

Formation of depression cones in main usable aquifers groundwater of regional span.

Considerable changes in the groundwater table level were noted. More than 55% of the river basin is at high or extreme risk of hydrogeological drought, with moderate risk for approx. 45%. 100% of the river basin is at high or extreme risk of hydrological drought[140]. In the case of mountain areas, the

[140] *Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy]*, Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

expansion of the accommodation facilities of spa and tourist resorts has a significant impact on the amount of underground water abstraction for municipal purposes. Water consumption by "users" (tourists) is several times higher than that of inhabitants, especially in the summer. In addition, the prolonged drought in the area increases the risk of interruptions regarding water supply for residents.

MODERATELY SIGNIFICANT

Impact of excessive surface water abstraction for crop irrigation on inviolable flows during low water levels.

Excessive surface water abstraction from the monitored watercourses may pose a significant threat to inviolable flows in the SWB, especially during hydrological drought. 99% of the Elbe and Ostrożnica (Upa) water region has been identified as an area with significant risk of hydrological drought.

INSIGNIFICANT

Uncontrolled groundwater abstraction for irrigation of arable crops.

Unregistered water abstraction from private wells for irrigating agricultural crops may, especially in periods of drought, constitute a significant share of total groundwater abstraction in the balancing area.

INSIGNIFICANT

Impact of excessive groundwater abstraction on average river flow SQ.

The current (2013) and projected (2030) groundwater intake shows a low level of groundwater utilisation, lack of detailed data.

INSIGNIFICANT

Water abstraction and drainage of mining areas.

At the river basin level, there is no significant pressure from underground and opencast mines.

Degree of utilisation of groundwater resources.

INSIGNIFICANT

The utilisation rate is less than 2%. The projected groundwater abstraction does not affect the significant increase in the utilisation of these resources. No deficit areas have been identified in the river basin district.

Impact of maximum abstraction from guaranteed resources on inviolable flows.

INSIGNIFICANT

No data. In the case of a maximum allowable non-returnable abstraction, the average annual groundwater flow may fall below the inviolable flow. **The problem is significant in periods of drought.**

3.4 THE BANOVKA RIVER BASIN DISTRICT

3.4.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS

Industrial wastewater (5 discharge points).

SIGNIFICANT

Exceeding the limit values of several particularly hazardous substances (including perfluorooctanesulfonic acid, brominated diphenyl ethers). They may be released into waters also from landfill leachates.

Atmospheric deposition.

MODERATELY SIGNIFICANT

Exceeding the limit values of certain particularly hazardous substances from fossil fuel combustion and low emissions (mercury, PAHs).

MODERATELY SIGNIFICANT

Municipal sewage (from 4 discharge points) discharged to 1 SWB and domestic sewage (1 point).

Despite the sewage discharge in the river basin, small exceeding was noted only with regard to one biological element (phytobenthos) and phosphate phosphorus were noted.

MODERATELY SIGNIFICANT

Agriculture - domination of agricultural land (main arable land).

Despite the very high share of arable land in the river basin, slight exceeding of good level was noted only with regard to one biological element (phytobenthos) and phosphate phosphorus.

3.4.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

INSIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

No derogation under Article 4(7) of the WFD has been identified in the river basin district; hence, the problem is insignificant.

INSIGNIFICANT

Insufficient potential for natural retention.

No need of restoration works is anticipated in the river basin; hence, the problem is insignificant.

Evaluation of the current passability of rivers in terms of the potential migration of bi-environmental fish species.

INSIGNIFICANT

The Banovka river basin includes rivers that have not been identified as priorities for restoring passability due to the location of the lower course of the main rivers outside Poland and the significant degree of their damming. For this reason, the analysed problem should be considered insignificant in the river basin scale.

3.4.3 PROTECTION OF QUANTITATIVE SURFACE AND GROUNDWATER STATUS

Formation of depression cones in main usable aquifers groundwater of regional span.

SIGNIFICANT

The entire region is affected by documented depression cones in the main usable aquifers. They are connected with the observed anthropogenic changes in the groundwater regime from the last 20 years. Decreasing the permeable surface of the catchment areas within large agglomerations means that 70–90% of rainwater runs off without supplying groundwater, while excessive water abstraction leads to the lowering of the water table.

Impact of excessive surface water abstraction for crop irrigation on inviolable flows during low water levels.

MODERATELY SIGNIFICANT

Excessive abstraction of surface waters from watercourses for agricultural purposes, often unregistered, carried out by local ponding of water, may pose a significant threat to inviolable flows in SWBs, especially during hydrological drought.

Uncontrolled groundwater abstraction for irrigation of arable crops.

INSIGNIFICANT

Unregistered water abstraction from private wells for irrigating agricultural crops may, especially in periods of drought, constitute a significant share of total groundwater abstraction in the balancing area.

Water abstraction and drainage of mining areas.

INSIGNIFICANT

At the river basin level, there is no significant pressure from underground and opencast mines.

Degree of utilisation of groundwater resources.

INSIGNIFICANT

The utilisation rate of guaranteed resources in the river basin is less than 2%, while the projected abstraction will not have a significant impact on the increase of the utilisation rate (ca. 15% increase). No deficit areas have been identified in the river basin district.

Impact of excessive groundwater abstraction on average river flow SQ.

NO DATA

The lack of gauging data for the river basin makes it impossible to assess the impact of groundwater management on surface waters.

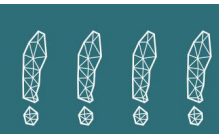
Impact of maximum abstraction from guaranteed resources on inviolable flows.

NO DATA

The lack of gauging data for the river basin makes it impossible to assess the impact of groundwater management on surface waters.

3.5 THE PROKHLADNAYA RIVER BASIN DISTRICT

3.5.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS



VERY SIGNIFICANT

Atmospheric deposition.

Monitoring conducted in the new planning cycle indicates the exceeding of limit values for PAHs (benzo(a)pyrene, benzo(a)fluoranthene, benzo[g,h,i]perylene, benzo[g,h,i]terylene) coming from low emission.

MODERATELY SIGNIFICANT

Domestic sewage (3 discharge points) and municipal sewage (1 point).

Monitoring conducted in the previous planning cycle indicated the exceeding of concentration limits for organic pollution indicators (COD, TOC). Monitoring in the new cycle indicates maintained high values of TOC and COD.

3.5.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

INSIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

No derogation under Article 4(7) of the WFD has been identified in the river basin district; hence, the problem is insignificant.

INSIGNIFICANT

Insufficient potential for natural retention.

No need of restoration works is anticipated in the river basin; hence, the problem is insignificant.

Evaluation of the current passability of rivers in terms of the potential migration of bi-environmental fish species.

INSIGNIFICANT

The Prokhladnaya basin includes rivers that have not been identified as priorities for restoring passability due to the location of the lower course of the main rivers outside Poland and the significant degree of their damming. For this reason, the analysed problem should be considered insignificant in the river basin scale.

3.5.3 PROTECTION OF QUANTITATIVE SURFACE AND GROUNDWATER STATUS

Impact of excessive surface water abstraction for crop irrigation on inviolable flows during low water levels.

MODERATELY SIGNIFICANT

Excessive abstraction of surface waters from watercourses for agricultural purposes, often unregistered, carried out by local ponding of water, may pose a significant threat to inviolable flows in SWBs, especially during hydrological drought.

Uncontrolled groundwater abstraction for irrigation of arable crops.

INSIGNIFICANT

Unregistered water abstraction from private wells for irrigating agricultural crops may, especially in periods of drought, constitute a significant share of total groundwater abstraction in the balancing area.

Water abstraction and drainage of mining areas.

INSIGNIFICANT

At the river basin level, there is no significant pressure from underground and opencast mines.

Degree of utilisation of groundwater resources.

INSIGNIFICANT

The utilisation rate of guaranteed resources in the river basin is less than 2%, while the projected changes will not have a significant impact on the increase of the utilisation rate (ca. 15% increase). No deficit areas have been identified in the river basin district.

Formation of depression cones in main usable aquifers groundwater of regional span.

INSIGNIFICANT

The entire region is affected by documented depression cones in the main usable aquifers. They are connected with the observed anthropogenic changes in the groundwater regime from the last 20 years.

Impact of excessive groundwater abstraction on average river flow SQ.

NO DATA

The lack of gauging data makes it impossible to assess the impact of groundwater management on surface waters.

Impact of maximum abstraction from guaranteed resources on inviolable flows.

NO DATA

The lack of gauging data makes it impossible to assess the impact of groundwater management on surface waters. The impact may be significant during periods of drought.

3.6 THE NEMAN RIVER BASIN DISTRICT

3.6.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS

VERY SIGNIFICANT

Domestic wastewater (at least 19 discharge points) discharged to 14 SWBs and municipal wastewater (at least 20 points) discharged to 10 SWBs.

A large number of domestic and municipal wastewater discharge points. As a result, the limit values for physicochemical indicators typical for wastewater pollution (COD, TOC) are exceeded.

VERY SIGNIFICANT

Atmospheric deposition.

Emissions of pollutants into the atmosphere and subsequent atmospheric deposition lead to the exceeding of heavy metal and PAH concentrations in all of the monitored SWBs. This is related to the presence of a large urban centre, transport emissions, low emissions and industrial emissions. The situation in the current planning cycle has significantly deteriorated compared to the years 2011–2016. The concentrations of brominated diphenyl ethers, which may originate from atmospheric deposition, among other things, have been exceeded.

SIGNIFICANT

Industrial wastewater (7 discharge points) discharged to 6 SWBs.

Exceeding of the concentration limits of particularly hazardous substances in all of the river SWBs monitored in the current planning cycle. This concerns mainly brominated diphenyl ethers, which may be released into the environment from industry and from landfill leachates.

MODERATELY SIGNIFICANT

Agriculture – approximately 50% of the catchment area used for agriculture, of which over 60% is arable land.

Few instances of exceeding limits for lake and river SWBs with regard to nutrients from agriculture and biological indicators susceptible to eutrophication. The concentration limits of heptachlor, belonging to the group of organochlorine insecticides commonly used in agriculture, were exceeded in some SWBs.

3.6.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

INSIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

No derogation under Article 4(7) of the WFD has been identified in the river basin district; hence, the problem is insignificant.

INSIGNIFICANT

Insufficient potential for natural retention.

No need of restoration works is anticipated in the river basin; hence, the problem is insignificant.

INSIGNIFICANT

Evaluation of the current passability of rivers in terms of the potential migration of bi-environmental fish species.

The Neman basin, like the Pregoyla basin, includes rivers that provide suitable conditions for eels and, additionally, some rivers with large populations of river trout may have been historically used by sea trout and salmon. However, also this river basin has not been identified as priority for restoring passability due to the location of the lower course of the main rivers outside Poland and the significant degree of their damming. For this reason, the analysed problem should be considered insignificant for water management in the river basin scale.

3.6.3 PROTECTION OF QUANTITATIVE SURFACE AND GROUNDWATER STATUS

MODERATELY SIGNIFICANT

Impact of excessive surface water abstraction for crop irrigation on inviolable flows during low water levels.

Excessive abstraction of surface waters from watercourses for agricultural purposes, often unregistered, carried out by local ponding of water, may pose a significant threat to inviolable flows in SWBs, especially during hydrological drought.

INSIGNIFICANT

Uncontrolled groundwater abstraction for irrigation of arable crops.

Unregistered water abstraction from private wells for irrigating agricultural crops may, especially in periods of drought, constitute a significant share of total groundwater abstraction in the balancing area.

INSIGNIFICANT

Impact of excessive groundwater abstraction on average river flow SQ.

The current (2013) and projected (2030) groundwater abstraction has little impact on the average annual river flow SQ. The impact of groundwater abstraction on the surface water flow in the catchment areas of Czarna Hańcza and Marycha shows significant dependence on the degree of return of used water to the hydrographic system of the catchment.

INSIGNIFICANT

Water abstraction and drainage of mining areas.

At the river basin level, there is no significant pressure from underground and opencast mines.

Degree of utilisation of groundwater resources.

INSIGNIFICANT

Groundwater abstraction in the Polish part of the Neman basin is approximately 5–11% of the established guaranteed resources. Large reserves of prospective resources (2030). Approx. 40% of guaranteed resources are found in the Czarna Hańcza water management region, where the highest intakes are located. No deficit areas have been identified in the river basin district.

Impact of maximum abstraction from guaranteed resources on inviolable flows.

INSIGNIFICANT

The maximum allowable abstraction from groundwater intakes does not cause a decrease of inviolable flow. The risk of failure to achieve inviolable flow may occur during periods of prolonged low water levels. The problem has been assessed as insignificant in the river basin. During drought, non-returnable abstraction will affect both SQ and inviolable flows.

Formation of depression cones in main usable aquifers groundwater of regional span.

INSIGNIFICANT

Decreasing the permeable surface of the catchment areas within large agglomerations means that 70–90% of rainwater runs off without supplying groundwater, while excessive water abstraction leads to the lowering of the water table.

3.7 THE PREGOYLA RIVER BASIN DISTRICT

3.7.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS

Atmospheric deposition.

VERY SIGNIFICANT

Exceeding the limit values of particularly hazardous substances (mainly PAHs) from fossil fuel combustion, low emissions and transport. The concentrations of brominated diphenyl ethers, which may originate from atmospheric deposition, have been exceeded. The current planning cycle is

characterised by a deterioration in terms of hazardous substances in water compared to the previous cycle.

VERY SIGNIFICANT

Municipal sewage (94 discharge points) and domestic sewage (46 discharge points).

Numerous instances of exceeding concentration limits of physicochemical indicators pointing to municipal sources of pollution (COD, TOC) – the situation has not changed in the new planning cycle. Significant exceeding of biological elements sensitive to nutrients in lake SWBs, which may have originated partly from wastewater. The presence of numerous summer resort settlements and high tourist pressure also have a negative impact on the region.

MODERATELY SIGNIFICANT

Agriculture – nearly 70% of the catchment area used for agriculture, most of which is occupied by arable land; the area is particularly susceptible to nitrates from agricultural sources.

Few instances of exceeding limits for lake and river SWBs, pertaining to nitrate nitrogen and reactive phosphorus, as well as serious exceeding in lake SWBs with regard to biological elements susceptible to nutrients, which may have partially originated from the application of mineral and organic fertilisers. Exceeding of concentration limits of heptachlor, belonging to the group of organochlorine insecticides commonly used in agriculture.

MODERATELY SIGNIFICANT

Industrial wastewater (78 discharge points).

Large number of wastewater discharge points (especially in the Łyna catchment area). Exceeding the concentration limits for particularly hazardous substances (e.g. brominated diphenyl ethers) in several SWBs. They may be released into the environment also from landfill leachates.

3.7.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

SIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

Like in the whole country, most of the RBMPu investments planned in the Pregoyla river basin, covered by the derogation under Article 4(7) of the WFD, are classified as "Regulation and maintenance works" (16 SWBs). Works were planned or commenced in the case of 9 investments (56%). Due to the area of the river basin, this indicates a considerable concentration of investments in this category and large significance of the problem in view of the fact that most of them have been taken up.

The construction of 3 reservoirs has been anticipated in the Pregoyla river basin, on the following rivers: Mała Łyna, Liwna and Sajna, for which derogations for 5 SWBs were indicated under Article 4(7) of the WFD. In the case of 3 SWBs, they are ongoing or indicated for implementation. Due to the area of the river basin, the significance of the tank construction problem has been determined as moderate in the sphere of the planned works and their implementation.

There are no other categories of investments or measures in the Pregoyla river basin – the activities include only maintenance and regulation work, as well as the construction of reservoirs. This indicates an overall moderate significance of the problem within the Pregoyla river basin.

SIGNIFICANT

Insufficient potential for natural retention.

Insufficient natural retention potential results in the necessity to carry out hydrotechnical investments interfering negatively with the hydromorphology of rivers; there are no planned restoration investments in the river basin. Environmentally beneficial solutions improving the natural retention in river valleys include proper maintenance or modernisation of water reclamation facilities (ditches) for controlling water runoff and slowing it down in dry periods (countering droughts), as well as water retention in periods of intense rainfall (limiting flood risk).

INSIGNIFICANT

Evaluation of the current passability of rivers in terms of the potential migration of bi-environmental fish species.

The Pregoyla basin includes rivers that provide suitable conditions for eels; however, it has not been identified as priority for restoring passability due to the location of the lower course of the main rivers outside Poland and the significant degree of their damming. For this reason, the analysed problem should be considered insignificant in the river basin scale.

3.7.3 PROTECTION OF QUANTITATIVE SURFACE AND GROUNDWATER STATUS

SIGNIFICANT

Formation of depression cones in main usable aquifers groundwater of regional span.

Decreasing the permeable surface of the catchment areas within large agglomerations means that 70–90% of rainwater runs off without supplying groundwater, while excessive water abstraction leads to the lowering of the water table.

MODERATELY SIGNIFICANT

Impact of excessive surface water abstraction for crop irrigation on inviolable flows during long-term low water levels.

Excessive abstraction of surface waters from watercourses for agricultural purposes, often unregistered, carried out by local ponding of water, may pose a significant threat to inviolable flows in SWBs, especially during hydrological drought.

INSIGNIFICANT

Uncontrolled groundwater abstraction for irrigation of arable crops.

Unregistered water abstraction from private wells for irrigating agricultural crops may, especially in periods of drought, constitute a significant share of total groundwater abstraction in the balancing area.

INSIGNIFICANT

Impact of excessive groundwater abstraction on average river flow SQ.

The current (2013) and projected (2030) groundwater abstraction shows a low level of groundwater utilisation; the current and projected abstraction has little impact on the average annual total river flow SQ. The assessment result regarding the impact of groundwater abstraction on the surface water flow in the Łyna, Guber and Węgorapa catchment areas, under conditions of being supplied

only by groundwater, shows a dependence on the degree of return of used water to the hydrographic system of the catchment area[141].

Water abstraction and drainage of mining areas.

INSIGNIFICANT

At the river basin level, there is no significant pressure from underground and opencast mines.

Degree of utilisation of groundwater resources.

INSIGNIFICANT

Groundwater abstraction in the Polish part of the Pregoyla basin is approximately 14% of the established guaranteed resources. The highest water abstraction, ca. 26% of the established guaranteed resources, was found in the water management region of Łyna from Lake Ustrych to the Spręcewo channel – 20% at the level of Giżycko, Dejna, and Guber regions and 10% in the remaining area. No deficit areas have been identified in the river basin district.

Impact of maximum abstraction from guaranteed resources on inviolable flows.

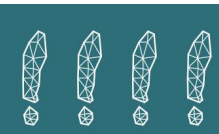
INSIGNIFICANT

There is no danger of maintaining inviolable flow when returning wastewater. In the case of a maximum allowable non-returnable abstraction, the average annual groundwater flow may fall below the inviolable flow. The flow of the Łyna, Guber and Węgorapa rivers, under the conditions of these rivers being supplied exclusively by groundwater, depends on the degree of return of the used water to the hydrographic system of the catchment area. **The problem is significant in periods of drought.**

[141] *Groundwater management including interactions with surface waters in the Polish part of the Dniester, Danube, Jarft, Elbe, Neman, Pregoyla, Prokhladnaya and Ücker river basins [Bilans wodnogospodarczy wód podziemnych z uwzględnieniem oddziaływań z wodami powierzchniowymi w polskiej części dorzeczy: Dniestru, Dunaju, Jarft, Łaby, Niemna, Pregoły, Świeżej i Ücker]*, www.pgi.gov.pl (accessed: 14 Oct 2019).

3.8 THE DNIESTER RIVER BASIN DISTRICT

3.8.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS



VERY SIGNIFICANT

Atmospheric deposition.

Exceeded limit values for particularly hazardous substances (both in the previous and current planning cycle), including substances originating mainly from low emission (e.g. fluoranthene, benzo(a)pyrene) discharged into waters with atmospheric deposition.

INSIGNIFICANT

Municipal wastewater (from 3 treatment plants) discharged to 1 SWB and domestic wastewater (1 point), as well as wastewater from people not using the sanitary sewage system.

As indicated by results of water monitoring carried out in the current planning cycle, no limit exceeding is recorded with regard to biogenic pollutants, including those typical for animal waste and production (including those typical for sewage: BOD_5, COD, suspension, ammonia nitrogen) and biological assessment elements sensitive to eutrophication (biological elements have improved compared to the previous cycle).

INSIGNIFICANT

Agriculture – agricultural land occupies less than 40% of the river basin area (including a large part of grasslands), forest areas dominate.

As indicated by results of water monitoring carried out in the current planning cycle, no limit exceeding is recorded with regard to biogenic pollutants, including those typical for animal waste and production (BOD_5, COD, suspension, ammonia nitrogen) and biological assessment elements sensitive to eutrophication (biological elements have improved compared to the previous cycle).

3.8.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

INSIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

No derogation under Article 4(7) of the WFD has been identified in the Dniester river basin district; hence, the problem is insignificant. There is no data regarding planned restoration activities in the Dniester river basin and the need for such activities – the problem should be considered insignificant.

The HYMO database for the Dniester river basin identifies 19 transverse dams (in 2 SWBs forming part of the river basin district in Poland), of which 1 has information regarding lack of a fish pass, whereas for the rest there is no data. This creates the problem of migration passability and the possibility of its assessment in relation to the area of the river basin; however, in the absence of any indication of rivers in this area as priority for bi-environmental fish, it is of little significance.

For the entire Dniester river basin, the problems should be identified as insignificant.

3.8.3 PROTECTION OF QUANTITATIVE SURFACE WATER STATUS

MODERATELY SIGNIFICANT

Impact of excessive surface water abstraction for crop irrigation on inviolable flows during low water levels.

Excessive abstraction of surface water from watercourses, often unregistered, during hydrological drought may pose a significant threat to inviolable flows in SWBs.

INSIGNIFICANT

Impact of maximum abstraction from guaranteed resources on inviolable flows.

During drought, when groundwater supply of rivers prevails, the maximum abstraction of groundwater from available resources may affect inviolable flows, especially in the case of accumulation of pressure from excessive use of surface water. The degree of significance may vary locally at the level of the river basin. Basin rivers show low sensitivity of river flows supplied by groundwater to the degree of water return to the hydrographic system.

Uncontrolled groundwater abstraction for irrigation of arable crops.

INSIGNIFICANT

Unregistered water abstraction from private wells for irrigating agricultural crops may, especially in periods of drought, constitute a significant share of total groundwater abstraction in the balancing area. The problem is insignificant at the river basin level.

Impact of excessive groundwater abstraction on average river flow SQ.

INSIGNIFICANT

According to the water management balance, the groundwater abstraction and the intake projected until 2030 will have little impact on the average annual river flow SQ.

Water abstraction and drainage of mining areas.

INSIGNIFICANT

At the river basin level, there is no significant pressure from underground and opencast mines.

Degree of utilisation of groundwater resources.

INSIGNIFICANT

The degree of utilisation of guaranteed resources for the river basin is less than 1%, while abstraction projected by 2030 will not have a significant impact on the increase in the utilisation rate. No deficit areas have been identified in the river basin district.

Formation of depression cones in main usable aquifers groundwater of regional span.

INSIGNIFICANT

Decreasing the permeable surface of the catchment areas within large agglomerations means that 70–90% of rainwater runs off without supplying groundwater, while excessive water abstraction leads to the lowering of the water table. This problem is insignificant in the river basin.

3.9 THE DANUBE RIVER BASIN DISTRICT

3.9.1 QUALITATIVE PROTECTION OF SURFACE WATERS AND GROUNDWATERS

SIGNIFICANT

Atmospheric deposition.

High values of individual hazardous substances (benzo(a)pyrene, mercury) originating mainly from low emissions. The river basin also experiences the reduction of the class of physicochemical elements affected by the pH value, which may also stem from the deposition of acidifying pollutants.

SIGNIFICANT

Municipal wastewater (from 7 discharge points) discharged to 4 SWBs and domestic wastewater (1 point).

Exceeding the limits of individual physicochemical parameters indicating eutrophication of waters in more than half of the monitored SWB areas. Exceeding of parameters indicating the origin of pollution from sewage (including COD, BOD_5, TOC). For one groundwater body, the concentration limits of ammonia, originating also probably from sewage, have also been exceeded (there are no other identified potential sources). This confirms the high impact of sewage on the water level.

MODERATELY SIGNIFICANT

Agriculture – agricultural land occupies less than 40% of the river basin area (including a large part of grasslands), forest areas dominate.

Exceeding of limits concerning biogenic indicators occurring possibly from animal production (including COD, BZT_5). For one GWB (PLGW1000164), the limit values for ammonia, which can be derived from animal production, have been exceeded (storage of organic fertilisers can be an important problem).

3.9.2 MORPHOLOGICAL CHANGES OF SURFACE WATERS

INSIGNIFICANT

The scale of application of derogation under Article 4(7) of the WFD due to the lack of possibility to achieve environmental objectives (regarding projects implemented in the current cycle).

No derogation under Article 4(7) of the WFD has been identified in the river basin district; hence, the problem is insignificant.

INSIGNIFICANT

Insufficient potential for natural retention.

No insufficient potential of natural retention has been identified in the Danube basin and no need of restoration works is anticipated in it; hence, the problem is insignificant.

INSIGNIFICANT

Evaluation of the current passability of rivers in terms of the potential migration of bi-environmental fish species.

The Danube basin includes rivers that have not been identified as priorities for restoring passability due to the location of the lower course of the main rivers outside Poland and the significant degree of their damming. For this reason, the analysed problem should be considered **insignificant** in the river basin scale.

3.9.3 PROTECTION OF QUANTITATIVE SURFACE AND GROUNDWATER STATUS

MODERATELY SIGNIFICANT

Impact of maximum abstraction from guaranteed resources on inviolable flows.

Maximum abstraction in the river basin does not cause a decrease of SQ below the level of inviolable flow. In drought periods, when groundwater supply of rivers prevails, the maximum abstraction of groundwater from available resources may significantly affect inviolable flows, especially in the case of accumulation of pressure from excessive use of surface water for agricultural purposes or slope

irrigation. The degree of significance may vary locally at the level of the river basin and it largely depends on the degree of water return to the hydrographic system of a given catchment area.

MODERATELY SIGNIFICANT

Impact of excessive surface water abstraction for crop irrigation on inviolable flows during low water levels.

Excessive surface water abstraction, often unregistered, during hydrological drought may pose a significant threat to inviolable flows in SWBs.

INSIGNIFICANT

Uncontrolled groundwater abstraction for irrigation of arable crops.

The problem is insignificant at the river basin level.

INSIGNIFICANT

Impact of excessive groundwater abstraction on average river flow SQ.

Excessive groundwater abstraction may have little impact on the average annual river flow SQ.

INSIGNIFICANT

Water abstraction and drainage of mining areas.

There is no significant pressure at the river basin level.

INSIGNIFICANT

Degree of utilisation of groundwater resources.

No deficit areas have been identified in the river basin district.

Formation of depression cones in main usable aquifers groundwater of regional span.

INSIGNIFICANT

Decreasing the permeable surface of the catchment areas within large agglomerations means that 70–90% of rainwater runs off without supplying groundwater, while excessive water abstraction leads to the lowering of the water table. The problem is insignificant at the river basin level.

3.10 SIGNIFICANT ECONOMIC AND FINANCIAL PROBLEMS IN INDIVIDUAL RIVER BASINS DISTRICTS

In the economic and financial aspect, it can rightly be assumed that the problems concern areas all over the country; however the scale of the issues is linked to the number of water users in a given basin, as well as to the number of activities anticipated in strategic documents related to water management. The nature of economic and financial problems lies in the way the national economy functions and the way water management activities are organised. Both these issues, which are regulated by law and concern the whole country at the same time determine the existence of significant economic and financial problems in all river basins.

Significant economic and financial problems have been identified for all river basins, however their significance in the individual river basins varies. This assessment influences the introduction of a hierarchy and significance of a given problem against problems in other areas in economic and financial terms.

Results of the problem significance assessment in the economic and financial area have been presented in a table form below, together with a justification. Such form is justified primarily by the lack of variability in individual river basins and in the nature of significant problems in the economic and financial area.

Water resource efficiency

The issue of water resource efficiency is a problem that underlies both the WFD and the Water Law. It is reflected in the idea of incurring costs for water services. In Poland, the problem of water management efficiency is one of the major problems of water management. Water management efficiency is suboptimal, mainly due to the low level of investments. Recent changes introduced in the Water Law, as well as the introduction of cost recovery for water services are the first steps to improve the situation.

River basin	Place in the hierarchy
Vistula	Very significant
Oder	Very significant
Dniester	Moderately significant
Danube	Moderately significant
Elbe	Moderately significant
Neman	Moderately significant

Pregoyla	Moderately significant
Banovka	Insignificant
Prokhladnaya	Insignificant

The assessment of the significance of the problem of water resource efficiency for individual river basin districts is presented above. It should be noted that in two cases the problem has been assessed as insignificant. This assessment is a result of the small area of the river basin in question and the number of measures projected for achieving environmental objectives.

In the case of the Oder and Vistula river basins, the issue of efficiency significance is mentioned, which is revealed as very important due to the presence of a significant number of entities using water, including water abstraction for conventional, hydropower and municipal purposes.

Financing water management activities

The problem of financing has an impact on the achievement of environmental objectives for individual SWBs. Water management measures are financed primarily from public budgets. A considerable difficulty involves the relatively small amount of funds allocated for implementation (shortage of funds) and the multitude of potential financing sources which also include financing of activities from other areas of environmental protection. The economic efficiency of water management measures is incomparable with the effectiveness of environmental protection measures supported by national and EU policies.

River basin	Place in the hierarchy
Vistula	Very significant
Oder	Very significant
Dniester	Moderately significant
Danube	Moderately significant
Neman	Moderately significant
Banovka	Insignificant
Elbe	Insignificant
Pregoyla	Insignificant
Prokhladnaya	Insignificant

The above is a summary of the problem of financing water management measures that could contribute to the non-deterioration of water status and to the achievement of environmental objectives. The problem has been described the same way for all river basins, as there are no significant differences between them regarding the nature of the problem.

However, it should be noted that, due to the small number of activities in smaller river basins and the lack of identification of this problem in the *Assessment of progress in the implementation of action*

programmes[142], the problem has been assessed as insignificant. This concerns river basins where the number of measures and water users that could potentially finance their measures to improve the achievement of environmental objectives is small.

Top priority (problem assessed as very significant) was given to the issue of financing in the Vistula and Oder river basins, which stems from the identification done in the aforementioned report and from a significant number of anticipated measures to improve the water environment in those basins. The number of measures determines the significance of the problem, because in the absence of financing it is not possible to implement a higher number of measures affecting environmental objectives.

[142] *Assessment of progress in the implementation of action programmes for SWBs and GWBs resulting from the NWEPu [Ocena postępu we wdrażaniu programów działań dla JCWP i JCWPd wynikających z aPWŚK],* Gliwice 2018.

4 SUMMARY

One of the main factors affecting aquatic ecosystems, resulting in the deterioration of water quality and ecological status, is the introduction of mechanical, biological and chemical pollutants into water[143]. In this group, atrophic pollutants (mainly phosphorus and nitrogen) should be distinguished as factors largely responsible for the degradation of standing and flowing waters by intensifying the eutrophication process, i.e. the process of water fertilization due to the inflow of nutrients, mainly from dispersed and point agricultural sources and municipal wastewater. However, in recent years an improvement in water quality has been observed, particularly regarding nutrients and other parameters associated with the water eutrophication process. This is due to structural changes in agriculture and the construction of new waste treatment plants[144]. However, monitoring[145] reveals regular exceeding of quality standards regarding nutrients, BOD_5 and COD, despite an improvement. Nutrients permeate surface waters mainly from areal and point sources which are responsible for more than 70% of nitrogen and phosphorus loads flowing into the Baltic Sea. These substances come mainly from agriculture and sewage discharge (also treated sewage). An important element impacting the concentration of nutrients in water involves also natural sources (e.g. released from seabed sediments) which account for less than 20% of loads that enter the Baltic Sea. The share of compounds deposited from air is small in this group[146].

An additional element influencing the process of water eutrophication, which is already noticeable and will continue to evolve in the future, involves the projected climate change, especially the temperature increase resulting in acceleration of biochemical and chemical processes in surface waters[147]. The negative effects of ecosystem eutrophication, impacting their ecological status, will be strengthened in situations of more intense evaporation and the maintaining low water levels[148].

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[143] J. Iron, *Restoration of rivers and valleys [Renaturyzacja rzek i dolin]*, Infrastruktura i Ekologia Terenów Wiejskich 2006/4/1, pp. 11–31.

[144] W. Rast; J.A. Thornton, *Trends in eutrophication research and control [Trendy w badaniach i kontroli eutrofizacji],* Hydrol. Process. 1996/10, s. 295–313; J. Zbierska, S. Murat-Błażejewska, K. Szoszkiewicz, A.E. Ławniczak, *Nutrient balance in Wielkopolska agroecosystems in the aspect of water quality protection on the example of the Samica Stęszewska catchment area [Bilans biogenów w agroekosystemach Wielkopolski w aspekcie ochrony jakości wód na przykładzie zledami Samicy Stęszewskiej]*, Poznań 2002, p. 133; D. Absalon, M. Matysik, *Changes in water quality and runoff in the Upper Oder River Basin [Zmiany w jakości i odpływie wód w dorzeczu Górnej Odry]*, Geomorphology 2007/92, pp. 106–118; A. Kuźniar, A. Kowalczyk, M. Kostuch, *Long-Term Water Quality Monitoring of a Transboundary River [Długoterminowe monitorowanie jakości wody rzeki transgranicznej]*, Pol. J. Environ. Stud. 2014/23(3), pp. 1009–1015; P. Ilnicki, K. Górecki, P. Lewandowski, R. Farat, *Long-term variability of total nitrogen and total phosphorus concentration and load in the south part of the Baltic sea basin [Zmienność długoterminowa całkowitego stężenia i zawartości azotu i fosforu w południowej części basenu Morza Bałtyckiego]*, Fresenius Environ. Bull. 2016/25/6, pp. 1892–1909.

[145] Monitoring results are available at www.gios.gov.pl (accessed: 30 Sep 2019).

[146] *Sources and pathways of nutrients to the Baltic Sea HELCOM PLC-6 Baltic Sea Environment Proceedings No. 153.*

[147] P. Poor, *Influence of temperature changes on processes related to lake eutrophication [Wpływ zmian temperatury na przebieg procesów związanych z eutrofizacją jezior]*, Ekonomia i Środowisko2013/2(45), pp. 242–254.

[148] E.S. Bakker, S. Hilt, *Impact of water-level fluctuations on cyanobacterial blooms: options for management [Wpływ wahań poziomu wody na rozwój cyjanobakterii: opcje zarządzania]*, Aquatic Ecology 2016/50, p. 485.

Non-trophic factors responsible for degradation of water ecosystems include acidification, toxic substances, heavy metals, as well as water heating. Acidification of aquatic ecosystems is usually caused by sulphuric and nitric acids from fossil fuel combustion, which enter water together with precipitation and run-off from catchment areas. In Polish conditions, the problem of water acidification occurs in mountain rivers (only in rivers with high silicate content). Save for some exceptions, acidification does not pose a problem in lowlands due to the carbon system[149] which buffers water. Heavy metals in surface water come from industrial installations (fuel combustion, industrial wastewater), means of transport, agriculture (plant protection products) and natural sources. Surface water can be heated by draining water from cooling systems of power plants or other industrial facilities. The temperature increase can also be the result of river damming and the creation of a dam where the water heats up much more than in flowing ecosystems[150]. As civilisation develops, we are dealing with new types of pollution, including pharmacological substances, coming from hospitals, veterinary plants, but also from households and animal farming. Many of these compounds are not utilised in existing wastewater treatment plants and are discharged into surface water and groundwater. These include anti-inflammatory drugs, hormones, substances used in chemotherapy, and antibiotics. In Poland, the presence of pharmacological substances has been found in rivers of various areas.

In the "morphological changes of surface waters" problem area, several significant issues were identified for water management in the 2022–2028 planning cycle. While these measures, with due justification of overarching social objectives and implementation of all legitimate mitigation and compensation measures, are acceptable under the WFD due to the derogations adopted, a significant transformation of numerous water bodies may increase pressure on other SWBs and deteriorate the ecological status of SWBs in the same river systems. To a certain degree, these unfavourable impacts result from the observed insufficient performance of restoration tasks, especially in the context of increasing the riverbed and valley retention in order to implement non-technical methods of flood protection. This leads to the necessity of applying technical measures (regulations, construction of water reservoirs) with a much higher degree of interference in the river ecosystem than when supporting the natural retention potential of the catchment area. However, this problem should be significantly reduced after the development and implementation of the water restoration programme, currently being prepared per order of the State Water Holding Polish Waters (PGW WP). Alleviation of the effects of hydrotechnical and maintenance works will also be supported by the implementation of codes of good practice and guidelines. The construction of damming structures on rivers and the construction of new reservoirs and weirs is an equally significant problem. Although the quantitative scale is much smaller than in the previous category of works, the impact of investments on the functioning of entire river systems is much stronger, especially in the case of the construction of reservoirs on the main river basins, which constitute migration corridors for fish (including bi-environmental species) of key importance on the national and regional scale. However, ensuring migration passability is essential to achieve the environmental objectives of many water bodies for which the ichthyological indicator D, based on the occurrence of bi-environmental fish species, is indicated as an element of ecological status or potential assessment. The scale of

[149] A system that buffers natural water to maintain a constant pH.

[150] P. Brimblecombe, *Atmospheric chemistry [Chemia atmosferyczna]* [in:] *Handbook of ecological restoration. Principles of restoration [Podręcznik odnowy ekologicznej. Zasady odnowy]*, ed. M.R. Perrow, A.J. Davy, Camridge 2002, pp. 206–219; J.R. Dojlido, *Chemistry of surface waters [Chemia wód powierzchniowych]*, Białystok 1995; A. Kabata-Pendias, H. Pendias, *Biochemistry of trace elements [Biogeochemiia pierwiastków śladowych]*, Warsaw 1999; Z. Kayak, *Hydrobiology-Limnology. Ecosystems of Inland Waters [Hydrobiologia-Limnologia. Ekosystemy wód śródlądowych]*, Warsaw 2001.

recognition of the functionality of these facilities is definitely insufficient; however, the methods of assessing fish pass efficiency have not yet been developed and implemented, and the available monitoring results for these facilities are difficult to interpret and compare in the absence of a uniform methodology. The same problems are identified in the remaining, smaller catchment areas, especially Pregoyla and Neman, as well as the Dniester and the Danube. However, the intensity of the problems is smaller in some catchment areas or their solving goes beyond the national framework and requires international cooperation. Some of the problems identified for the Vistula and Oder river basins do not occur in small river basins, because no particular types of investments have been indicated which would threaten the achievement of environmental objectives. The problem of transverse damming is also noticeable in these river basins, but due to the lack of identifying them as priority systems for restoring the migration routes of bi-environmental fish, their importance is lower than in the main river basins of the country.

When discussing significant problems in water management, one should start by a climate change analysis in the context of its impact on the existing anthropogenic pressures in catchment areas and water regions related to the management of surface waters and groundwaters. The effects of climate change are visible both at the level of entire river basins and water regions, as well as individual catchment areas, in the form of changes in the quantitative and qualitative status of waters. Since 2015, the intensifying drought has caused huge losses in agricultural crops every year. Between June 11 and August 10, 2019, the occurrence of agricultural drought was found in the area of 15 voivodeships (except Warmia and Mazury), in all crops[151]. High air temperatures, prolonged heat waves and a deficit of precipitation throughout the country caused a significant reduction of water levels in rivers, with sectional decline in water flow in many places. In regions particularly susceptible to changes in groundwater levels, the effects of rainfall deficit and hydrological drought had a significant impact on the quantitative status of waters and the status of water-dependent ecosystems. In the Central Oder water region, catchment areas particularly threatened by drought, e.g. the Bóbr catchment area, experienced shortage of water in many towns during the summer (Podgórzyn, Karpacz), while in mountain and submontane areas the prices per 1 m^3 of water exceed 20–30 PLN. The situation is aggravated by the change in the nature of precipitation in winter and by high evaporation. Snowless winters are contributing to early spring drought, which is particularly dangerous for crops, because the beginning of the growing season is crucial for the development of plants. At the same time, the rapid temperature increase in March-April leads to a rapid melting of the snow in upper parts of mountains, which leads to inundation and flooding – a high risk of flooding. In 2019, the groundwater level decreased by as much as 1–1.5 m, which has directly threatened not only agricultural crops, but also sensitive wetland ecosystems, peatbogs and protected forest habitats. Increased sensitivity to climate change in a given catchment area or water region, and thus greater accompanying losses, are additionally caused by pressures related to the way the catchment is managed and the way the water is used. Deforested catchment areas, drained meadows and fields, built-up urban areas – all this means losing retention of rainwater and meltwater, as well as faster flow of these waters into watercourses. In such conditions, heavy, pouring rain leads to quick flooding and inundation. Dried soil and regulated watercourses quickly drain water into other catchment areas. The lack of conditions for rainwater infiltration into the ground denotes a lack of ability to recreate groundwater resources, which in several years may become a major challenge for our water economy, especially in water regions with strongly altered water conditions (mining areas, large industrial centres, agglomerations). Drought and rainfall deficit caused an increase in demand for water for municipal, agricultural, economic and energy purposes.

[151] *Announcement regarding the occurrence of drought conditions in Poland*, www.susza.iung.pulawy.pl (access: 14 Oct 2019).

Traditional power engineering, as well as small hydropower plants, are based on water resources. In the event of drought and reduced flows in water courses, they are not able to function properly, which can lead to problems with securing electricity for individual users, and the demand during heat waves is growing. The same applies to water supply. In 2019, restrictions for water users with regard to water abstraction from the water supply network were introduced in many communes. The restrictions were temporary. The high demand for water during heat waves resulted from an increase in water consumption for watering gardens, lawns and filling swimming pools. In periods of prolonged drought, unregistered intake of water from privately owned wells for agricultural purposes may be a major problem in some water regions, as it often exceeds the permitted volumes that do not require metering. In the perspective of climate change and agricultural drought, the need for crop irrigation with groundwater will increase and may significantly affect available resources. In the areas where there are currently no reserves or where the reserves have been exceeded and the abstracted groundwater is discharged (transferred) in the form of sewage to other catchment areas, a problem may arise which requires the implementation of corrective measures in the field of water retention and optimisation of hydrology in the whole water region. The current approach to water abstraction should be reviewed as soon as possible. The often technical, engineering, dedicated solutions implemented for many years, deemed as beneficial, may prove to be unreliable in times of precipitation deficit and heat waves. Retention compensations are becoming a priority under the Water Law, which completely changed the definition of rainwater and meltwater, depriving them of the status of sewage and imbuing with new quality. This change triggers a whole range of water services supporting ecosystem services, providing opportunities for restoring groundwater resources. It turns out that rainwater is no longer sewage, but a joint, free of charge commodity. Rainwater retention in cities, along with the improvement of retention capacities of agricultural catchment areas, restoration of natural retention in valleys, and restoration of courses may positively influence the quantitative water status. This is a prerequisite for ensuring that the environmental objectives of the SWBs and GWBs can be met.

Five problem areas were identified with regard to legal, organisational and social aspects within the framework of water management issues:

- ensuring the effectiveness of the new institutional system for the implementation of WFD environmental objectives,
- reducing the development pressure on flood risk areas (preserving and restoring natural retention areas),
- ensuring effective mechanisms for obtaining rights to real estate for the purpose of river restoration and recreation of natural retention for flood prevention purposes,
- implementation of effective legal regulations concerning the method of estimating environmental flows,
- effective enforcement of new regulations concerning the implementation of the principle of cost recovery for water services.

All of the aforementioned problems should fall under the significant category. In the context of the above problem list, it should be pointed out that the main objective of the new Water Law Act concerning the principles of water management was to change the legal and organisational structure of public administration bodies competent in issues related to water management. In the context of executing WFD environmental objectives, the new institutional system framework creates the need to ensure adequate human and substantive resources of the new institutions, i.e. management boards of catchment areas in the scope of tasks assigned by way of the new Water Law, according to which the management boards:

- implement and cooperate in the implementation of measures aimed at sustainable water management, including achievement of environmental objectives in catchment areas;

- conduct projects related to the reconstruction of ecosystems degraded by the exploitation of water resources and cooperate with the relevant authorities and entities in this respect.

As for reducing the development pressure on areas exposed to flood risk (preservation and restoration of natural retention areas), it is necessary to ensure absolute transposition of hazard maps into local spatial development plans and to implement instruments supporting the execution of FRMP activities.

In the sphere of river restoration and natural retention restoration for flood protection purposes, two problems should be highlighted:

- restoration of rivers and river valleys is a measure aimed at fulfilment of the environmental objectives defined in the WFD,
- insufficient potential for natural retention results in the necessity to carry out hydrotechnical investments interfering negatively with the hydromorphology of rivers.

It should be assumed that the above problems will be minimised or eliminated to a large extent as a result of the completion of projects by the water management authority (Wody Polskie) under "Implementation of instruments supporting the execution of FRMP measures" (implementation period until 31 July 2020) and the "National programme for surface water restoration" (project completion by 29 Feb 2020).

As regards the implementation of effective legal regulations concerning the method of estimating environmental flows, it is necessary to continue the existing research and development projects and to establish final legal solutions acceptable from the economic and social point of view.

Finally, particular emphasis should be placed on creating an effective mechanism for enforcing the principle of cost recovery for water services. In the context of executing WFD environmental objectives, the implementation of the principle of cost recovery for water services should encourage rational management of water resources, which is of *"particular importance in the case of Poland, i.e. a country with low water resource volume per citizen"*[152]. One should hope that *"the new water management model will entail the introduction of a complete system of economic instruments, which will primarily aim at more efficient management of water resources"*[153].

Significant problems in the economic and financial area were also pointed out in previous reviews of significant water management issues for river basins. The reason behind the review in this respect is known and results directly from the problems faced by the entire Polish economy, i.e. mainly financing shortages and low level of investments[154].

These problems were identified in the works on the introduction of the new Water Law, and the provisions of this Act are aimed at minimising them. Fees for water services have been introduced, which will allow for creating budgets for the implementation of tasks of key importance from the point of view of water resources quality. Work is underway on further changes in various areas of

[152]Reply to a parliamentary question regarding the increase in water service fees, granted by the Undersecretary of State at the Ministry of the Environment, Mr Mariusz Gajda, 12.07.2017, ref. no. DZW-I.070.48.2017.SW, www.sejm.gov.pl (accessed: 30 Sep 2019).

[153]Regulation Impact Assessment [in:] Government bill on Water Law, Sejm of the 8th term, document no. 1529, Warsaw 2017.

[154] In the Strategy for Responsible Development, which is a long-term strategy for the entire economy, in many places there is a description of challenges for particular areas of the national economy, described as low level of investment – lack of financing and low efficiency of the assets, i.e. use of available resources.

water resources management. Nevertheless, today economic and financial problems have to be identified in a set of significant problems, because they have a significant impact on the achievement of environmental objectives.

Two SIs have been identified in the economic and financial area in all river basin districts:

1) inefficiency in water use,
2) lack of proper funding.

Inefficient water use affects the whole country. It is illustrated by losses from water supply systems for municipal purposes, as well as inadequate efficiency of production and transmission of electricity and heat. If water were used efficiently, the demand for it would be reduced.

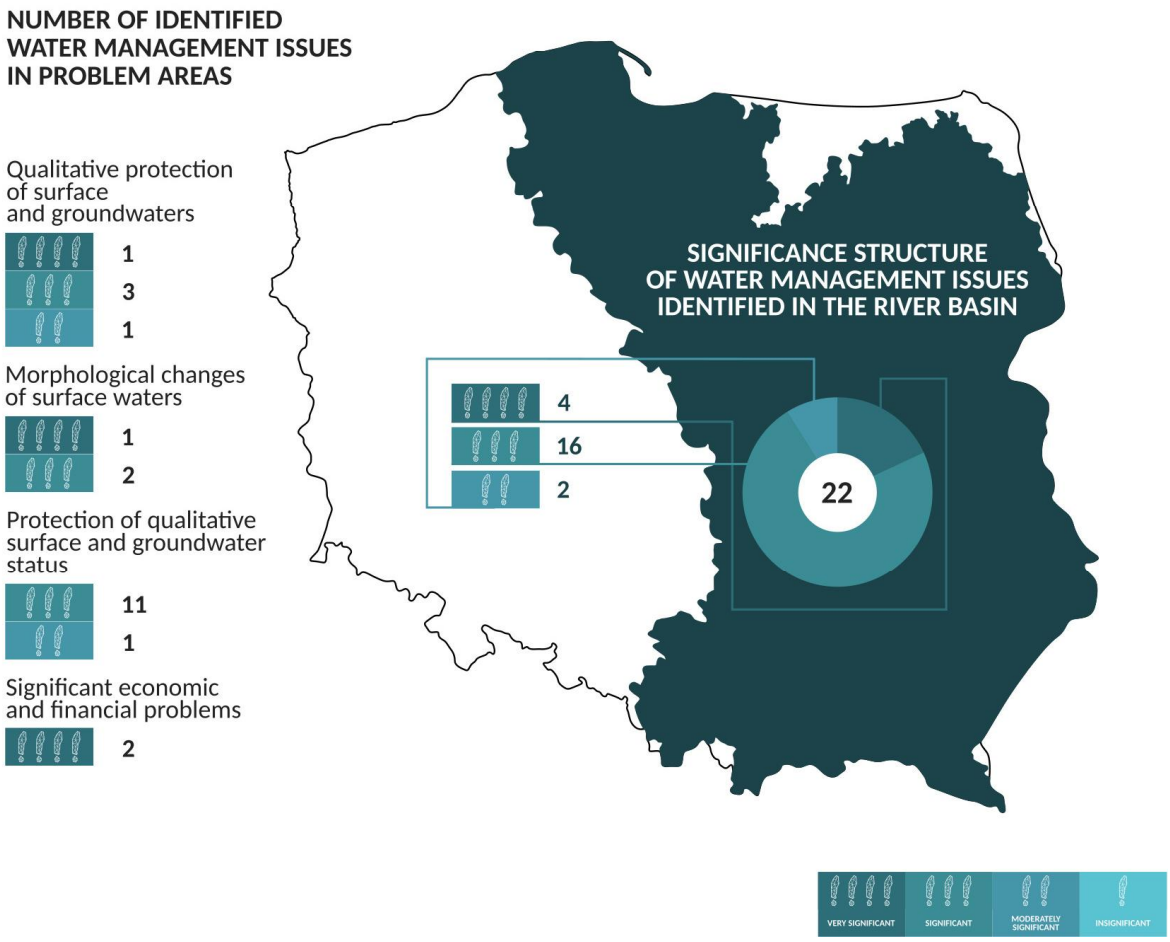
From the point of view of efficiency improvement, it may be expected that the introduction of water service fees can provide an incentive for investment and modernisation of infrastructure and water usage systems to match the consumption to actual demand.

The problem of proper funding has an impact on the achievement of the environmental objectives for individual SWBs. Water management measures are financed primarily from public budgets. Significant difficulties involve the relatively small amount of funds allocated for implementation (shortage of funds) and the multiplicity of potential sources of financing. Potential sources of financing water management measures also include financial support for measures from other areas of environmental protection. In the context of the recent problems, it should be added that the economic efficiency of water management measures is incomparable to that of environmental measures supported by policies, be they national or EU.

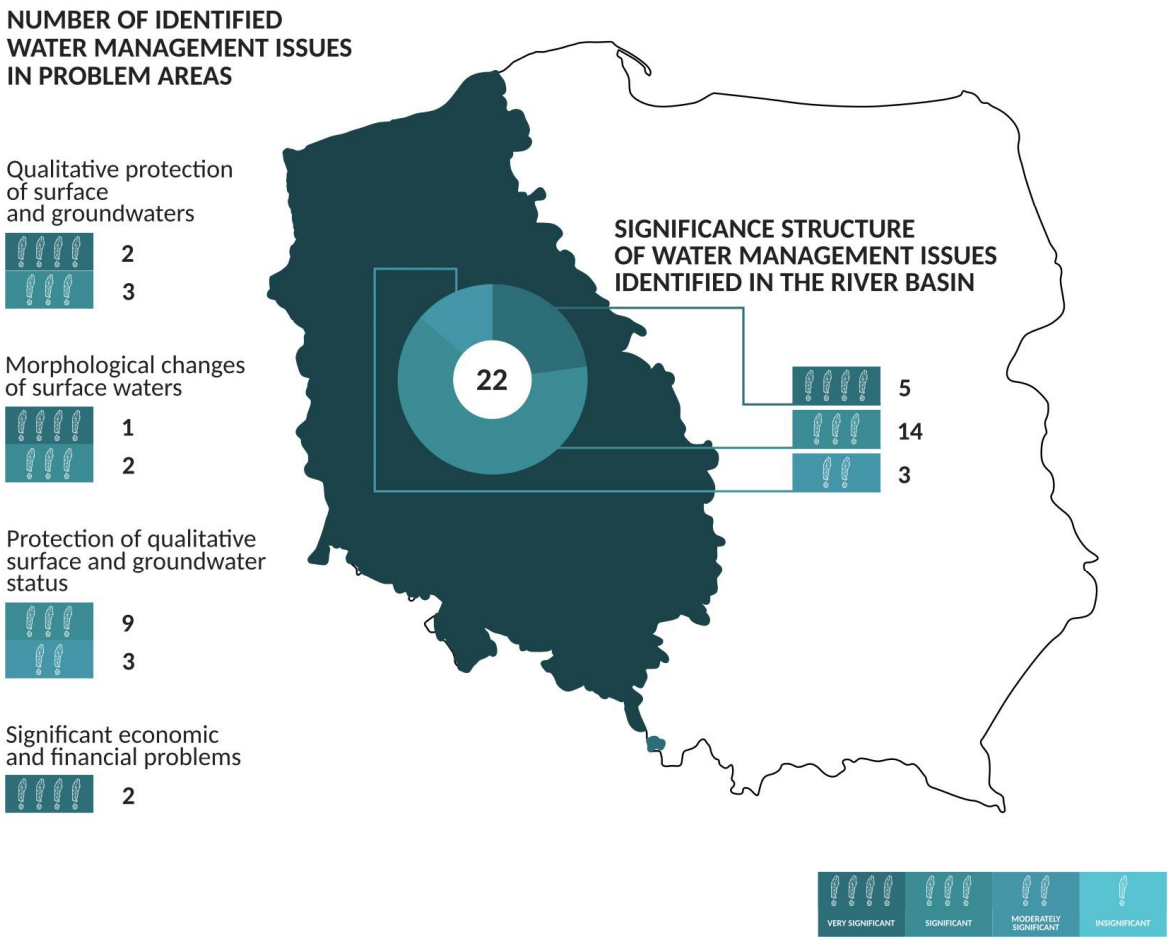
The problem of suitable financing was already noticed in the identification of significant problems in 2008. Since then, there has been a fundamental change in this area by introducing a new Water Law. Nevertheless, it remains an important problem.

A summary of the works regarding identification of water management issues in particular thematic areas for river basins is presented in the following graphs.

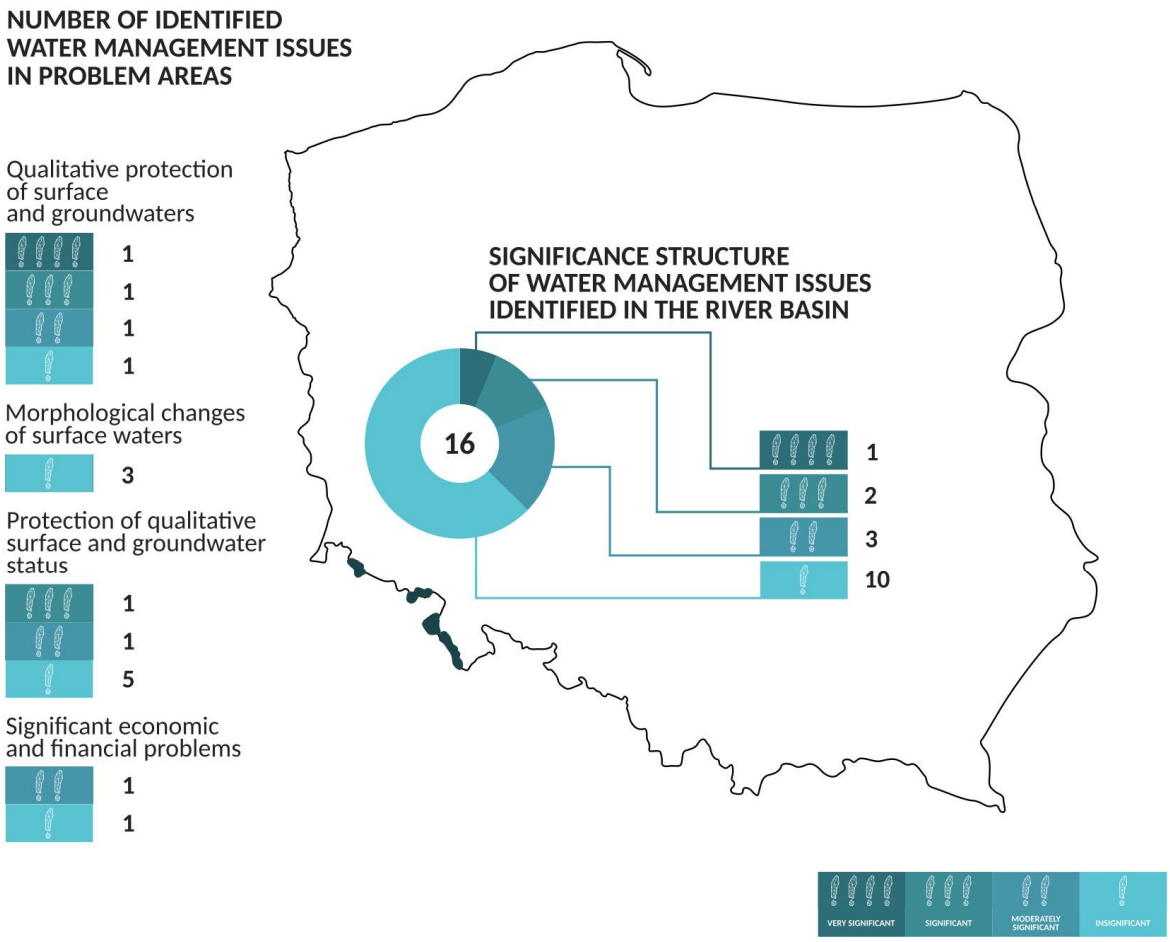
VISTULA RIVER BASIN



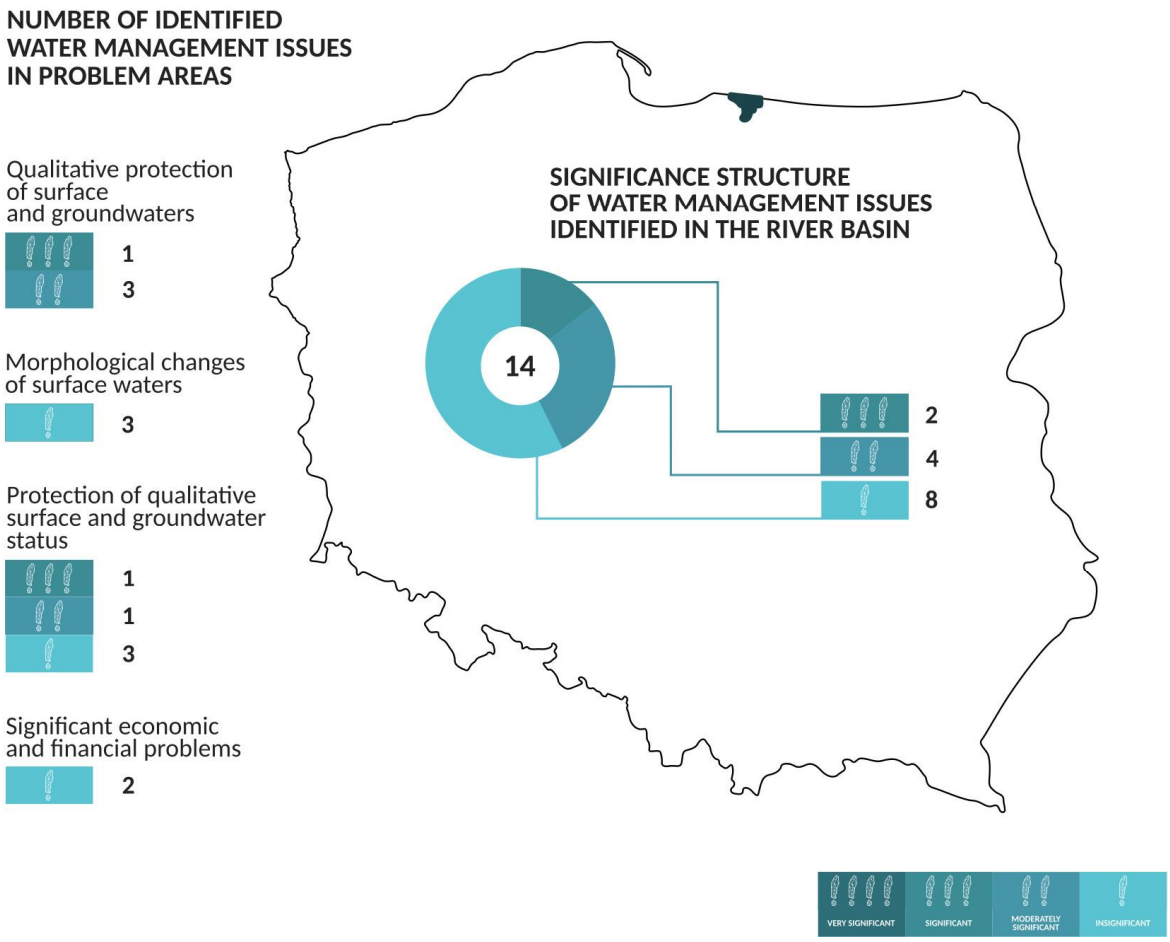
ODER RIVER BASIN



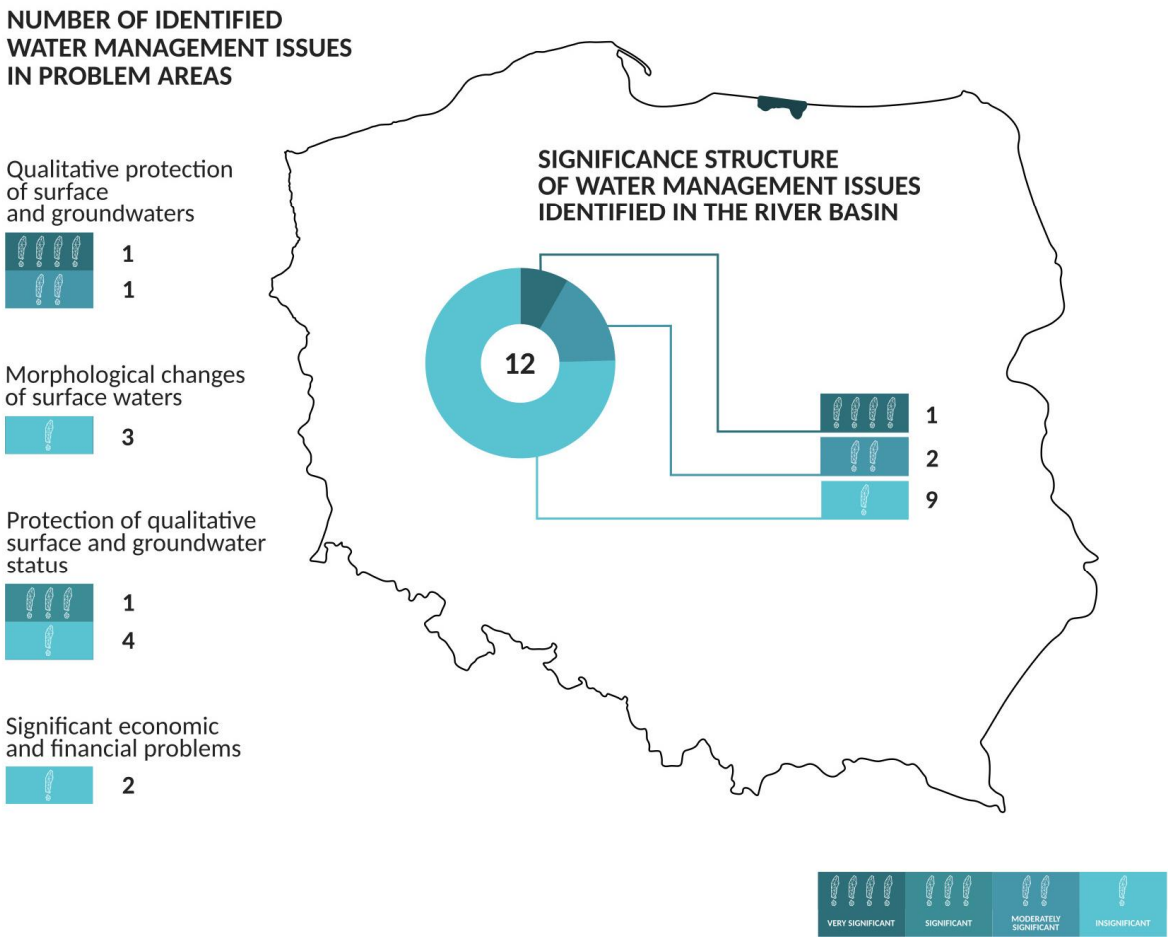
ELBE RIVER BASIN



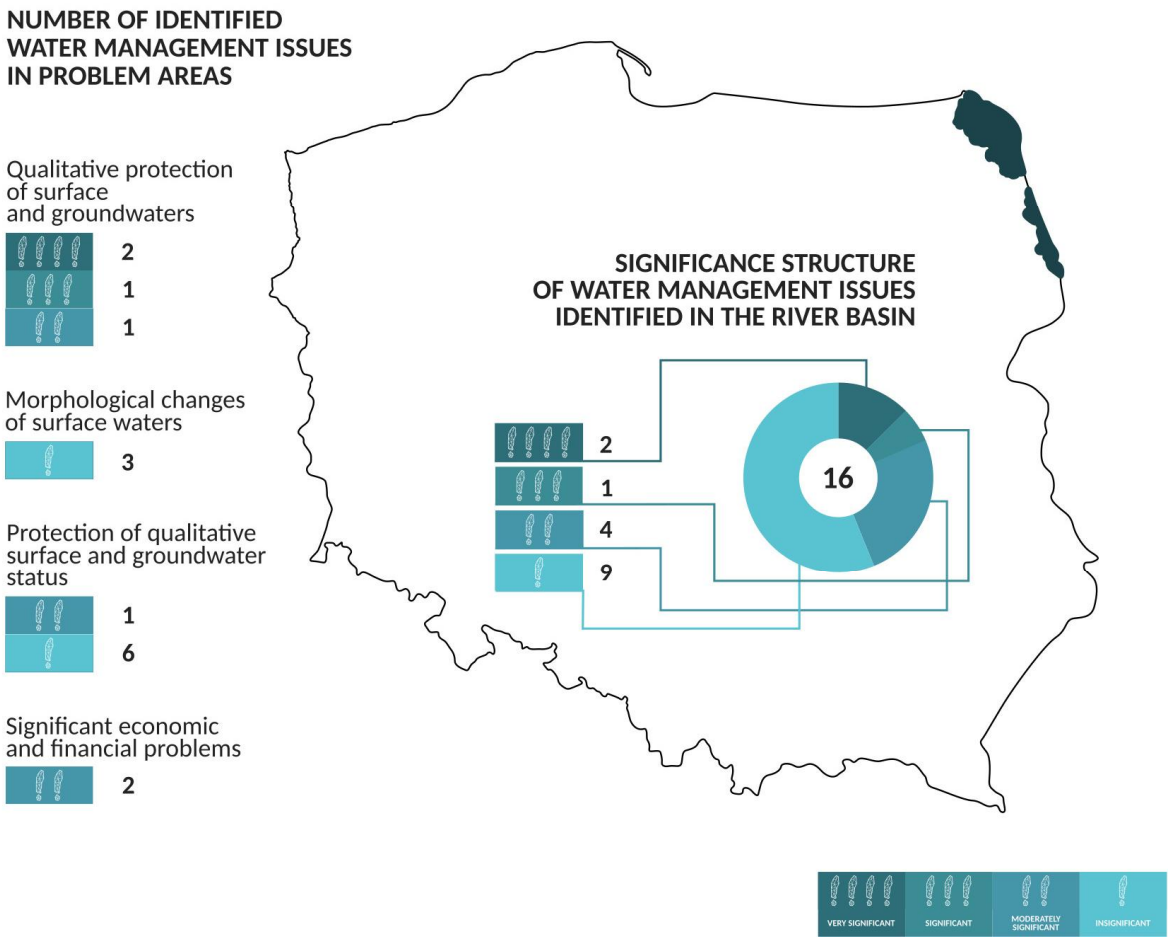
BANOVKA RIVER BASIN



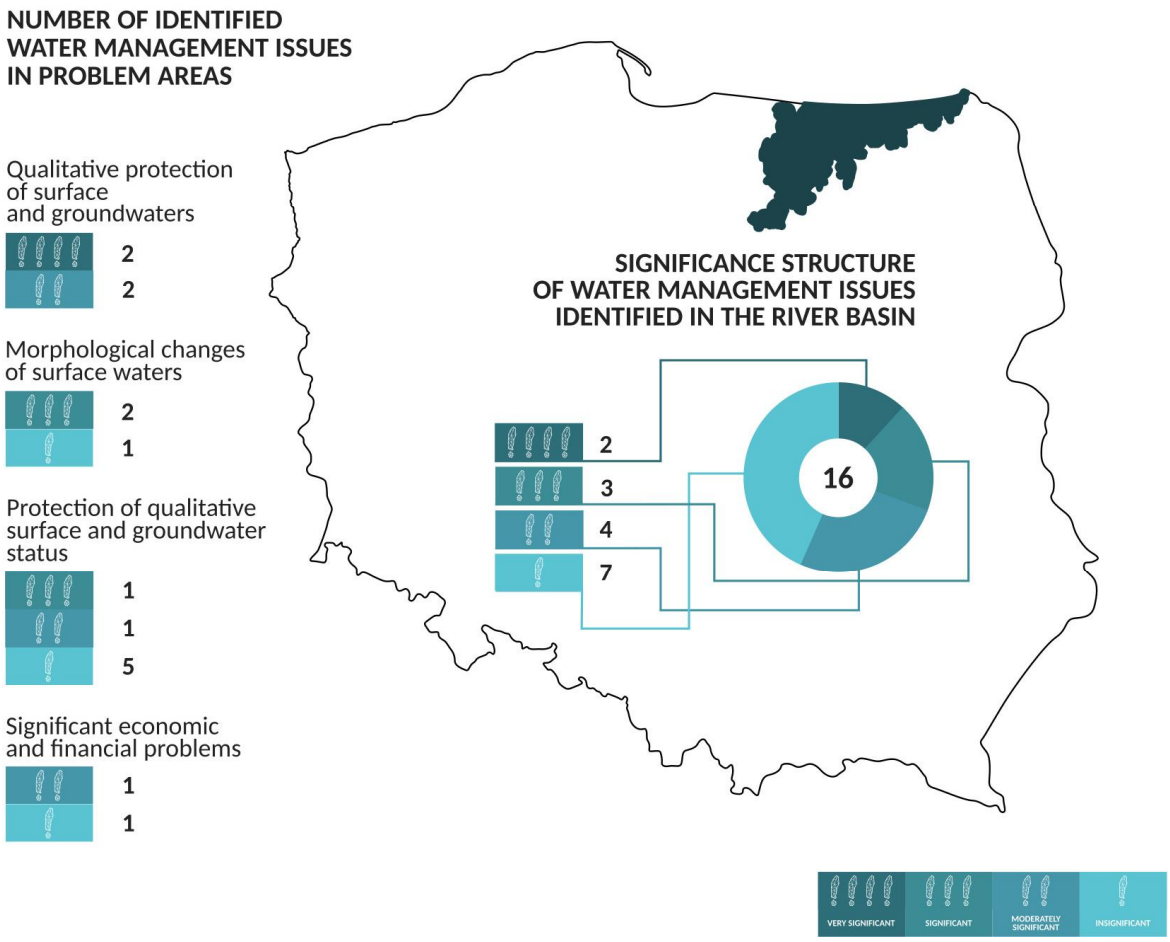
PROKHLADNAYA RIVER BASIN



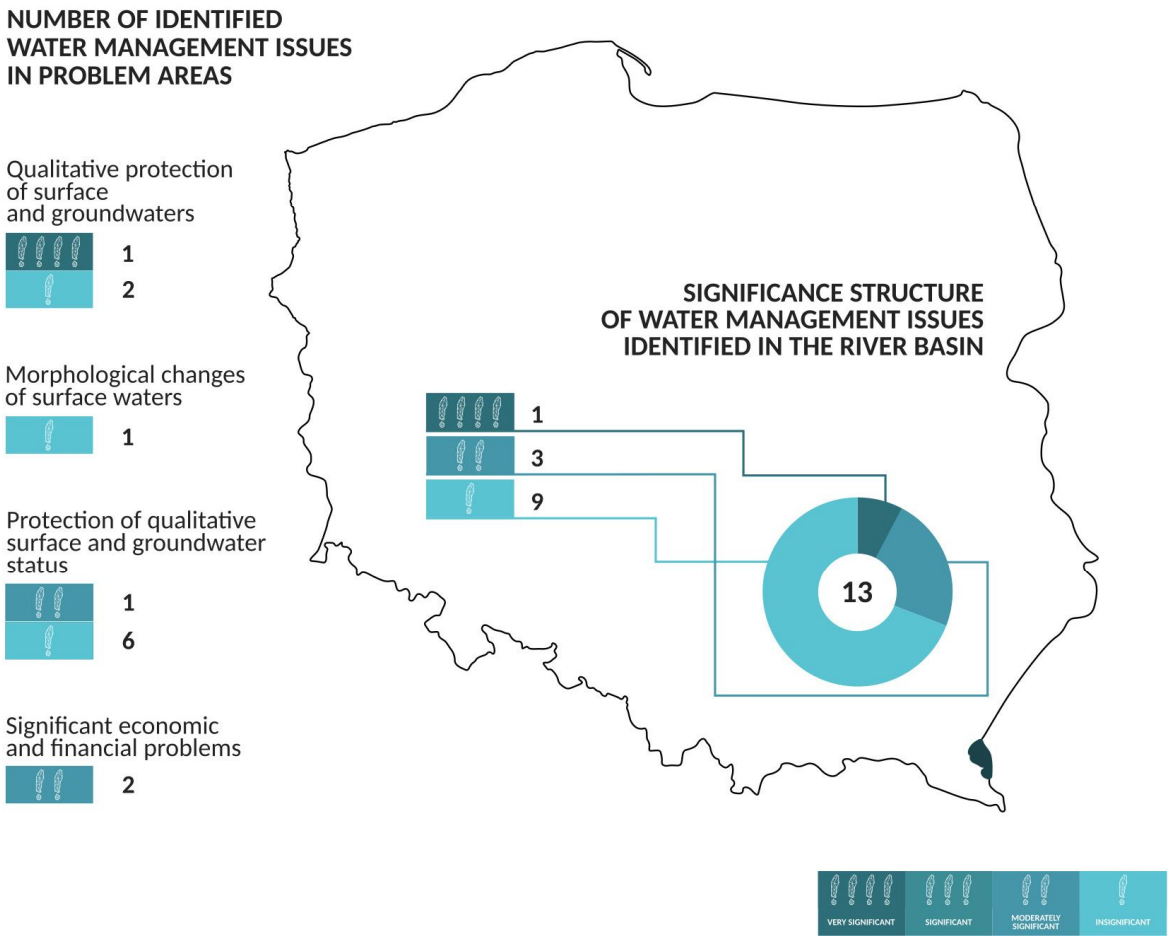
NEMAN RIVER BASIN



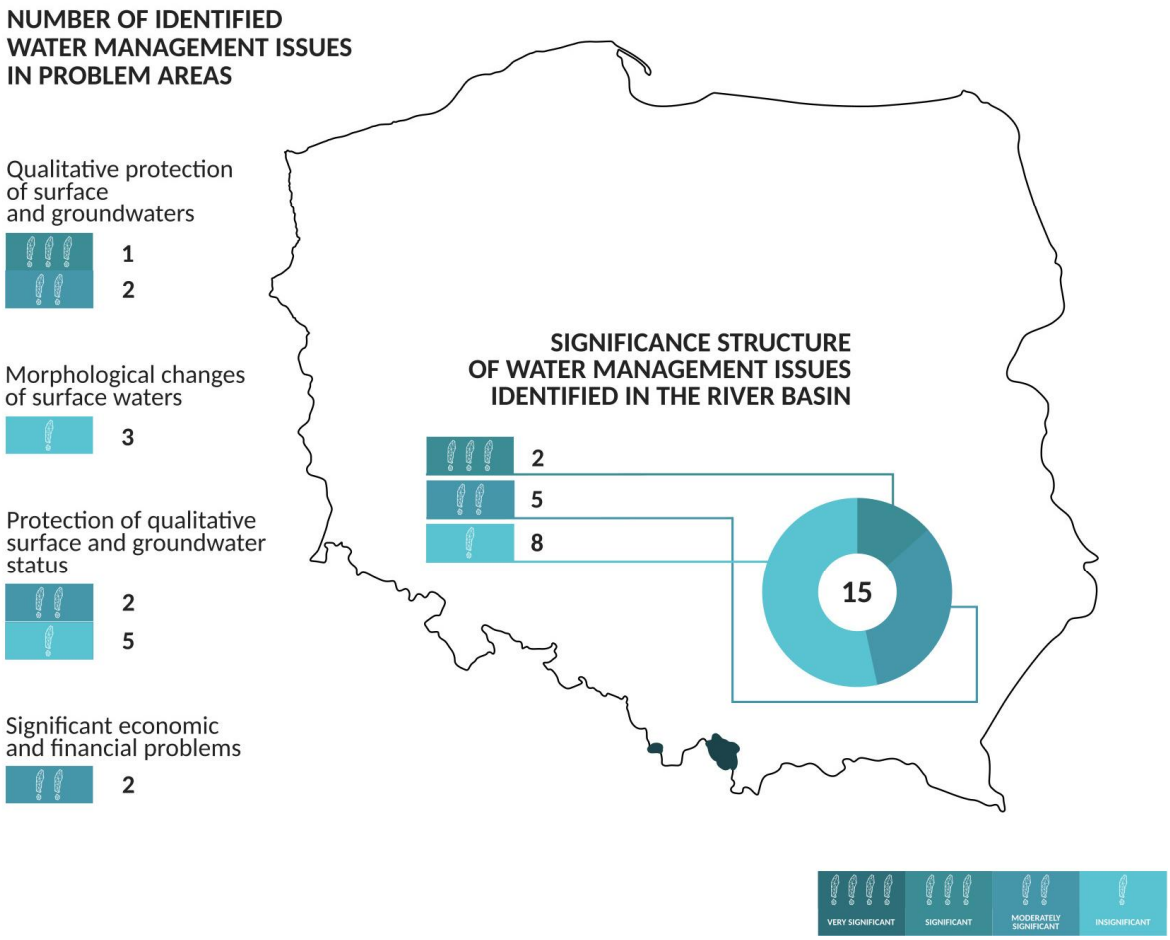
PREGOYLA RIVER BASIN



DNIESTER RIVER BASIN



DANUBE RIVER BASIN



5 LITERATURE

Absalon D., Matysik M., *Changes in water quality and runoff in the Upper Oder River Basin [Zmiany w jakości i odpływie wód w dorzeczu Górnej Odry]*, Geomorphology 2007/92

Update of the National Water and Environmental Programme [Aktualizacja Progrmau Wodno-Środowiskowego Kraju], Warsaw 2016

M. Alp, I. Keller, A.M. Westram, C.T. Robinson, *How river structure and biological traits influence gene flow: a population genetic study of two stream invertebrates with differing dispersal abilities*, Freshwater biology, 2012/57(5), pp. 969–981 Oxford: Blackwell Scientific Publications 10.1111/j.1365-2427.2012.02758.x.

Bakker E.S., Hilt S., *Impact of water-level fluctuations on cyanobacterial blooms: options for management [Wpływ wahań poziomu wody na rozwój cyjanobakterii: opcje zarządzania]*, Aquatic Ecology 2016/50

Bartkowski K., *Are pesticides an environmental issue? [Czy pestycydy są problemem w środowisku naturalnym?]*, Tutoring Gedanensis 2016/1(1) 7–10.

Bartnik W.,Bonenberg J., Florek J., *Effect of a catchment area losing its natural soil retention capacity on the morphological characteristics of the catchment area and of water courses [Wpływ utraty naturalnej retencji zlewni na charakterystykę morfologiczną zlewni i cieku]*, Polish Academy of Sciences (PAN), Countryside Infrastructure Committee, Kraków 2009.

Biedka P., *Influence of temperature changes on processes related to lake eutrophication [Wpływ zmian temperatury na przebieg procesów związanych z eutrofizacją jezior]*, Ekonomia i Środowisko2013/2(45)

Biedroń I., Dubel A., Grygoruk M., Pawlaczyk P., Prus P., Wybraniec K., *Catalogue of good practices with regard to hydraulic engineering and maintenance work, including the rules of their implementation [Katalog dobrych praktyk w zakresie robót hydrotechnicznych i prac utrzymaniowych wraz z ustaleniem zasad ich wdrażania]*, Kraków 2018

Groundwater management including interactions with surface waters in the Polish part of the Dniester, Danube, Jarft, Elbe, Neman, Pregoyla, Prokhladnaya and Ücker river basins [Bilans wodnogospodarczy wód podziemnych z uwzględnieniem oddziaływań z wodami powierzchniowymi w polskiej części dorzeczy: Dniestru, Dunaju, Jarft, Łaby, Niemna, Pregoły, Świeżej i Ücker], www.pgi.gov.pl (accessed: 14 Oct 2019).

Bilek M., Małek K., Sosnowski S., *Physicochemical parameters of potable water from wells dug in the Podkarpacie area [Parametry fizykochemiczne wody pitnej ze studni kopanych z terenu Podkarpacia]*, Bromat. Chem. Toksykol. – XLVIII, 2015/4

Błachuta J. et al., *Assessment of the needs for restoring morphological passability of rivers from the perspective of the pursuit of good status and potential of water bodies in Poland [Ocena potrzeb udrożnienia ciągłości morfologicznej rzek w kontekście osiągnięcia dobrego stanu i potencjału części wód w Polsce]*, Warsaw 2010

Brimblecombe P., *Atmospheric chemistry [Chemia atmosferyczna]* [in:] *Handbook of ecological restoration. Principles of restoration [Podręcznik odnowy ekologicznej. Zasady odnowy]*, ed. M.R. Perrow, A.J. Davy, Camridge 2002

BS EN 17233. Water quality. Guidance for assessing the efficiency and related metrics of fish passage solutions using telemetry [Jakość wody. Wytyczne w zakresie oceny efektywności i mierników rozwiązań dotyczących przepławek przy użyciu telemetrii.], 2018.

Chmielowski K., *Sewage sludge supports plant cultivation [Osady ściekowe wspomagają uprawę roślin]*, Przegląd Komunalny 2018/11

Chmielowski K., *An increasing number of sewer systems is being built [Powstaje coraz więcej systemów kanalizacji]*, Przegląd Komunalny, 2017/10

Chmielowski K., *The dairy industry and wastewater [Przemysł mleczarski a ścieki]*, Przegląd Komunalny 2018/7

Chmielowski K., *Preparation for the construction of industrial wastewater treatment plants [Przygotowanie do budowy oczyszczalni przemysłowych]*, Przegląd Komunalny 2018/4

Chmielowski K., *Extension of the sewage system in progress [Rozbudowa kanalizacji trwa]*, Przegląd Komunalny 2017/9

Chmielowski K., *Industrial wastewater and its treatment [Ścieki przemysłowe i ich oczyszczanie]*, Przegląd Komunalny 2018/5

Chmielowski K., *Water and wastewater in the cellulose and paper industry [Woda i ścieki w przemyśle celulozowo-papierniczym]*, Przegląd Komunalny 2018/12

Czekała W., *Management of digestate from an agricultural biogas plant in line with the circular economy concept [Gospodarka pofermentem z biogazowni rolniczej w myśl GOZ-u]* , Energia & Recykling 2018/7.

Dojlido J.R., *Chemistry of surface waters [Chemia wód powierzchniowych]*, Białystok 1995

Dymaczewski Z., Sozański M., *Water supply and sewage systems in Poland: tradition and the present [Wodociągi i kanalizacja w Polsce: tradycja i współczesności]*, Poznań-Bydgoszcz 2002

Ecological flows in the implementation of the Water Framework Directive Guidance Document No. 31; Technical Report - 2015 – 086, European Union 2015.

Fundala-Książek S., Łuczkiewicz A., Kowal P., Szopińska M., *Optimisation of pre-treatment of leachates and sewage [Optymalizacja podczyszczania odcieków i ścieków]*, Plus Komunalny 2019/8

Gromiec M., Sadurski A., Zalewski M., Rowiński P., *Hazards related to water quality [Zagrożenia związane z jakością wody]*, Nauka 2014/1

Gutry P., Zajkowski J., Wierzbicki K., *Can sewage treatment in rural areas be cheaper? [Czy można taniej oczyszczać ścieki na obszarach wiejskich?]*Wiadomości Melioracyjne i Łąkarskie 2009/3

Herbich P., *Groundwater resources – current state of exploration [Zasoby wód podziemnych – aktualny stan rozpoznania]*, www.pgi.gov.pl (accessed: 30 Sep 2019)

Horska-Schwarz S. et al., *Drought or flood? How to adapt to climate changes through small retention and protection of biodiversity [Susza czy powódź? Poradnik adaptacji do zmian klimatu poprzez małą retencję i ochronę bioróżnorodności]*, Legnica 2018

Ilnicki P., Górecki K., Lewandowski P., Farat R., *Long-term variability of total nitrogen and total phosphorus concentration and load in the south part of the Baltic sea basin [Zmienność długoterminowa całkowitego stężenia i zawartości azotu i fosforu w południowej części basenu Morza Bałtyckiego]*, Fresenius Environ. Bull. 2016/25/6

Municipal infrastructure in 2017 Statistical analysis. GUS 2018

Kabata-Pendias A., Pendias H., *Biogeochemistry of trace elements [Biogeochemia pierwiastków śladowych]*, Warsaw 1999

Kaca E., *Water and sewage infrastructure in rural areas at the turn of the centuries [Infrastruktura wodno-ściekowa na wsi na przełomie wieków]*, Problemy Inżynierii Rolniczej 2007

Kayak Z., *Hydrobiology-Limnology. Ecosystems of Inland Waters [Hydrobiologia-Limnologia. Ekosystemy wód śródlądowych]*, Warsaw 2001.

Code of Good Fishery Practice in Fish Rearing and Farming [Kodeks Dobrej Praktyki Rybackiej w Chowie i Hodowli Ryb], www.mgm.gov.pl (accessed: 30 Sep 2019)

National Air Protection Programme until 2020 (with an outlook to 2030) [Krajowy Program Ochrony Powietrza do roku 2020 (z perspektywą do roku 2030)], Warsaw 2015

Kupiec J.M., *Evaluation of infrastructure for storage of manures in selected farms of Poland. Conference materials*, Vinnica 2019

Kupiec J.M., *Overview of the methods of NPK macroelement balancing in agricultural production [Przegląd metod bilansowania makroskładników NPK w produkcji rolnej]*, Inżynieria i Ochrona Środowiska 2015/18/3

Kuźniar A., Kowalczyk A., Kostuch, M., *Long-Term Water Quality Monitoring of a Transboundary River [Długoterminowe monitorowanie jakości wody rzeki transgranicznej]*, Pol. J. Environ. Stud. 2014/23(3)

Groundwater body status map at http://mjwp.gios.gov.pl/mapa/mapa,172.html (accessed: 30 Sep 2019)

Marszalewski W., Piasecki A., Analysis of sewage infrastructure development in Poland in ecological and economic terms [Analiza rozwoju infrastruktury ścieków w Polsce w aspektu ekologicznym i ekonomicznym], Polityki Europejskie, Finanse i Marketing 2014/ 11(60)

Monitoring of animal species. Methodology guide. [Monitoring gatunków zwierząt. Przewodnik metodyczny]. Part III., M. Makomaska-Juchiewicz, P. Baran (eds.), Warsaw, 2012

Surface water monitoring [Monitoring wód powierzchniowych] at http://www.gios.gov.pl/pl/stan-srodowiska/monitoring-wod (accessed: 30 Sep 2019)

Natural small water retention – Method for mitigating the effects of drought, limiting the flood risk and protecting biodiversity [Naturalna, mała retencja wodna – Metoda łagodzenia skutków suszy, ograniczania ryzyka powodziowego i ochrona różnorodności biologicznej]. Fundamentals of methodology [Podstawy Metodyczne], W. Mioduszewski, T. Okruszko (eds.), Poland 2016

Assessment of progress in the implementation of action programmes for SWBs and GWBs resulting from the NWEPu [Ocena postępu we wdrażaniu programów działań dla JCWP i JCWPd wynikających z aPWŚK], Gliwice 2018

Retrospective assessment of the status of water bodies for purposes of an individual analysis of compliance with the Water Framework Directive of projects co-financed with EU funds [Ocena wsteczna stanu jednolitych części wód na potrzeby indywidualnej analizy zgodności z Ramową Dyrektywą Wodną projektów współfinansowanych z funduszy unijnych], M. Pchalek (ed.), Warsaw 2014

Environmental Protection 2018 [Ochrona Środowiska 2018], www.stat.gov.pl (accessed: 30 Sep 2019)

Environmental Protection in 2018, Central Statistical Office of Poland, Warsaw 2018

Reply to parliamentary question no. 18075 on the effects of introducing a water price regulator, delivered by Undersecretary of State at the Ministry of Maritime Economy and Inland Navigation, Anna Moskwa, 2.02.2018, www.sejm.gov.pl (accessed: 30 Sep 2019)

Reply to parliamentary question no. 21887 on EU funding of water investments in Końskie and Radoszyce, delivered by Undersecretary of State at the Ministry of Maritime Economy and Inland Navigation, Anna Moskwa, 30.05.2018,www.sejm.gov.pl (accessed: 30 Sep 2019)

Reply to a parliamentary question regarding the increase in water service fees, granted by the Undersecretary of State at the Ministry of the Environment, Mr Mariusz Gajda, 12.07.2017, ref. no. DZW-I.070.48.2017.SW, www.sejm.gov.pl (accessed: 30 Sep 2019)

Development of a draft Plan for drought prevention in the Lower Vistula water region, including the indication of the areas most exposed to its effects [Opracowanie projektu Planu przeciwdziałania skutkom suszy w regionie wodnym Dolnej Wisły wraz ze wskazaniem obszarów najbardziej narażonych na jej skutki], Mędłów 2015, www.rzgw.gda.pl (accessed: 14 Oct 2019).

Palmer M.A., Bernhardt E.S., Allan J.D., Lake P.S., Alexander G., Brooks S. et al., *Standards for ecologically successful river restoration [Standardy ekologicznie skutecznej renaturyzacji rzek]*, Journal of Applied Ecology 2005/42

Draft plan for counteracting drought effects [Projekt planu przeciwdziałania skutkom suszy], Warsaw 2019, www.stopsuszy.pl (accessed: 14 Oct 2019).

Prus P., Popek Z., Pawlaczyk P., *Good practice in river maintenance [Dobre praktyki utrzymania rzek]*, Warsaw 2018

Prus P., Wiśniewolski W., *Diversity of forage for fish in mountain and lowland storage lakes and its consequences for the composition of ichthyofauna [Zróżnicowanie bazy pokarmowej ryb w górskim i nizinnym reservoir zaporowy i jego konsekwencje dla składu ichtiofauny]* [in:] *Fishing in lakes, rives and storage lakes in 2004 [Rybactwo w jeziorach, rzekach i zbiornikach zaporowych w 2004 roku]*, ed. M. Mickiewicz, A. Wołos, Olsztyn 2005

Review of Significant Water Management Issues [Przegląd istotnych problemów gospodarki wodnej], Kraków 2008

Review of Significant Water Management Issues [Przegląd istotnych problemów gospodarki wodnej], Warsaw 2012

Fish passes – design, dimensions and monitoring [Przepławki dla ryb – projektowanie, wymiary i monitoring], P. Nawrocki (ed.), Warsaw 2016

Przytuła E., Filar S., Mordzonek G., Groundwater management balance including interactions with the surface waters in the Polish part of the Oder basin [Bilans wodnogospodarczy wód podziemnych z uwzględnieniem oddziaływań z wodami powierzchniowymi w polskiej części dorzecza Odry], Warsaw 2013

Raczuk J., Królak E., *Assessment of infant health risk related to exposure to nitrates and nitrates in potable water in agricultural areas [Ocena ryzyka zdrowotnego niemowląt związanego z narażeniem na azotany (V) i (III) w wodzie pitnej na terenach rolniczych]*, Probl. Hig. Epidemiol. 2016/97(2)

Rast W., Thornton J.A., *Trends in eutrophication research and control [Trendy w badaniach i kontroli eutrofizacji],* Hydrol. Process 1996/10

Implementation of collective water supply for the inhabitants of rural communes, NIK 2018, Registration No. 186/2017/P/17/107/LZG

Rules of Organisation of the National Water Management Authority of 26.03.2019 [Regulamin organizacyjny Państwowego Gospodarstwa Wodnego Wody Polskie z 26.03.2019r.]., www.wody.gov.pl (accessed: 30 Sep 2019)

Register of Plant Protection Products [Rejestr Środków Ochrony Roślin], www.gov.pl (accessed: 30 Sep 2019)

Reservoir limnology: Ecological Perspectives, ed. K.W Thronton., B.L. Kimmer, F.E. Payne, New York – Chichester – Brisbane – Singapore 1990

Agriculture in 2018. Statistical analyses [Rolnictwo w 2018. Analizy statystyczne], www.stat.gov.pl (accessed: 30 Sep 2019)

Government bill on Water Law, Sejm of the 8th term, document no. 1529, Warsaw 2017

Sikora J., *Level of satisfaction of rural population with life in rural areas in the light of empirical research [Poziom zadowolenia mieszkańców wsi z życia na wsi w świetle badań empirycznych]*, Studia Obszarów Wiejskich 2016/41

Dictionary of hydrogeology, ed. J. Dowgiałło, A.S. Kleczkowski, T. Macioszczyk, A. Różkowski, Warsaw 2002

Sources and pathways of nutrients to the Baltic Sea HELCOM PLC-6 Baltic Sea Environment Proceedings No. 153

Position of the Helsinki Commission (HELCOM) on sewage sludge of 15 March 2017 (recommendation (38/1)

Steller J., *Hydropower engineering in Poland – a challenge beyond comprehension [Energetyka wodna w Polsce – niepojęte wyzwanie]*, conference materials 2009

Stepnowski P., Synak E., Szafranek B., Kaczyński Z., *Monitoring and analysis of environmental pollution [Monitoring i analityka zanieczyszczeń w środowisku]*, Gdańsk 2010

Strategy for Responsible Development until 2020 (with a perspective until 2030), Warsaw 2017

Strategy for common solution of significant water management issues in the international Oder river basin, Wrocław 2013

Strategy for common solution of significant water management issues in the international Oder river basin, Wrocław 2019

Strategic adaptation plan for sectors and areas sensitive to climate change up to 2020 with prospects up to 2030 [Strategiczny plan adaptacji dla sektorów i obszarów wrażliwych na zmiany klimatu do roku 2020 z perspektywą do roku 2030], Warsaw 2013

Establishment of a method for estimating environmental flows in Poland, Stage II of the final report [Ustalenie metody szacowania przepływów środowiskowych w Polsce, Etap II raport końcowy], Warsaw 2015

Analysis of the variants for restoring passability of ponding structures on water courses in the territory administered by the Regional Water Management Board in Kraków [Wariantowa analiza sposobu udrożnienia budowli piętrzących na ciekach w obszarze RZGW w Krakowie], Kraków 2017–2018

Verification of water typology and boundaries of surface water bodies [Weryfikacja typologii wód oraz granic jednolitych części wód powierzchniowych], Gliwice-Warsaw 2015

Wierzbicki K., Gromada O., *Relationship between village class and sewage system infrastructure [Związek między klasą wsi i jej infrastrukturą kanalizacyjną]*, Wiadomości Melioracyjne i Łąkarskie 2000/(43)2

Wilkowski M., *Small hydropower plants matching the needs of the 21st century [Małe elektrownie wodne na miarę XXI w.]*, Czysta Energia 2011/4

Wiśniewolski W., *Factors conducive and harmful to the development and maintenance of fish populations in lotic waters [Czynniki sprzyjające i szkodliwe dla rozwoju i utrzymania populacji ryb w wodach płynących]*, Supplementa ad Acta Hydrobiologica2002/3

Wiśniewolski W., Prus P., Ligięza J., Adamczyk M., Suska K., Parasiewicz P., *Possibilities of compensation for and minimisation of the effects of river training and maintenance [Możliwości kompensacji i minimalizacji oddziaływań prac regulacyjnych i utrzymaniowych w rzekach]* [in:] *Functioning and protection of flowing waters [Funkcjonowanie i ochrona wód płynących]*, ed. R. Czerniawski, P. Bilski, Szczecin 2017

Wiśniewolski W., *Changes to the composition of ichthyofauna, its biomass and harvesting in selected storage lakes in Poland [Zmiany w składzie ichtiofauny, jej biomasa oraz odłowy w wybranych zbiornikach zaporowych Polski]*, Arch. Pol. Fish. 10 Suppl. 2002/2

List of emission and concentration values of priority substances and other pollutants in the basins of the Vistula, Pregoyla and Neman basins in the area of the National Water Management Authority in Białystok, Białystok 2018

Management of water resources in Poland 2018 [Zarządzanie zasobami wodnymi w Polsce 2018], www.ungc.org.pl (accessed: 30 Sep 2019)

Zbierska J., Murat-Błażejewska S., Szoszkiewicz K., Ławniczak A.*Nutrient balance in Wielkopolska agroecosystems in the aspect of water quality protection on the example of the Samica Stęszewska catchment area [Bilans biogenów w agroekosystemach Wielkopolski w aspektuktu ochrony jakości wód na przykładzie zledami Samicy Stęszewskiej]*, Poznań 2002

Collection of Good Agricultural Practice Recommendations for the protection of waters against nitrate pollution from agricultural sources [Zbiór Zaleceń Dobrej Praktyki Rolniczej mający na celu ochronę wód przed zanieczyszczeniem azotanami pochodzącymi ze źródeł rolniczych], ed. IUNG-PIB Puławy, Ministry of Agriculture and Rural Development, Ministry of Maritime Economy and Inland Navigation, Warsaw 2019

Żelaziński J., *The role of floodplain maps in flood protection planning [Rola map terenów zalewowych w planowaniu ochrony przeciwpowodziowej]* [in:] *Safe commune on the Oder [Bezpieczna gmina nad Odrą]* , ed. P. Nieznański, Wrocław 2007.

Żelaziński J., *Changes in Polish Water Law necessary for full transposition of the Water Framework Directive [Zmiany polskiego prawa Wodnego niezbędne dla pełnej transpozycji Ramowej dyrektywy Wodnej],* Warsaw 2004.

Żelazo J., *Restoration of rivers and valleys [Renaturyzacja rzek i dolin]*, Infrastruktura i Ekologia Terenów Wiejskich 2006/4/1

The phenomenon of drought in the area of activity of the Regional Water Management Board in Kraków in 2011 [Zjawisko suszy na obszarze działania RZGW w Krakowie w 2011 r.], Kraków 2012, www.krakow.rzgw.gov.pl (accessed: 14 Oct 2019).

6 APPENDICES

Appendix 1. Review of Significant Water Management Issues.

Appendix 2. Statistical Summary of Significant Water Management Issues.