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Legal and water management policy during climate warming in Poland

Michał Marszelewski[1, CDFMR], Adam Piasecki[2, CDFMR]

[1]*Nicolaus Copernicus University in Toruń,* Faculty of Law and Administration, Toruń, Poland, e-mail: marszelewski@umk.pl *(corresponding author)*, ORCID ID https://orcid.org/0000-0002-2479-9051; [2]*Nicolaus Copernicus University in Toruń*, Faculty of Earth Sciences and Spatial Management, Toruń, Poland, e-mail: piasecki@umk.pl, ORCID ID https://orcid.org/0000-0002-8787-7520

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Abstract. The article discusses some of the effects of global warming on rivers, lakes and underground water in Poland. It documents serious difficulties in river shipping and energy, as well as the exposing of areas previously occupied by lakes as a result water levels lowering. It is pointed out that the rapid increase in intensive irrigation of agricultural areas is causing excessive exploitation of underground water. The analysis takes into account the relevant data. The presentation of the effects of global warming is expanded upon with the legal provisions applicable in these situations. In the absence of climate change law, these are general regulations that face a number of difficulties in application. The detailing of areas of law and hydrology leads to the conclusion that Poland lacks a coherent policy on climate warming.

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1. Introduction

The changes in climate that have been observed over recent decades present particular societal challenges. On the national level, these changes affect virtually every area of policy (e.g. agriculture, energy, transport). Supra-regionally and globally, climate changes are still not been fully understood. Countering their effects requires immediate and long-term actions, which will involve further complications in taking into account the interests, priorities or capabilities of individual countries (Bodansky et al., 2017). The countries that contribute significantly to climate changes and thus can have a real impact in countering them lack the motivation to act quickly (Lazarus, 2009). Thus, the problem is not merely environmental, but also economic (requiring that profits and losses be calculated in order to arrive at an "efficient" outcome) and even ethical, focused on issues of distributive and corrective justice (Bodansky et al. 2017). With this in mind, the literature indicates that, from a public policy perspective, the issue of climate change exacerbates known problems in other areas, creating a "super wicked problem". This view also applies to the possibility of drafting climate change legislation, especially in the absence of any global law-making institution with jurisdictional reach and authority (Lazarus, 2009).

Among the elements of the environment that depend on climate conditions, water resources are key. The prevailing climate determines their size. Beginning in the latter 20th century, climatic changes have been accelerating. Most noticeable are global warming and its associated heatwaves. These have various social and economic effects (e.g., Smoyer 2003, McGregor et al. 2007, Guirguis et al. 2014, Zuo et al. 2015, Kibria 2016, Urban et al. 2017, Schiermeier 2019, Dąbrowski & Marszelewski, 2021). In the years 1961–2015 in the Central European Lowland the annual average air temperature increased from 1.4 to 1.7°C (Marszelewski & Pius, 2019) and the annual average temperature of rivers from 1.1 to 1.5°C (Marszelewski & Pius, 2015). This has resulted in, among other things, a reduction in surface and underground water resources and an increase in water temperature, hindering its use for economic purposes. Such situations are increasingly affecting areas not previously classified as subject to water deficits. And one such area is found in the centre of the European Lowland, in Poland.

One important domain where the consequences of negative changes in surface and groundwater resources are seen is the law. The general normative regulations in force have not been adjusted to the new phenomena and processes. Hence the need to analyse the climate-change-related difficulties in executing the law. This relationship is recognised in the literature. For example, the American literature recognises the potential for climate change to affect the jurisdictional status of water bodies in the USA. Apart from alleged difficulties in applying the Clean Water Act of 1972 (33 United States Code, Chapter 26) and its definition of "waters of the United States" (currently under revision) it is indicated that such a jurisdictional status could shift as a result of climate change (Faust et al., 2016).

This article discusses emerging new hydrological situations caused by global warming that current Polish law is ill-suited to handling. In addition, attention is also given to hydroclimatological situations demanding legal debate.

2. Research area and methods

Hydrological-legal aspects and policy in water management are discussed on examples seen in the Vistula and Oder basins of Central Europe, in a temperate climatic zone. According to "Significant water management issues for river basins" (2019), the land-use structure is dominated by agricultural land (66% in the Vistula river basin and 62% in the Oder river basin) and forests together with seminatural ecosystems (29 and 33%, respectively). Because of its good soil quality, the area was deforested already in the 18th century and developed for high-yield agricultural production.

Both river basins belong to the Baltic Sea catchment and respectively occupy 193,96 and 119,07 km^2 (Fig. 1). The respective average annual flows of the Vistula and Oder rivers at their estuaries are 1,080 and 567 m^{3}s^{-1}. This means that the average water resources of both river basins are small, at 5.6 and 4.8 dm^{3}s km^2. The lowest water resources are found in the east of the Oder river basin (in the Noteć and Warta drainage basins of the Kujawy region), averaging only 1.8 to 2 dm^{3}s km^2 per year. These outflow values are among the lowest in Europe. The main reasons are low atmospheric precipitation (averaging 544 mm per year, Ilnicki et al., 2014) and high evapotranspiration. Annual precipitation is slightly higher (around 700 mm) in the northern parts of the Vistula and Oder basins, and highest in the mountains (up to 1,200 mm

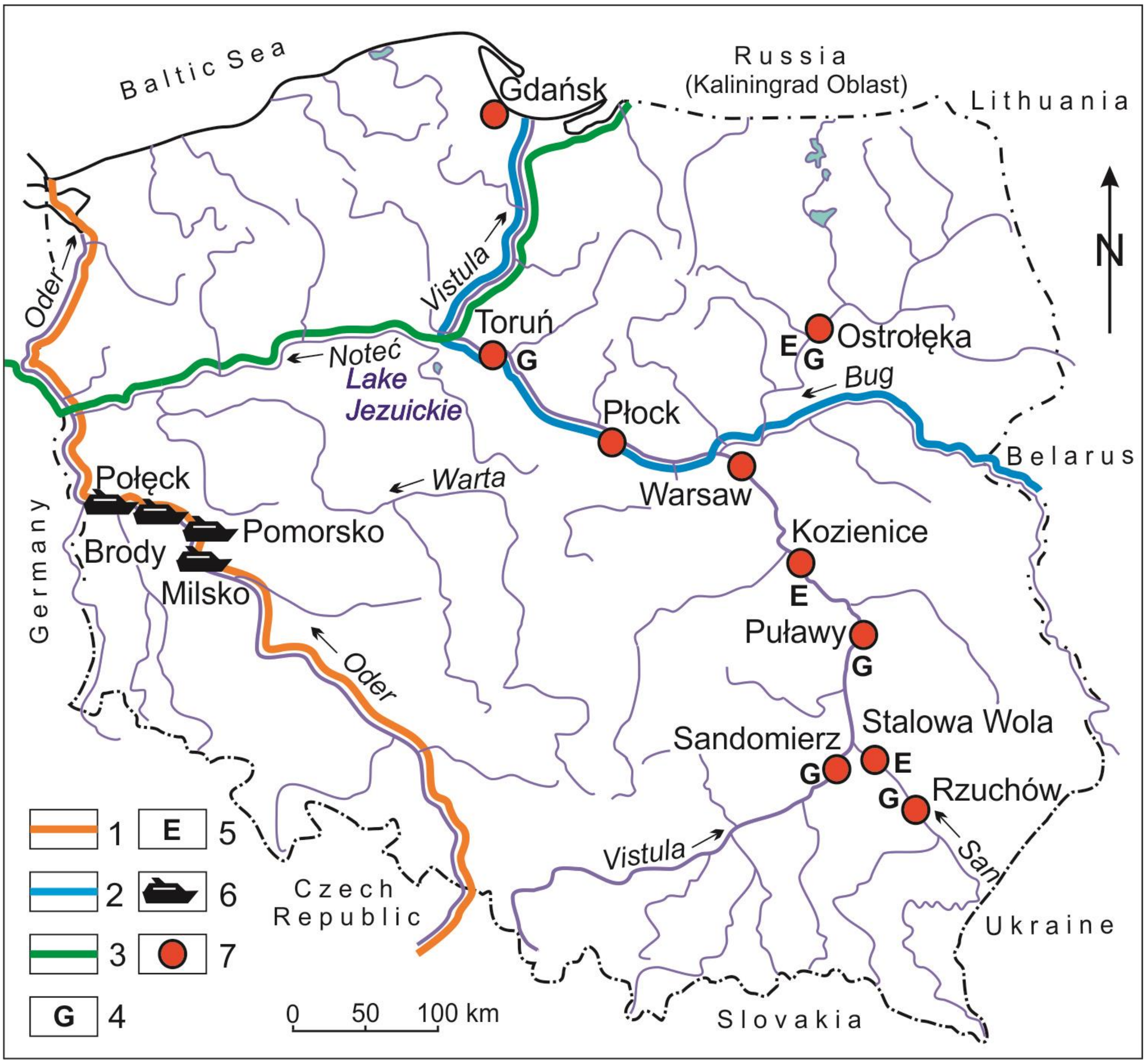

Fig. 1. The Vistula and Oder river basins, showing international waterways in Poland and objects referred to in the article. Explanation: 1 - E30 European waterway; 2 - E40 European waterway; 3 - E70 European waterway; 4 - gauging station; 5 - power plant; 6 - river ferry; 7 - city.

Source: author's own work.

in the Sudetes and over 1,300 mm in the Tatra Mountains).

The article uses hydrological data from the Institute of Meteorology and Water Management - National Research Institute (IMGW-PIB) in Warsaw, including: daily and average monthly water levels of the Vistula River at the Puławy and Toruń gauging stations, and daily water temperatures for the Vistula River (Sandomierz gauging station) and the San River (Rzuchów gauging station). The datasets were subjected to standard statistical analyses indicating trends and statistical significance at the 0.05 level. In addition, queries were made of scientific, industrial and energy-sector materials and court rulings.

3. The influence of climate changes on water management and water resource from a hydrological and legal perspective

3.1. Rivers

In terms of the economy, rivers are particularly used as waterways and as source of water for industrial and municipal purposes. However, the role of inland waterways is marginal in Poland. In 2014 the share of inland waterway transport in total freight transport was 0.4% (Kozerska, 2016). This is primarily due to historical conditions. Waterways in Western Europe were built at the turn of the 20th century. At that time, no independent Polish state existed.

According to “Inland waterway transport in Poland” (2018), the length of inland waterways in 2017 was 3,654 km, including 2,417 km of regulated navigable rivers. In Poland, requirements for routes of international significance (classes IV and V) are met only by 5.9% of the length of waterways (214 km). At the same time, waterways are not properly maintained, in contravention of the law. Article 41 of the Act of 21 December 2000 on inland navigation (consolidated text, Journal of Laws 2020, item 1863) requires that such routes be maintained in a manner that ensures safe navigation, including by systematically improving operating conditions in accordance with the standards required to the relevant waterway class.

Efforts have been ongoing for more than a decade to develop water transport and integrate Polish waterways into the European system through the international waterways E30, E40 and E70 (Fig. 1). By 2030, the entire length of the Oder River and the Warsaw–Gdańsk section of the Vistula River are to become international shipping routes. Thus far, particular focus has been given to designing infrastructure development and related benefits, and forecasting transport demand and the costs of hydro-engineering investments (Nowakowski et al., 2015). At the same time, due attention has not been paid to the possible consequences of global warming, despite warnings from certain researchers (e.g. Schweighofer, 2014), and statements that future adaptation plans for water management during climate warming should better link science, society and policy (Drenkhan et al., 2015).

3.1.1. Water level

Low water levels in rivers make water transport difficult or impossible. One example is the transport of a gas turbine and generator with accessories with a total weight of 3,074 tonnes. This was planned from Gdańsk to Stalowa Wola (646 km) along the Vistula, and along the San River for the short final leg. Barges and pusher craft with the shallowest permissible draft (from 0.7 to 0.9 m) were used for transport. The transport time was calculated at 14–15 days (Rabant et al., 2016). In fact, the transport lasted from July 10, 2013 to May 12, 2014, but only up to the San River’s confluence with the Vistula. The low water level on the San River meant that the last leg had to be overland. The need to switch from water to land transport not only caused further delay, but also increased costs. It was necessary to rebuild sections of national road 77 and to disassemble or raise electrical and communication installations, and to disassemble and reassemble road signage, lighting, and traffic lights. It was also necessary to reinforce a pedestrian underpass that platforms each bearing loads of up to 460 tonnes had to pass over. Financial losses were also incurred by a 450-MW deficit in the national grid and the inability to sell and receive payment for the approximately 600 million m^3 of gas that went unused due to the delay in commissioning the new power unit into use.

Pursuant to shipping regulations and the binding Regulation of the Council of Ministers of 7 May 2002 on the classification of inland waterways (Journal of Laws 2002, No. 77, item 695), transports from Gdańsk along the Vistula to the mouth of the San should be possible without obstruction in the shipping season. According to this regulation, on the route of the transported cargo, the Vistula River should have waterway parameters from Ib to III, guaranteeing a transit depth of more than 1.6 m and, for class IV, more than 2.8 m. Waterways not complying with the parameters of their designated categories, especially in periods of climate changes, causes economic and social losses.

The lack of required transit depths in the Vistula River are currently becoming the biggest threat to navigation and waterway modernisation plans in Poland. Since 1966, the annual number of days of water levels that prevent barge traffic even at low draft, i.e. 0.8–1.0 m has more than doubled. There has been a particularly large increase in days without transport possibilities on the Vistula since the mid-1980s, both on the regulated section (Toruń gauging station) and the unregulated section (Puławy gauging station). It is worth noting that until the mid-1980s the water level of the regulated section of the Vistula (which was also part of the E40 international waterway) was only sporadically below that required for navigation (Fig. 2).

The lack of required transit depths on the Vistula had many other economic and social effects. The last functioning river shipyard in Płock is threatened with bankruptcy. This shipyard builds tankers with a displacement of up to 4,000 tons and 110 m in length for a Dutch shipowner, but cannot deliver them due to the low water level on the Vistula. This, in turn, makes it impossible to procure new contracts. In the 1960s, four other river shipyards operated along the Vistula: in Kraków, Sandomierz, Warsaw and Tczew.

The operation of the few transport enterprises on the Vistula is also at risk. In the early 20th century, one had at least 12 services from Płock to Gdańsk. In recent years, it has completed at most two in a shipping season, if hydrological conditions allow. When determining terms and conditions for orders, the company is unable to fix a date for the provision of the service, which usually causes potential clients to withdraw.

Low water levels also cause difficulties for river ferry traffic. This problem was particularly evident in the case of the Oder River, on which several ferry crossings operate. In the summer of 2019, no river ferries ran in the middle course of the Oder, including in Połęck, Brody and Pomorsk. This meant that drivers had to use bridges, extending journeys by 30–40 km, which is especially troublesome for

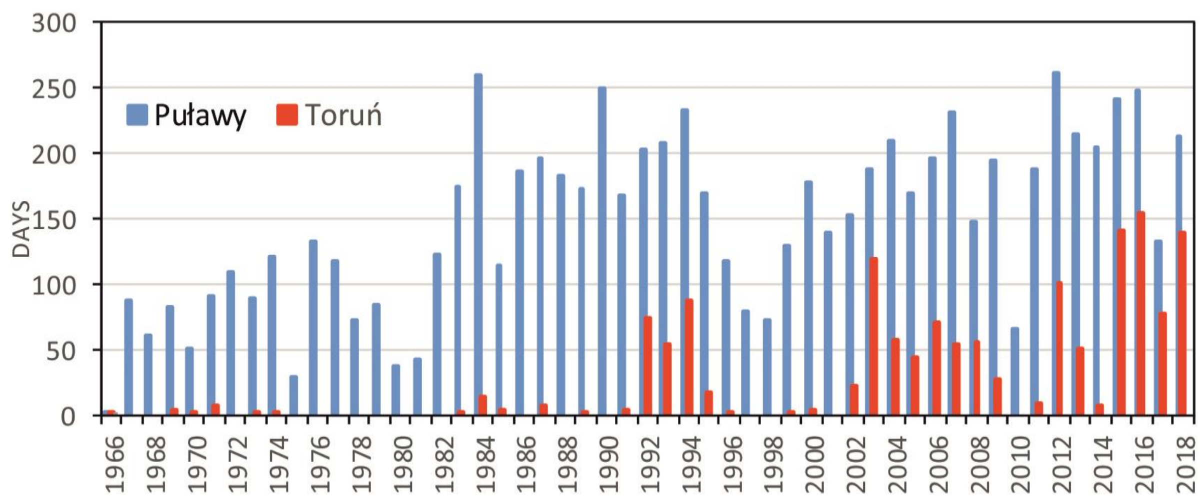

Fig. 2. Annual number of days of excessively low water levels preventing water transport on the Vistula, 1966–2018 Key: blue – Puławy gauging station (middle section of river); red – Toruń gauging station (lower section of river). Based on data from the Institute of Meteorology and Water Management - National Research Institute in Warsaw.

Source: author's own work.

local traffic. This is also troublesome for farmers who own land on both banks of the Oder. Around the town of Milsko, farmers could not cross the river for more than half the year.

Another measurable example of the effects of low water levels on the Vistula is the Kozienice power plant – Poland's second-largest coal power plant (over 4,000 MW). In 2015, hydrological drought caused persistent unnaturally low water levels in the Vistula and high water temperatures, making it difficult to effectively cool the generating units. These circumstances have created a real threat to the energy security of Warsaw and the Mazowsza region. Hence, the competent authority – Mazowiecki Voivode – pursuant to the provisions of the Act of April 26, 2007 (consolidated text, Journal of Laws 2020, item 1856 as amended) on crisis management, gave permission for the immediate commencement of work to temporarily dam the Vistula at the power plant "in order to ensure the continuity of the cooling process for devices designed to generate electricity" (PAP 2015). The extraordinary powers invoked to initiate these activities allows them to be carried out first and legalised later. This constituted the basis for constructing a check dam of Larssen sheet piling to enable the power plant to operate normally (Ciepielak, 2016). This dam, according to the Voivode's consent, was to be temporary, i.e. until the hydrological situation on the Vistula stabilised (Basaj, 2015), but not longer than one year.

Independently of work having begun, a decision on the environmental conditions for the temporary check dam was applied for. In 2016, determining – contrary to an environmental impact assessment on the investment – that the dam structure had no significant environmental impact, the mayor of Kozienice issued the decision (judgment of the Provincial Administrative Court in Warsaw of March 15, 2017 (VIII SA/Wa 778/16). A decision was also issued on the location of a development for public purposes. Both decisions were issued with immediate effect. Then a permit was issued for the construction of the dam.

The actions taken by the power plant to legalise the check dam were challenged by environmental organisations. The Supreme Administrative Court in its judgement of 7 May 2019 (II OSK 1584/17) dismissed the cassation complaint from the judgement of the Provincial Administrative Court in Warsaw of 15 March 2017 (VIII SA/Wa 778/16) in which the decision on environmental conditions was revoked for the check dam. The decision was annulled on technicalities relating to the issuing procedure, and not for substantive reasons. Despite the check dam having been in use for over two years, no permit has been obtained for its use. Therefore, it has not formally been commissioned into use (Elektroproblem 2019a). As a consequence, the legal status of the check dam is indeterminate. This allows allegations to be made regarding the lack of a legal basis for the structure's existence, all the more so because it has interrupted the waterway.

The check dam in Kozienice is not equipped with a lock. The waterway has been closed in the area since 2017. However, the power plant has made available a crane that can move units of up to 13 metres long, 4 metres wide and 2.5 tonnes in weight (Fundacja Przystań Wisła 2017).

The construction of the check dam stirred many controversies from it inception. Ichthyologists believe it has interrupted the ecological continuity of the Vistula and negatively affects fish life, including Atlantic salmon and other protected fish species. The partition negatively affects six Natura 2000 areas (Ciepielak, 2016; Sieński, 2016). The following are also pointed out:

- the failure of construction of the check dam to comply with the Water Framework Directive (WFD), 2000/60/EC;
- the negative environmental impact of the barrier and the need to assess the environmental impact of the project (as required by European environmental law);
- the operation of the power plant deliberately resulting from a desire to avoid the costs of investing in a pro-ecological structure (Elektroproblem 2019b, Żelaziński 2015).

Water levels are also reduced in other rivers. In the case of the Narew river (Ostrołęka gauging station), minimum water levels have fallen by on average 0.9 cm year-1 since 2000. In order to provide the required amounts of water from the river to cool the generating units of the "Ostrołęka" power plant, an innovative weir was constructed to accumulate water at the plant's intake from the river. The damming structure was equipped with a unique, prototypical system across the river bed. The segments have gaps in between them allowing water to flow, despite the damming. The gaps allow aquatic organisms to migrate and debris to pass through. This solution has avoided the need to build a fish ladder for migratory fish.

3.1.2. Water temperature

The increase in river water temperature is another effect of global warming seen in various parts of the world (e.g., Web and Nobilis, 1995; Morrison et al., 2002; Swansburg et al., 2004; Caissie, 2006; Hari et al., 2006). The main factor in changes in water temperature is air temperature (Webb et al., 2003; Garner et al., 2013). The same is true of rivers in the Central European Lowland, with strong correlations between average air and water temperatures ranging from r=0.80 to r=0.87. In the same rivers in the years 1961–2010 the average annual water temperature increased from 0.17 to 0.27°C/10 years depending on many environmental conditions (Marszelewski & Pius, 2015).

However, to assess the impact of an increase in water temperature on water use, maximum temperatures are more important, especially in terms of their use for refrigeration purposes, e.g. by power plants using open water circulation. Water temperature above 25°C decreases the cooling efficiency of power plants and increases the risk of power supply reductions. Before 2000, such situations were rare on Polish rivers. In the present age, water temperatures above 26°C and even above 28°C are increasingly frequent (Fig. 3). They occur especially during droughts and heatwaves, i.e. when electricity demand increases rapidly. A further increase in incidence of high river water temperatures combined with higher air temperatures may result in temporary electricity shortages. It may also increase energy production costs through the need to pump cooling water or to run splash coolers.

The water temperature also increases in winter. In the Central European Lowland, this season was usually characterised each year by ice phenomena (including ice cover). However, since the beginning of the 20th century the duration of ice phenomena has systematically fallen on all rivers in this part of Europe, by more than 1.5 days/year on average (Pawłowski, 2017). Since 2012, there has been no ice cover on, for example, the Vistula and the Oder. These changes are beneficial in that they extend

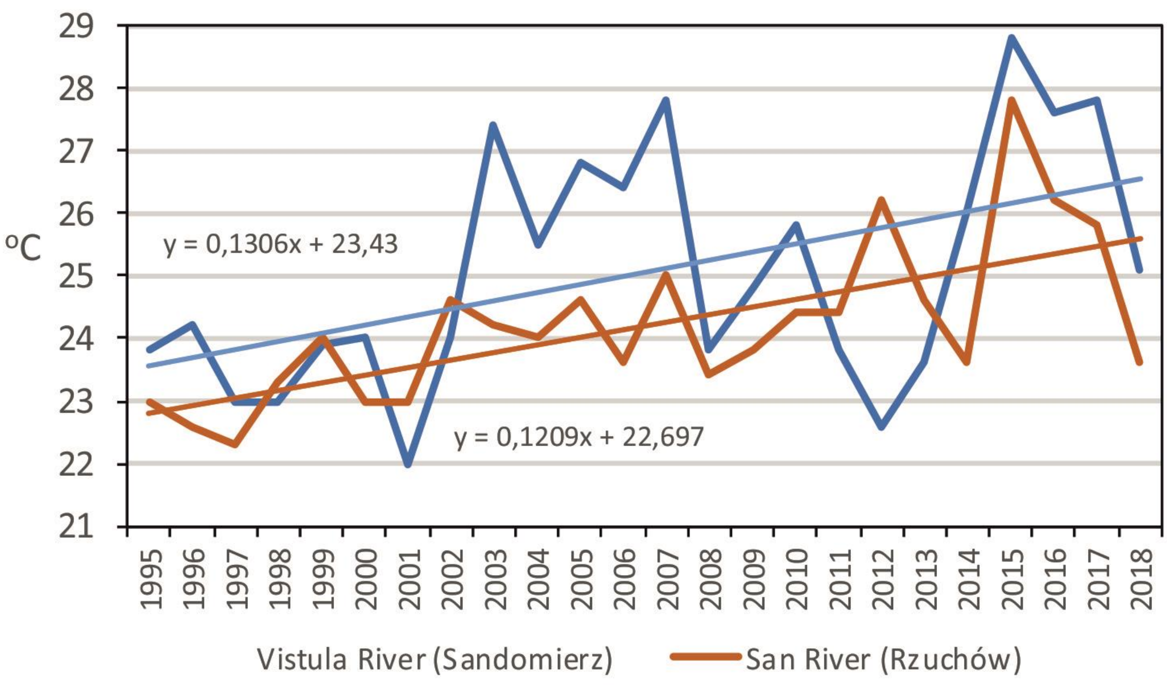

Fig. 3. Increase in maximum water temperature of the Vistula (at Sandomierz) and the San (at Rzuchów) near conventional power plants with open water circulation cooling. Based on data from the Institute of Meteorology and Water Management - National Research Institute in Warsaw.

Source: author's own work.

the navigation season (understood as the period without ice phenomena). In practice, however, these favourable changes are irrelevant to inland navigation for the reasons outlined above.

3.2. Lakes

3.2.1. General information

Global warming is causing ever more changes in the social and economic uses of lakes. This mainly manifests as a decrease in water resources and associated changes in shoreline. These phenomena are occurring despite the annual precipitation values in central Poland remaining fairly steady, though low, at an average of 544 mm (Ilnicki et al., 2014). However, due to the authors research, the increase in air and water temperatures is increasing evaporation from the surfaces both of the lakes and of their catchments. In the years 1992–2018, annual evaporation from lakes in central-western Poland increased on average from 795 to 920 mm, and in 2015 amounted to as much as 1,025 mm. Hence, the water balance of lakes, especially of closed lakes, is becoming increasingly negative. Lake water levels are lowering, and the shallow part of the littoral zone is transforming into a shore zone. Such phenomena are especially seen on beaches, i.e. flat banks devoid of vegetation. One example is Jezuickie Lake. Based on satellite images, it can be determined that in 2011–18, the lowering water level increased the beach area by 2,520 m^2, i.e. by over 80% compared to 2011 (Fig. 4). However, the increase in beach area caused the designated bathing area to disappear, forcing the owner to extend jetties.

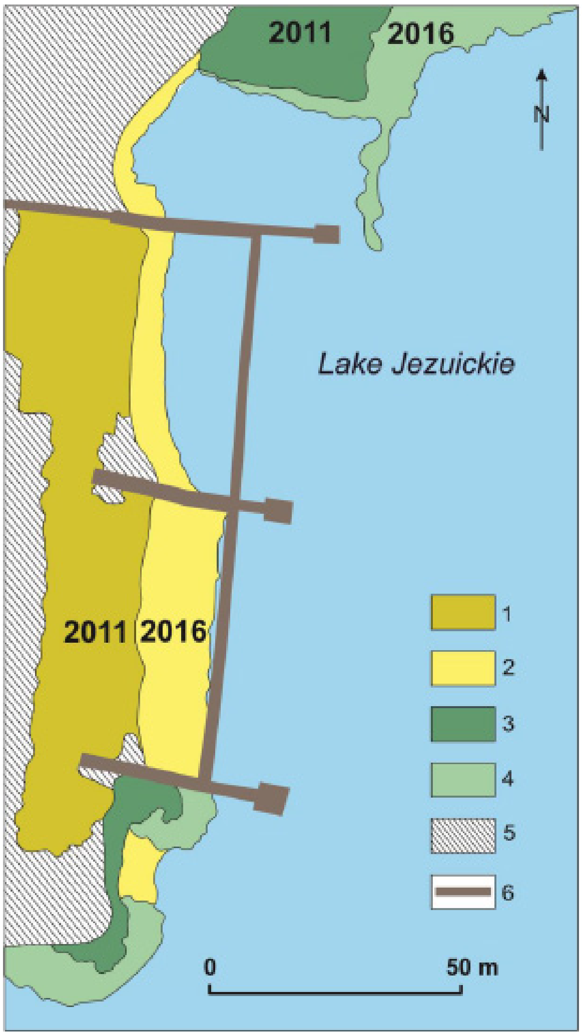

Fig. 4. Stages of water level dropping at Jezuickie Lake, and expansion of beach and adjacent areas. Drawn up based on GoogleEarth. Explanation: 1 - beach (sand) in 2011; 2 - beach (sand) in 2016; 3 - macrophytes in 2011; 4 - macrophytes in 2016; 5 - recreational area; 6 - tourist pier.
Source: author's own work.

The impact of global warming on lakes is also visible in winter. As with rivers, periods of ice phenomena, including ice cover, are shortening. Additionally, the ice cover is becoming thinner and poses a threat to people. Such ice conditions, termed "weak", prevent winter sports and recreational ice fishing. Winter sports (ice-skating) competitions in the Central European Lowland are being cancelled and transferred to Northern European areas.

3.2.2. Difficulties in the legal classification of lakes

According to distinctions originating in the times of socialist law, lakes can be classed as either flowing or standing waters. Lakes legally recognised as flowing belong to the Treasury. The vast majority of lakes in Poland, including all larger lakes, are flowing waters. The classification criterion for this is "continuous or periodic natural inflow or outflow of surface water" (Act of July 20, 2017, Water Law, consolidated text, Journal of Laws of 2021, item 624 as amended). In turn, a lake can be classed as standing water when it is "not directly naturally connected to surface inland flowing waters" (Art. 23, para. 1 of the Water Law).

These classification criteria are difficult to apply in practice. One immediate complication occurs when a watercourse listed in the law as periodic is found to now be episodic. The decreased resource quantities in surface waters results in existing watercourses drying up, especially small ones. This makes it difficult to apply the provisions of the water law. While the authors have already postulated on the need to adjust the classification criteria for lake waters, this issue is becoming increasingly important as periodic streams become replaced by episodic streams. Here, the increasing irregularity of precipitation during the period of global warming becomes relevant. Precipitation is increasingly often torrential, and separated by longer periods of drought.

3.2.3. The problem of new land

The drop in water resources is also causing lake shorelines to recede. This acquires a special dimension in the case of lakes classified as flowing waters. The lowering water level uncovers land designated in land and mortgage registers as lying under flowing waters. Lakes belonging to the State Treasury and local government bodies are covered by the law on universal water use (Art. 32 para. 1 of the Water Law). This allows for, among other things, use in satisfying personal and recreational needs, and in tourism (Art. 32 para. 2 of the Water Law). Inspections by the Supreme Audit Office (NIK) in 2011 and 2016 showed that the uncovered land is illegally developed (NIK 2016). At the same time, numerous applications are being sent to the competent authorities to lease such land to create recreational and tourist infrastructure for lakes. Because they are formally still land under flowing waters, they cannot in any way be involved in civil law trade. The reclassification of these areas is a long and uncertain process, because it is not known whether the future lake level will return to its past state. This is one reason why there is often illegal construction.

3.3. Ground waters

Climate warming affects groundwater resources. In the period 1981–2015, hydrogeological lows (i.e. periods when the water table fell below average long-term minimum level) became more common. The largest numbers of low waters across Poland were found in 1983–1985, 1990–1993, 2004–2007 and 2015, continuing into 2016 (Kowalczyk et al., 2017). The low waters usually lasted 35 weeks. The longest hydrogeological lows occurred in central, lowland Poland, which is also typically agricultural. They lasted from 5 to 12 years.

Hydrogeological drought is the last component of a significantly longer period of drought, and consists first of atmospheric drought, then soil drought and hydrological drought. Thus, groundwater resources take longest to replenish in this case, and they should be used in a particularly rational manner.

Increasing frequent atmospheric and soil droughts have forced farmers and agricultural businesses to install new agricultural groundwater intakes for crop irrigation. Until 2009, such new intakes were infrequent due to a lack of demand, and only about 0.5% of arable land in Poland was irrigated (Kuśnierz et al., 2011).

Farmers' and agricultural businesses' interest in building underground water intakes for irrigation has steadily been growing with the increasing frequency of droughts. The exceptionally warm year in 2015 was a watershed year that precipitated a rapid acceleration in the construction of such intakes (mainly in areas of intensive agriculture). Data collected by Marszelewski and Piasecki (unpublished) show that, in 2015–2017, in one poviat alone (Radziejów Kujawski, 607 km^2) 84 permits were issued for new irrigation water intakes with an average capacity of 25 m^3/h each. The difficult hydrological conditions make it easier for farmers to obtain permits, all the more because state policy supports a rapid increase in irrigation of agricultural areas, in light of farmers' potential demands for damages in the event of further droughts. An additional incentive was the call for applications for the "Modernisation of farms in the area of farm irrigation" drive conducted throughout the country in the period 09.25–22.11.2019. This drive allowed applications for funding to construct underground water intakes up to the amount of EUR 23,000. The interest of farmers was very high. In one voivodeship alone (Kujawsko-Pomorskie) 111 applications were made for such facilities in this short time.

Groundwaters are the property of the state treasury, with the proviso that the landowner – as part of the ordinary use of water – has the right to collect them at an annual average not exceeding 5 m^3 per day (Art. 211 para. 2 and 33 of the Water Law). This right allows the landowner to collect a total of 1,825 m^3 of groundwater per year, and in practice over a period of just a few days.

Notwithstanding the difficulties in devising optimal legal regulation to effectively prevent difficult-to-control groundwater abstraction, the Polish legislator decided in 2017 to introduce a compromise solution. This provides that, if an inspection finds landowners entitled to ordinary water use collecting groundwater at an annual average exceeding 5 m^3 per day the state water management body Państwowe Gospodarstwo Wodne Wody Polskie (PGWWP) may at its own expense furnish landowners with instruments for metering collected water (Art. 36 para. 6 of the Water Law). However, such a condition is very difficult to ascertain.

The intensive use of groundwater is noticeably lowering the water table. The first negative effects of the uncontrolled proliferation of wells have already been noted. One municipality has banned their construction within a radius of a few kilometers from a municipal water intake that lacked water to feed the rural water supply. In addition, it seems that surface water from reservoirs, ditches and other watercourses should be used for irrigation. Financial resources should mainly be allocated to increasing surface retention for later use in irrigation, and not to groundwater intakes that can lead to over-exploitation and have negative environmental effects that are difficult to reverse.

4. State policy on shaping water resources

4.1. Counteracting drought effects in the Water Law

Poland has no legal norms whose adoption would be directly dictated by changes in the quantitative structure of waters as a consequence of global warming. Therefore, in analysing Polish state policy, solutions for counteracting the effects of drought should be considered, being closest to the issues under discussion. The relevant framework is contained in the Water Law of 2017 (Art. 183–185). These provisions specify both entities tasked with countering drought effects (central and local government, and PGWWP), as well as the instrument for taking such actions, i.e. a plan for countering the effects of drought.

The plan for countering the effects of drought establish a course of action in the event of increased risk of drought. Its main purpose is to supply water to the populace and economic entities. Taking into account the division of the country into river catchment districts, this plan constitutes a proactive form of risk management by creating a substantive foundation for public administration bodies and local governments. It is one of the types of planning documents used in water management planning. According to art. 184 para. 2 of the Water Law of 2017, the plan to counter the effects of drought includes: analysis of the possibilities for increasing available water resources; proposals to construct or expand water facilities; proposals for essential changes in the use of water resources and in natural and artificial retention; and a list of actions to counteract drought effects. "Available water resources" are the amount of water (returnable and non-returnable resources) that can be extracted while maintaining essential flow. In order to determine their size, the balances of individual river basins need to be analysed. A plan to counter drought effect was eventually adopted in July 2021 as an attachment to the Regulation of the Minister of Infrastructure of 15 July 2021 on the adoption of the Drought Effects Counteracting Plan (Journal of Laws 2021, item 1615).

The plan above includes a drought threat analysis in the form of maps of agricultural, hydrological and hydrogeological drought threats, proposals for constructing or expanding water facilities, and an identification of the extent to which available surface and ground water resources need to be increased. This makes it is an instrument for shaping state policy for total water resources. Its purpose, however, is to minimise the effects of drought. However, drought is a temporary atmospheric anomaly that is a normal and recurring feature of the climate: it is a consequence of a natural drop in precipitation for a certain period in a given area (Łabędzki 2004). By contrast, the increasingly evident change in the quantitative structure of waters caused by global warming is a different phenomenon. The effectiveness of actions to counter drought – despite being similar in that they compensate for water shortages – is especially limited in time. The real "effectiveness" of a plan to counteract the effects of drought primarily requires that the latest hydrological data be considered showing that water resources are now smaller than previously. Such estimation is hampered both by the fact that the plan was prepared since 2016 and the fact that the plan must consider the prospective availability of water resources for at least a few years.

4.2. Water management plans for river catchment districts

The basic planning documents for water management are water management plans for a river catchment. These must be drawn up according to EU law – more precisely, according to the WFD. These plans are the basis for future water management. They include activities leading to the achievement of WFD goals for obtaining and maintaining good water status in individual river catchments.

These plans should not be seen as a direct and exclusive expression of individual national or EU policy on adapting water resources to climate change and anthropopressure. The document on mentions the possibility of a growing water resource deficit in references to global warming. In the case of the water management plan in for Vistula river basin (2016) – Poland's largest river basin – reference is only made to the foreseeable increased shortage of water resources resulting from global warming and growing economic needs. This translates into a recommendation to implement programmes to increase surface and underground retention. Such recommendations for individual hydrographic units resemble general and long-known postulates. It would be advisable for these recommendations to include measures necessary due to quantitative changes in water, together with details on their costs and funding sources.

One debatable feature of these plans is whether they should cover periodic monitoring only of lakes exceeding 50 ha in area. In Poland, this would be only 14.3% of the total number of lakes. It would ignore 5,820 lakes of 1 to 50 ha, despite the fact that over 90% of them are owned by the treasury. Many such lakes are of great importance to local communities, who have an interest in their proper functioning. In addition, a significant proportion of the omitted lakes are important parts of hydrographic networks and are therefore hydraulically connected, including to larger lakes of >50 ha. In this way, lakes of less than 50 ha can also shape the ecosystems of larger lakes. They are also important water retention facilities and their water resources could be significantly increased in the future. It seems, therefore, that of the <50 ha lakes, at least the ecologically and socially significant should be selected for monitoring.

5. Conclusion

The analysis leads to the conclusion that there is no coherent Polish state policy on water management during climate warming. There is an unavoidable need to review the assumptions and existing legal regulations in this regard, given the hydrological conditions and forecasts presented. The application of current law is problematic in numerous ways. It is ineffective in terms of protecting water resources and may lead to complex, undesirable situations such as the dam on the Vistula. The Polish legislative has insufficient awareness of global warming and the need to take appropriate action. While it is hard to suggest that a comprehensive climate change law should be adopted immediately, the time has certainly come for decisions to be taken on the subject of climate change policy. One element should be legal solutions on the shaping of water resources as water deficits and shortages increase.

Decisions by regional and national authorities are particularly important. The possibility of private parties countering the consequences of decreasing water resources is small. Polish legislation does not provide satisfactory solutions in this area. Therefore, it needs to be suggested that current climate change policy should be carried out by the government and in cooperation with insurers (as a private method).

In consequence, innovative insurance programs could be created and developed under the public-private partnership.

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