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Hydraulic Structures as a Key Component of Sustainable Water Management at the Catchment Scale—Case Study of the Rgilewka River (Central Poland)

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Abstract: Poland is among the European countries with the lowest water resources. The central part of Poland features the least water resources in the country. In this region, proper water management is particularly critical to maintaining high agricultural productivity. The objective of this study was to present the effects of the restoration of hydrotechnical infrastructure in the Rgilewka River catchment in the zone of the greatest water deficits. This paper analyses the effects of such works on water resources and their management. The catchment featured seven weirs in 2014, all built in the 1950s. Due to the lack of maintenance and ongoing renovation, they have lost their basic functions. In 2014, modernisation of the system commenced by rebuilding all the existing weirs. Two new weirs were also constructed. The work was completed in 2021. The currently existing weirs provide greater water retention and management capabilities. The direct impact of weirs ranges from 1.9 to 3.5 ha, their indirect impact from 34 to 70 ha, and the river channel retention varies from 2200 to 5400 m^3. Total water retention in the Rgilewka River channel due to the modernisation of hydrotechnical infrastructure reaches 25,400 m^3. The direct (total) impact range will cover an area of 16.4 ha, and the indirect impact range an area of 284 ha.

Keywords: weirs; management of hydraulic structures; drought; water resources

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1. Introduction

The availability of water resources is determined by natural factors (climate, hydrographic network, geology, and forest coverage) that are influenced by broadly understood human activity (melioration and regulation of river beds, water abstraction for consumption, industrial and agricultural purposes, mining drainage, catchment development, etc.) [1,2]. The complexity of these two components is increasing due to the observed environmental and anthropogenic transformations. Many developing countries face challenges related to water resources and the need to increase water supply [3]. Climate change, population growth, and mismanagement have led to severe water shortages in many regions of the world [4,5]. Water scarcity in the context of rapid economic development continues to intensify [6]. It is therefore necessary to take action to mitigate the effects of these processes. The reduction in the risk of water scarcity involves pursuing the objectives of stabilising and improving the availability of water resources. In Pakistan, for example, long-term strategies include formulating legal regulations for groundwater abstraction, constructing large dams, and resolving water distribution issues between regions [7]. In the case of England, Welbank [8] mentions activities related to water reservoirs as a potential solution improving water conditions in the context of the challenges of climate change, population growth, and environmental protection, involving both the construction of new, and modernisation of the existing water reservoirs. The problem of optimal water management is increasingly apparent in Poland, among the countries with the lowest water resources per capita in Europe [9]. Extreme droughts that occurred in Poland in 1992, 2003, 2006, 2015, and 2019 caused not only major economic, but also ecological losses [10,11]. The spatial distribution of water resources in Poland is diversified, and influenced by the current climatic conditions, particularly the components of the water balance (the amount of precipitation and evaporation), land orography, in addition to historical human activity, focused on draining excess water for years (through deforestation, one-way meliorations, and watercourses regulation)—primarily to acquire new agricultural and construction land [12]. The highest currently recorded water shortages occur in the central part of the country. Specific runoff in that area averages q = 2.5–3.5 $dm^3\ s^{-1}\ km^{-2}$, dropping to 0 in selected catchments in summer [2,13]. The approach to water has changed with the development of agrarian culture, currently producing high yields per usable area. Water is not perceived as a factor hindering agriculture. On the contrary—its shortages may contribute to losses in this economic sector [14]. In the context of proper management of water resources, suppressing its excess—commonly identified as a flood—is also essential. Flood events may become more frequent in the future and result in increased damage [15]. Moreover, given the scarce water resources in some agricultural regions in Europe, it is necessary to use them in an economical way [16]. In the long term, loss of water in the agricultural landscape due to the current climate change may lead to negative changes in the biodiversity of ecosystems, both productive and unproductive [17]. Given the above, projects are being implemented in Poland to optimise the management of water resources. The most significant project is the Drought Effects Counteracting Plan, stipulating a broad range of measures limiting the negative phenomena related to drought, and increasing water retention in the country. According to the assumptions of this document, it is expected that the retention rate in Poland will reach 15% by 2030 [11], among others due to the implementation of measures increasing water retention by the State Water Holding Polish Waters—a government entity responsible for national water management. The stipulated measures include investment, planning, as well as social and educational activities aimed at the rational use of water resources and their protection. Hydrotechnical works include the construction of barrages and large dam reservoirs on larger rivers, increasing the share of riverbed retention in smaller streams, or water storage in lakes and wetlands. Legal regulations and measures are also proposed to reduce water consumption and prevent excessive water outflow from urban areas, or redistribution of polluted water. Depending on the scale of the activities and time needed to implement the investment, their effects are expected to be observed in a broad time window of several weeks to several years, when it will be possible to intercept at least a dozen percent of water currently flowing out of the territory of Poland. A significant element of this program, implemented from 2020, is riverbed retention, allowing for water retention in the upper parts of river catchments. It requires properly designed and operating hydrotechnical structures. The construction of a number of small structures such as weirs or thresholds may cause evident changes in the hydrological regime of rivers [18]. In the context of the observed weather and hydrological changes, causing a new situation of operation of water reservoirs and hydrotechnical devices built under different assumptions several decades ago, their reorganisation is also essential [19]. There is a need not only to expand the network of hydrotechnical devices, but also to improve the existing infrastructure.

The objective of this study is (1) to present the range of the modernisation and development of hydraulic infrastructure in the Rgilewka River basin, (2) to evaluate the impact of these activities on the growth of water resources in the catchment, and the possibilities of water distribution in the catchment to satisfy the agricultural water demand.

2. Study Area

The catchment of the Rgilewka River, with an area of 637 km^2, is located in the central part of Poland. The 44 km long river itself starts at an altitude of ~140.0 m above sea level in the upland zone formed during the Warta glaciation. It flows into the Warta River at 93.3 m above sea level. The Rgilewka River catchment is mostly a flat moraine plateau with land denivelations reaching several meters. Relative heights exceed several meters only in the zone of frontal moraine hills, marking the watershed boundaries to the north-west and south-east. In this area, the groundwater table is usually at a level of 2.0 to 5.0 m below ground level, and the annual amplitude of groundwater fluctuations does not exceed 1 m. The upland is crossed by a network of river valleys, constituting drainage axes for surface and underground waters. The Rgilewka River valley in its upper and middle section is up to several hundred meters wide. In the lower section, its width exceeds 1 km, and in the estuary section, it reaches 2 km (Figure 1). The valleys of Rgilewka's tributaries, including the most important ones, namely Struga Kiełczewska, Orłówka, Dopływ z Zalesia (Tralalka), and Struga Dąbrowicka (Dzierzbicki Canal), usually do not exceed 1 km in width. In valley zones, the groundwater level is 0.5–1.0 m below terrain level. It primarily depends on the water table in rivers.

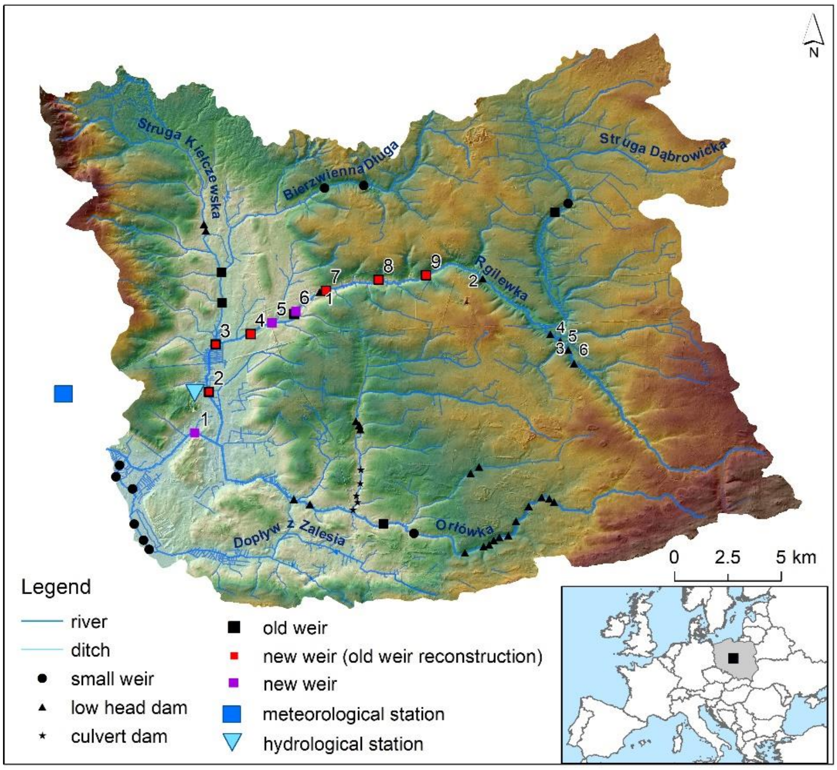

Figure 1. Location of the study area.

The surface geological structure of the eastern and southern part of the river alimentation area is dominated by Warta's tills, in the central part giving way to fluvioglacial sands and gravels. Towards the west, the surface lithology becomes more diversified. Next to the aforementioned lithological subdivisions, deluvial sands are observed. Boulders, gravels, and sands of frontal moraines have also been found in the frontal moraine elevation zones. The valleys of the Rgilewka River and its tributaries are dominated by Holocene fluvial sands of floodplain terraces. Among them, particularly in the central part, accumulation of peats, sandy muds, and peat muds is observed. In higher parts of the valleys and their edges, the fluvial sands of floodplain terraces are encountered.

The distribution of water stages and flows in the annual cycle is typical of lowland rivers with a spring (relatively short) flooding period and a much longer (more than half of the year) domination of low water stages. Rgilewka is characterised by high flow irregularity, particularly resulting from low retention in the catchment. It is primarily caused by the land use structure in the catchment, and lack of natural lakes or larger water reservoirs. As indicated above, the study area is characterised by low water resources. Expressed as specific runoff, they amount to 3 dm^3 s^{-1} km^{-2}. During periods of low water stages, they drop to even 0.6 dm^3 s^{-1} km^{-2}. Mean annual air temperature over the last 50 years for the nearest synoptic station in Koło is 8.7 °C (for January −1.4 °C, for July 18.7 °C). Total annual precipitation reaches 515.6 mm, and potential evapotranspiration exceeds 700 mm/year. Between 1971 and 2020, no changes in annual precipitation were observed despite a significant increase in mean annual temperatures. An increase in mean annual temperatures reached 0.38 °C dec^{-1}, and was statistically significant at a level of 0.05 (Figure 2).

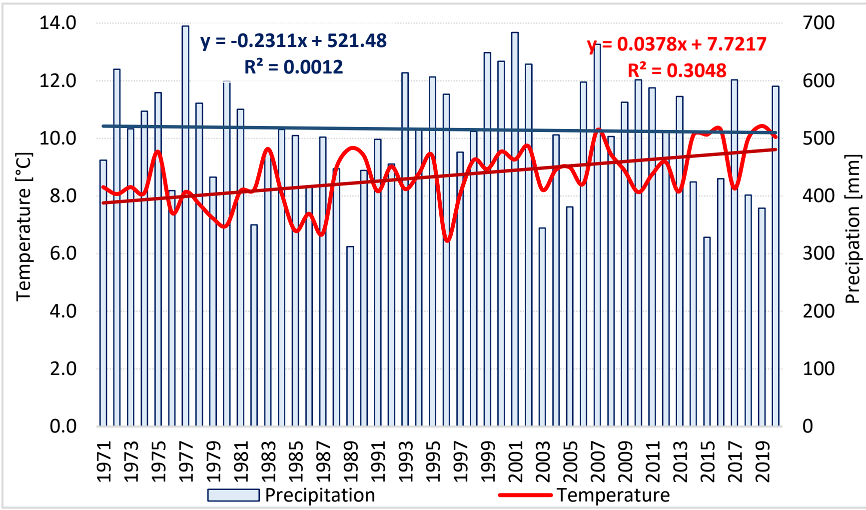

Figure 2. Mean annual air temperatures and annual precipitation at the synoptic station in Koło in the period 1971–2020 (own elaboration based on data from IMGW-PIB).

The Rgilewka catchment area has a predominantly agricultural character. Its land use structure covers as much as 89.4%. The hydrotechnical structure of the Rgilewka River (Figure 1) includes correction thresholds and nine weirs, six of which required reconstruction. Arable fields occupy the elevated areas, and intensively used meadows and pastures occur in river valleys, supporting numerous dairy farms in the area. The land has been heavily drained over the years to increase agricultural productivity. Rgilewka and valleys of its tributaries have been particularly affected by such measures. The areas were dissected by a dense network of drainage ditches, aimed at draining excess water from grasslands and adjacent fields. Rgilewka and its tributaries were regulated to accelerate the outflow of water during periods of water surplus. In the second half of the 20th century, weirs and damming thresholds were constructed on these rivers to limit water outflow and create the possibility of irrigation of meadows and pastures in summer. Smaller rivers were equipped with single- or dual-span gates and correction thresholds, and the Rgilewka River with six trestle weirs, one gate weir, and six correction thresholds. Weirs were constructed in the middle and lower course of Rgilewka (Figure 1) to dam water for the purpose of its distribution over the surrounding green areas. They were built of concrete thresholds with steel structure (Figure 3), with mounted wooden planks permitting control of water outflow. It is worth emphasising that some steel elements date back to the times of World War 2. In addition to the aforementioned weirs, the hydrotechnical development of the Rgilewka also includes concrete damming thresholds (Figure 4), 40 cm high and 2.0–2.6 m wide, depending on the width of the river bed. They were built in the 1970s. They are located in the upper and middle section of the river (Figure 1). They are equipped with permanent overflows with a trapezoidal cross-section to guarantee unhindered water flow during low-flow periods. Their basic functions include: correction of the gradient of the river, limitation of outflow and slowing down of water velocity, and prevention of bottom erosion. They also increase the riverbed retention, and improve the soil and water conditions on land adjacent to the river. Information on these devices is summarised in Supplementary Materials Table S1.

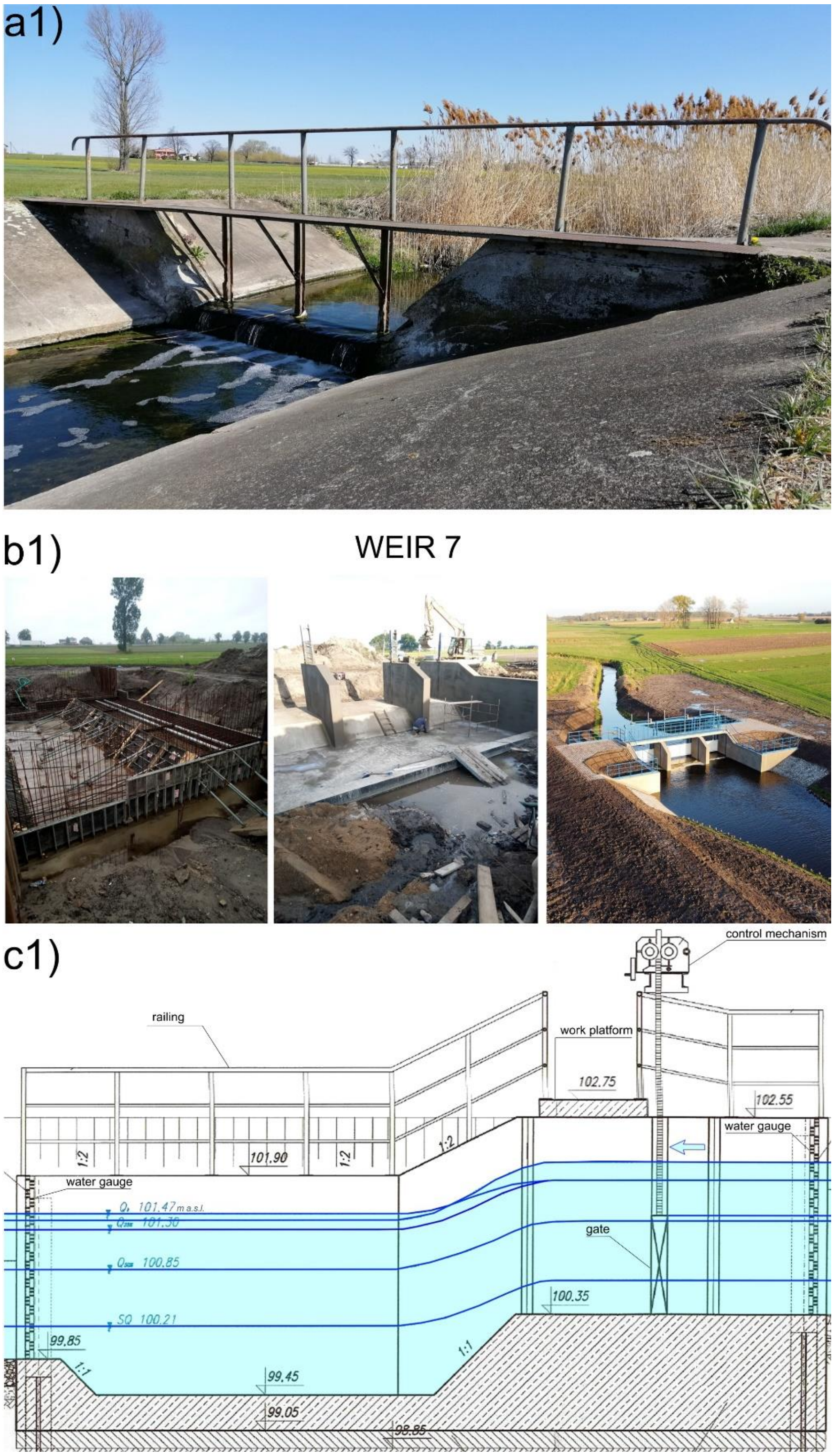

Figure 3. *Cont.*

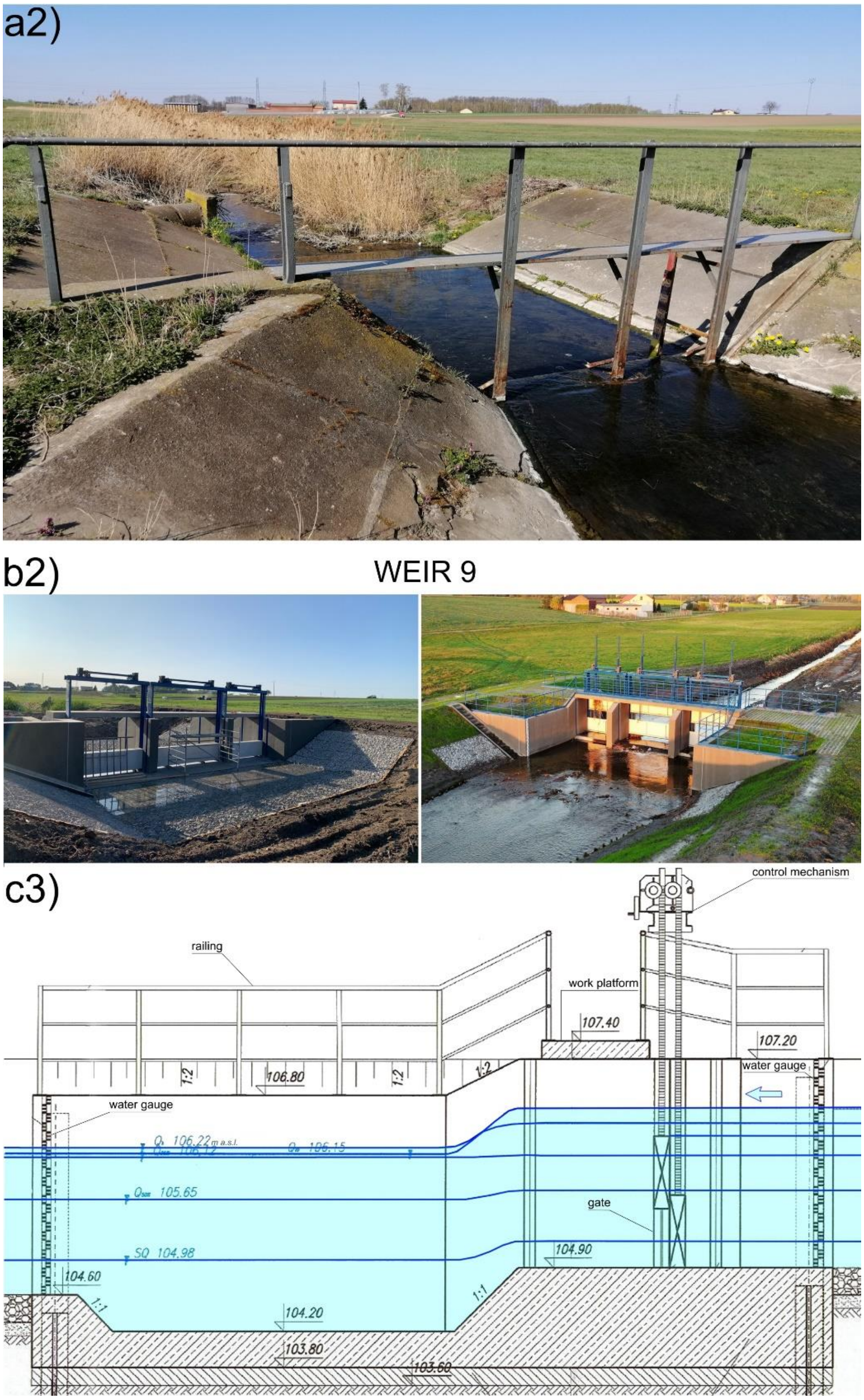

Figure 3. Example reconstruction of weirs (weir No. 7 and weir No. 9) on the Rgilewka River: (**a1**,**a2**) original state, (**b1**,**b2**) present state, and (**c1**,**c3**) longitudinal cross-section (source: [20]—changed).

Figure 4. Concrete threshold No. D on the Rgilewka River at km 31 + 118 (author of the photo: Bartosz Rygas).

3. Materials and Methods

The source material included construction designs of particular hydrotechnical structures, as-built documentation, and guidelines on water management on the structures provided by the State Water Holding Polish Waters. Moreover, the historical results of the assessments of the technical state of the historical structures were analysed. This provided the basis for drawing conclusions in the scope of justification of the undertaken measures related to the renovation of the system. An important element was the analysis of the guidelines on water management on the structures. They include information on the height of water damming in the river, and the period of damming. For the purpose of providing a spatial visualisation of results, cartographic materials were obtained from digital spatial data bases. The physical and geographic description of the area employed information included in orthophotomaps, topographic and hydrographic maps available on the Geoportal website (https://geoportal.gov.pl, (accessed on 20 March 2022)), and raster geological and hydrogeological maps at a scale of 1:50,000, available on the Internet portal of the Polish National Geological Institute—National Research Institute (https://geologia.pgi.gov.pl, (accessed on 20 March 2022)). The land use structure was determined based on data provided under Corine Land Cover 2021, downloaded from the Head Office of Geodesy and Cartography website. Hydrological and meteorological characteristics were based on data from the Institute of Meteorology and Water Management—National Research Institute. Data from the synoptic station in Koło 2 km northwest of the Rgilewka estuary, and from the water gauge station in Grzegorzew at weir No. 2 were used for this purpose (Figure 1).

The range of the impact of damming on the adjacent land was analysed using a digital terrain model. The digital model of the site was developed based on data from airborne laser scanning (LIDAR) provided by the Head Office of Geodesy and Cartography. LIDAR measurements were performed in 2011. Point cloud density after processing is 6 points per m^2. The classes of the point cloud in the LAS 1.2 standard of the American Society of Photogrammetry and Remote Sensing (ASPRS) contain information on points lying on the ground. These elevation points (x, y, z) were used in the ArcMap 10.8 (Esri, West Redlands, CA, USA) environment to develop a digital terrain model. The model was created with the Topo to raster function. The model development employed layers of highlighted watercourses (rivers) and undefined watercourses (ditches and canals) from the digital Map of the Hydrographic Division of Poland at a scale of 1:10,000, and digital inventory maps of drainage and irrigation networks constituting resources of the State Water Holding Polish Waters. The resulting model had a spatial resolution of 1 m. The range of impact of damming on adjacent areas was determined in the ArcMap 10.8 environment, using the water damming ordinate during irrigation (Supplementary Materials Table S2) and the range of capillary rise that determines effective irrigation.

All resulting maps were made with reference to the Kronstadt'86 elevation level and the State Geographic Coordinate System 1992 (EPSG2180).

The conducted simulations were confronted with field measurements carried out in 2021, including measurements of the water table during the periods of water damming and outside of such periods. This provided the basis for the determination of the ranges of backwater caused by a given hydrotechnical facility on Rgilewka and the associated drainage ditches. Geodetic measurements were conducted by means of an optical leveler, in reference to the elevation points installed on the weirs.

Descriptions and diagrams of hydrotechnical facilities were prepared based on the design documentation, construction logbooks and as-built protocols of the investments, water-legal reports, and water-legal permits (administrative decisions enabling damming) held by the administrator of the facilities, namely the State Water Holding Polish Waters.

4. Results

The natural morphometric transformations of the river bed associated with the processes of erosion and sediment accumulation, and the loss of the existing efficiency of water structures were the main reasons for undertaking the discussed works. The functioning weirs built in the late 1950s and early 1960s (renovated in the 1990s) were in poor technical condition (corrosion of metal elements, cracks, other defects of concrete, overgrowth of vegetation, damage or lack of bottom plates, etc.), failing to meet or only partially meeting the original design assumptions for damming the river water.

In the second decade of the 21st century, the hydrotechnical infrastructure of the Rgilewka River was largely rebuilt. It involved modernisation of seven old weirs, and construction of two new ones. All of them took shape of reinforced concrete gate weirs with locks in the form of a two-part steel gate valve driven by a manual lifting mechanism. Depending on the width of the river bed and the amount of water that the river can carry, the weirs feature 3-, 4- or 5-span structures with a total clearance of 10–12 m. Each weir has concrete abutments and pillars, a concrete sill, and a bottom plate of the profiled basin.

A reinforced concrete footbridge with a thickness of T = 20 cm and a width of W = 120 cm was set on the pillars and bridgeheads. For the safety of users, steel barriers made of pipes were installed on the abutments, wings, and the working footbridge. The underground surfaces of the structures were covered with an insulating preparation based on bituminous masses. The air-vent and drain surfaces were protected with a two-component hydro-insulating mortar based on cement and polymer dispersion. The wings of the weirs are caps on steel sheet piles from profiles (sheet piles) for protection against filtration from the upper and lower waterside. The crown of the wings abutments and pillars was designed on an ordinate elevated above the natural banks of the Rgilewka River by more than 1 m. To enable the control of water stages/levels and subsidence of the structure, water level gauges and benchmarks were installed on each structure. Additionally, markers indicating damming levels were installed on the weirs. Weir closures are equipped with manual lifting mechanisms with a mandrel suitable for mounting both a river wheel for manual operation and an electric key.

Dykes are located on both sides of the weirs to protect the pillars and wings of the weirs from soil washout as water from the Rgilewka riverbed passes through them. The dykes were made of compacted fine-grained sand covered with a 10 cm thick layer of humus to provide a base for a specially prepared mixture of grasses. Below and above the structure, along a section with a length of L = 5 m, in the bottom and on the slopes, there are riverbed reinforcements made of gabion mattresses with a thickness of T = 15 cm placed on separation geotextile and bedding material with a thickness of T = 15 cm. A palisade made of wooden pegs with a diameter of ϕ = 10–12 cm and length of L = 1.5 m was constructed at the ends of the fortifications and along the foot of the slope (Figure 5).

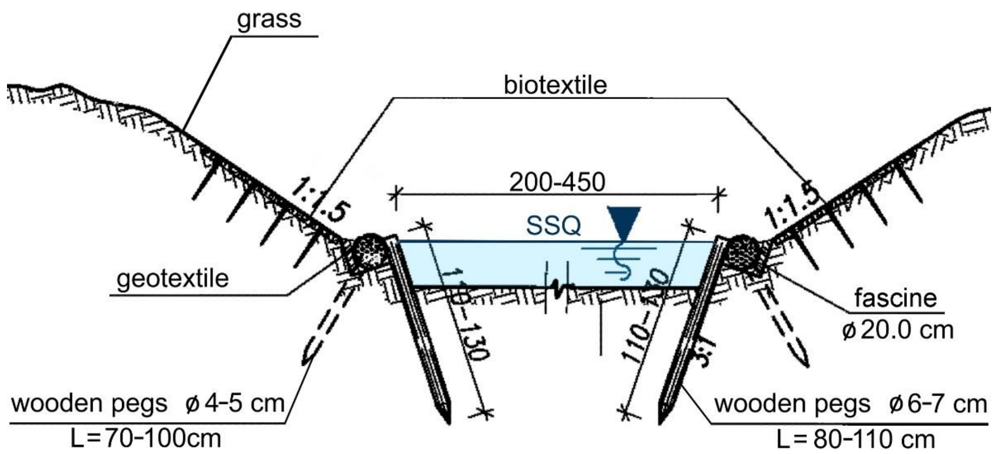

Figure 5. Cross-section through the river channel, presenting the fortification in the vicinity of rebuilt weirs on the Rgilewka River (source: [20]—changed).

The investment works were implemented in three stages. In the scope of the first stage, in 2014, in the estuary section of the river, a new 4-span gate weir No. 1 was constructed at km 5 + 200 of the river, and a 5-span gate weir No. 2 was modernised at km 8 + 900 of the river. Four years later, the trestle weir No. 3 at km 11 + 371 of the river was dismantled, and a new 3-span gate weir was built in its place. The third stage of works was implemented in the period 2020–2021 as part of the Water Resource Development Program of the State Water Holding Polish Waters [13]. This investment project, with a cost reaching ~2.6 million USD, involved demolishing five old trestle weirs (at km 12 + 980, at km 15 + 500, at km 18 + 100, at km 20 + 250, at km 22 + 762), construction of 3-span gate weirs near their original location (No. 4, 6, 7, 8, and 9), and building one new weir of the same structure (No. 5 at km 14 + 305).

According to the adopted assumptions, the damming of water on the weirs takes place over the period from 1 April to 1 November, and specifically on three dates: 11 April–10 May, 11 June–10 July, and 11 August–9 September. The dates correspond with the periods of grass growth between cuts. The damming is removed for the time of mowing meadows. Weather conditions and plant vegetation potentially influencing damming dates was also considered, depending on the groundwater level in the areas covered by irrigation (it has no effect on the continuity and hydrological regime of the river in question). The primary mode of operation of the weirs involves the regulation of water flow in the river, assuming that it cannot cause flooding of the affected areas, but only provide optimal conditions for vegetation growth. The range of backwater for the reconstructed weirs is from 0.87 to 2.47 km. Riverbed retention ranges from 2200 to 29,600 m^3. The range of direct impact within the riverbed ranges from 1.9 to 9.9 ha, and the indirect impact corresponding to the impact on the adjacent land ranges from 34 to 120 ha. Total water retention in the Rgilewka riverbed resulting from the modernisation of the hydrotechnical structures now reaches 85,200 m3. The total direct range of impact covered an area of 42.5 ha, and an indirect area of 538 ha. The modernisation of the weirs aimed at restoring one of their primary functions, namely provision of water to the irrigation ditch system on the adjacent agricultural land. The range of this impact based on the example of weir No. 3 at km 11 + 371 is presented in Figure 6.

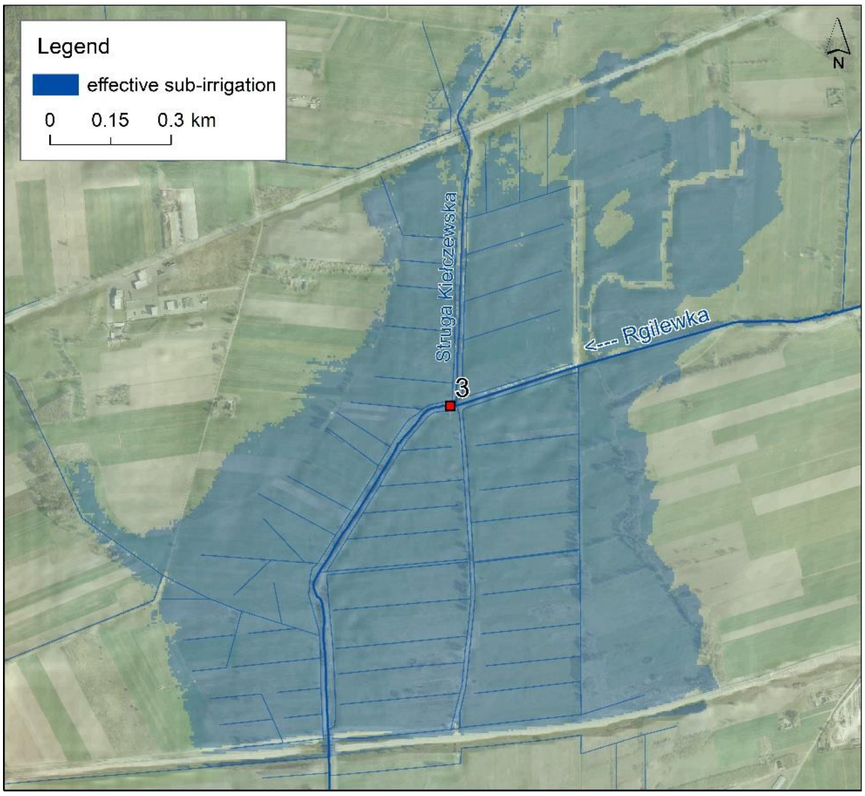

Figure 6. The range of the impact of water damming on weir No. 3 at km 11 + 371 of the Rgilewka River on the adjacent land (range of effective irrigation).

5. Discussion

According to forecasts regarding changes in water retention (with no direct water management), it will decrease by the end of the 21st century in the vast majority of regions around the globe [21], including Poland. Other components of the water balance will also change in the future, causing difficulties in access to water. For the region where the Rgilewka catchment is located (Wielkopolska), the annual sum of surface evapotranspiration is predicted to increase by 45 mm, with the highest increases expected in the growing season in March, July, and June [22]. The above simulations show that the reorganisation of the Rgilewka River regulation system, aimed at more sustainable distribution of water resources, is justified, not only in reference to the current (already unfavourable) hydrological situation, but also in the long term. Works aimed at an increase in retention should start with modifying the catchment area. It is a precondition for implementing the hydrotechnical construction stage [23]. Although this concept is justified and effective, for many reasons (economic, legal, business), it is not easy to implement in a comprehensive way.

Measures aimed at slowing down surface runoff are currently necessary in the context of the progressive transformation of the characteristics of the natural environment. The hydrotechnical development of the river provides for immediate effects of increased retention while offering opportunities to control it. As Miler emphasises [24], the construction of gates on watercourses and backwaters of water reservoirs is the cheapest method of increasing water resources in drainage basins. Hydrotechnical structures, essential for water management, are often in poor condition, and therefore unsuitable for the challenges of climate change and population growth [25]. The development of water management slower in Poland than in Western Europe is somewhat historically determined—by several partitions and war damage [26]. Neglected hydrotechnical infrastructure is among the factors that have been causing the poor condition of water management in Poland for decades [27]. Such a situation occurred in the analysed case, where the weirs built several decades ago were systematically destroyed after the collapse of large-scale State Agricultural Farms, and failed to fulfil their original tasks in modern times. Similar problems are faced by other regions of the world. The reasons for undertaking the reconstruction of the Bray Weir (Thames, England) were consistent with the repair measures adopted for the weirs discussed in this study. Higgs et al. [28] describe the risk of danger to workers (when lifting or lowering the gates) at that location in detail. They include the inability to open the gates during a flood (flooding of areas located in the upper course of the river), and the inability to close the gates during low water flow. A similar example can be found in Germany, where the Untertürkheim weir was completely renovated between 2007 and 2012 after more than 80 years of operation. In several construction phases, the weir pillars were completely renewed, the bottom of the weir was reinforced, and the weir's gates and drives were replaced with new structures [29]. The condition of the weir on the Tur River (Hungary), built in the first half of the 20th century, was in many aspects similar to the early weirs on the Rgilewka River (broken reinforced concrete structure, cracked and peeling concrete surface, numerous cavities, reinforcement steel visible on the surface). Several minor and major repairs were carried out, and complete reconstruction took place in the second half of the 1990s. An urgent decision in this matter was taken due to the condition of the structure that reached the level of high risk of collapse [30]. The hundred-year-old weir on the Tabor River was in poor condition (cracking of the concrete crown, structural defects, damaged weir overflow, bent steel beams), preventing its optimal operation [31]. Restoration of its function required modernisation that involved among others #filling the body of the weir with broken stone in steel mesh, making a concrete slab, and using stone bands on the outflow from the weir. Moreover, in the case of the development of the river with a sequence of weirs (nine in the analysed case), the proper functioning of each of them is important, because they form a set of "connected vessels". Faulty operation of one of these links may affect the functioning of the others. An example of such a situation is described by Khorida et al. [32], where improper work parameters of the Lomaya Weir (Indonesia), located above the Pilohayanga Weir, affected its exploitation and caused failure to satisfy the demand for water and irrigation of 1045 ha of land. A number of hydrotechnical structures in the territory of Tatarstan have been operated without reconstruction for over 70 years. The problem of ensuring the safety of hydrotechnical structures still remains underestimated [33]. It is also worth mentioning that hydrotechnical structures require repair and reconstruction not only due to many years of operation, but also in emergencies, for example the Cullochy weir (Scotland), damaged during a flood wave [34].

The Polish government was among several in Europe to introduce the Drought Effects Counteracting Plan, stipulating a broad range of activities aimed at reducing negative drought-related phenomena and increasing retention. The state policy assumed achieving a 15% retention rate in Poland by 2030 [11]. In this context, it is essential to assess the technical condition of weirs and dams in terms of safety and optimal operation effectiveness [35]. Therefore, constant monitoring of the functioning of hydrotechnical elements is crucial for optimal water management within the catchment area. A response to any malfunctions should involve specific remedial actions, and restoration or improvement of the effectiveness of their original assumptions. Water retention in the catchment area plays a significant role in both flood and drought management. The conducted water management may favour different solutions to achieve this goal [36], depending on the size of the catchment. One of them is the technical approach presented in this paper, aimed at the reconstruction of the existing ineffective devices controlling water flow in the river.

The development of new strategic programs points to the key importance of water management in Poland, including the improvement of the efficiency of water management, among others in agriculture. The main priority is the use of the existing technical infrastructure within the range of arable fields, its reconstruction, or provision of additional infrastructure enabling water use [37]. Climate change negatively affects the functioning of technical infrastructure [38]. Mitigating the effects of climate change requires continuous monitoring of the functioning of the existing water infrastructure in terms of the need to rebuild it or the method of water management in facilities of the type. Drainage-subirrigation system models [39] help plan water management in such facilities. Water and drainage infrastructure is the main condition for achieving an increase in production [40]. Water and drainage infrastructure has been neglected for many years, and has now failed to fulfil its basic economic functions [41]. In addition to purely quantifiable (economic) benefits, according to Brittain [42], weirs have a positive effect on landscape and aesthetics, fish survival in winter, and increased biodiversity. Regarding the negative effects of such solutions, the same author mentions increased sedimentation above the damming facility, migration barriers, and excessive growth of macrophytes. The negative effects can be reduced through active planning and management. Such solutions have been applied among others on the Rgilewka River, where a model was applied involving free flow of water for most of the year, damming during the growing season, and removing dams during harvest. It improves the soil and water conditions in the river valley. The implementation of water management plans and maintenance works also considers the migration periods of fish and the breeding periods of birds.

6. Conclusions

Human-induced changes to the natural environment currently have a number of negative consequences, including water issues—either its shortage or excess. The search for solutions to stabilise this unfavourable state requires effective actions within the catchment area. The analysed case of the Rgilewka River with damaged and inadequately working weirs shows the quick and precise results of such an approach in the context of stabilisation and a more rational distribution of water resources. It should also be emphasised that the newly created hydrotechnical infrastructure offers the possibility of precise water control in terms of flow increase and surface and ground retention. The construction and reconstruction of weirs in one of the most deficit-prone regions in the country have brought a positive result, as evidenced by an increase in riverbed retention or a greater possibility of irrigating agricultural land with surface waters—particularly during the growing season. A broader context of the performed works should be emphasised. They are the result of the implementation of an extensive programme aimed at slowing down water outflow from Poland. The scale of these assumptions (in terms of both surface area and finances) justifies the decisions of government institutions responsible for water management, striving to improve the water resource retention rate in the country.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/buildings12050675/s1. Table S1: Technical parameters of concrete damming thresholds on the Rgilewka River. Table S2: Technical parameters of weirs on the Rgilewka River. Bold font signifies weirs analyzed in the paper–covered with reconstruction in the recent period.

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