Received: 31 May 2022 | Revised: 1 October 2023 | Accepted: 17 January 2024

DOI: 10.1002/ldr.5053

RESEARCH ARTICLE

WILEY

Dammed context: Community perspectives on ecosystem service changes following Poland's first dam removal

Michał Habel[1] | Karl Mechkin[2] | Iwona Wagner[3] | Zbigniew Grabowski[4] | Zbigniew Kaczkowski[3] | Damian Absalon[5] | Dawid Szatten[1] | Magdalena Matysik[5] | Sławomir Pytel[5] | Tomasz Jurczak[3] | Krystian Obolewski[6]

[1]Faculty of Geographical Sciences, Kazimierz Wielki University in Bydgoszcz, Bydgoszcz, Poland

[2]Inland Waterways International, Folkestone, UK

[3]UNESCO Chair on Ecohydrology and Applied Ecology, Faculty of Biology and Environmental Protection, University of Lodz, Lodz, Poland

[4]Center for Land Use Education and Research, University of Connecticut, Haddam, USA

[5]Faculty of Natural Sciences, University of Silesia in Katowice, Sosnowiec, Poland

[6]Department of Hydrobiology, Faculty of Biological Sciences, Kazimierz Wielki University in Bydgoszcz, Bydgoszcz, Poland

Correspondence
Krystian Obolewski, Department of Hydrobiology, Faculty of Biological Sciences, Kazimierz Wielki University in Bydgoszcz, 10 Powstancow Wielkopolskich Ave., 85-090 Bydgoszcz, Poland.
Email: obolewsk@ukw.edu.pl

Funding information
Ministerstwo Nauki i Szkolnictwa Wyższego; Polish Minister of Science

Abstract

Decisions to build or remove dams and other large engineered hydraulic infrastructures are always entangled in social and environmental impacts, which are often evaluated formally through bureaucratic processes. In Europe dam removals are relatively infrequent, even though extensive hydraulic infrastructure has degraded biodiversity and water quality. The Wilkówka dam in southern Poland was required to be removed rapidly, primarily due to engineering failures during its construction. Using survey methods, we examine the local community's perceptions of the net environmental and social impacts of the Wilkówka dam removal. In surveying the opinions of households, 62% of respondents expressed that decisions about the removal were taken without sufficient community consultation, and 92% felt that the dam had been removed despite their opposition. Although the dam had been built recently and had failed to operate at design capacity, respondents reported strong attachments to the services they perceived it to provide, including water supply, flood regulation and cultural significance. In spite of the possibility of an environmental disaster and long-term environmental degradation, most surveyed households would have preferred it to have been renovated or reconstructed. In short, the removal of the Wilkówka dam was perceived by local households but also by local officials as bringing about a net loss in socially relevant ecosystem services, despite the urgent need for removal perceived by regional and national authorities. The local community's rapid attachment to the dam despite its potential negative impacts on biodiversity and the local environment were primarily attributable to the high expectations as to the hydrological services that the dam was to provide (water supply, flood regulation and its larger symbolic value as an infrastructural investment in the community). This work provides an empirical demonstration of the importance of understanding the social, ecological and technological context within decision-making processes regarding dam removals, and its implications may improve the planning and implementation of future dam removal projects.

KEYWORDS
ecological awareness, ecosystem services, Europe, social impact, water infrastructure, Wilkówka dam

1 | INTRODUCTION

Hydrological infrastructures evolve in response to shifting social values, climatic instabilities and ecological change (Habel et al., 2020). As the ecological awareness of society increases, basin management is increasingly oriented towards explicitly environmental objectives and nature-based solutions that include explicit evaluations of ecosystem services (Auerbach et al., 2014; Ling et al., 2019; Kalantari et al., 2022). Still, removing engineered hydraulic infrastructures—or announcing plans to do so—can fuel social tensions resulting from the competing needs of the public and the dam's owners (Fox et al., 2016). Residents' attitudes are associated with their sense of place and their attachment to a place, which derives from the physical environment, human behaviour and social and psychological processes (Stedman, 2003). People are often afraid of change, including new investments, because they sense that they threaten a place's perceived significance (Devine-Wright, 2009; Stedman, 2003). Attachment to place largely depends, however, on a person's frame of reference, which is determined by their intergenerational experiences (Keilty et al., 2016; Stedman, 2003). Individual or institutional attachment and preferences also influence concerns about restoration projects (Buijs, 2009). There is a cognitive dissonance of sorts in which people, even as they recognise the need for change, do not want it to upset the *status quo* to which they are attached (Clarke et al., 2018). This perception may result from 'loss aversion', which is the phenomenon of people perceiving a loss as roughly twice as negatively as they perceive the equivalent gain positively (Kahneman & Tversky, 1984). Greater risks, for example flood risks, increase the desire to see remedial actions taken, but greater attachment to the current state may reduce the desire to intervene (De Dominicis et al., 2015). Cultural and political factors also play an important role in the way communities perceive adapting pathways (Adger et al., 2013).

Most of the dam removal literature focuses on ageing dams that local communities often perceive as permanent features of the landscape (Bellmore et al., 2017; Fox et al., 2016). Many removals have resulted from dam deterioration, which is often accompanied by a degradation in their social utility and in the provision of services related to the hydrotechnical infrastructure, such as energy generation and flood control (Graber, 2002; Lejon et al., 2009; Kiedrzyńska et al., 2021). Dams are also removed due to technical failures that affect their safe operation, with 12% of failures occurring during the filling of the reservoir or within the first 10 years after construction and the vast majority of failures appearing on ageing dams that have been insufficiently maintained (Vahedifard et al., 2021). Dam failure, a complex issue potentially exacerbated by changing hydroclimatological conditions, appears to be increasing (Vahedifard et al., 2021). For example, the rate of dam failures in the United States increased from 10 per year to more than 25 after 2010 (NPDP, 2018).

Existing data on dam removal and rehabilitation needs in the United States indicate that removal may often be more cost-effective than rehabilitation for structures considered to be obsolete, hazardous or too expensive to retrofit to comply with environmental and social regulations and alternative uses (Grabowski et al., 2018). In general, the removal of obsolete structures is often driven by the desire to avoid the cost of major overhauls and necessary maintenance when this exceeds the cost of removal, and by the perceived social utility and degradational environmental impacts of dams.

Policies to prevent environmental degradation by restoring the continuity of rivers as ecological corridors have focused attention on dam removal as a method to assist nature (e.g., Duda et al., 2021; Germaine & Lespez, 2017). This is observed in the United States, where more dams are being removed than built, with hydroelectric and water supply dams being the most common types of large dams removed (Grabowski et al., 2018; Waldman et al., 2019). In Europe, such a trend is barely evident, despite rivers being interrupted by more than 1.2 million barriers, of which 68% are less than 2 m tall (Belletti et al., 2020).

The attitudes of respective groups of stakeholders involved in the decision-making process may differ radically depending on the size of the dam to be removed and the region of the world (Habel et al., 2020). At present, only the United States appears to have a public consultative stakeholder process for dam removals (Fox et al., 2016), though this does not necessarily include the majority of smaller, privately owned dams (Ho et al., 2017). In European countries, public administration usually decides on the removal of hydrotechnical structures (e.g., dams) and social participation in this area is marginal (Buijs, 2009). Dam removals are often accompanied by significant social conflicts—with or without a formal public consultative process—as has been found in New England, USA (Fox et al., 2016) and the Pacific Northwest (Grabowski et al., 2017). These conflicts often arise due to local community attachment to 'long-humanised landscapes' featuring infrastructures that are regarded to be important elements of regional heritage and identity (Fox et al., 2016; Germaine & Lespez, 2017; Keilty et al., 2016). Strategically speaking, early identification of social expectations and desires can facilitate lower-conflict strategies for making decisions on dam futures (Habel et al., 2020). There is greater acceptance of changes if they are perceived as improving the *status quo* and retaining the familiarity of the area (von Wirth et al., 2016). As pointed out by Cohen et al. (2014), investments in new infrastructure attain social acceptance when impacts on welfare are perceived as net positive or neutral. This welfare is expressed in utility to the individual, which also includes intangible aspects. Whilst financial compensation for negative impacts can shift this balance, it is often more effective to modify the design processes and parameters taking into account to concerned impacted stakeholders (Cohen et al., 2014).

Here, we examine the first documented large dam removal in Poland through a multi-year., three-phase interdisciplinary study of its hydrological, geological, ecological, and social impacts in three distinct phases. The three phases are included immediately prior to the beginning of the onset of removal works, during the removal works, and 1 year after the conclusion of deconstruction. This study provides a reproducible method for joint monitoring of the multi-faceted impacts of dam removal as a social-ecological intervention. It also extends the scope of place attachment theory to explicitly include ecological services that are a function of interactions between built, natural and human pools of capital (Jones et al., 2016). By providing specific insights into how the local community perceived the net changes in ecosystem services that the removal would bring about, we hope to contribute to ongoing discussions over the role of appropriate public consultation on the planning of infrastructure and restoration projects. Whilst, on the one hand, this case provides an unusual example of a modern dam being removed early due to engineering failure, it is also relevant for ongoing efforts to remove dams in Europe and other parts of the world. The Wilkówka dam is the first dam to be demolished in Poland, thus we established an interdisciplinary team of researchers to monitor this process over the long term. The team's research will involve monitoring hydrological, geological, biological and social changes. The schedule of activities involves the ongoing monitoring of physical phenomena and social surveys of households and stakeholders in three periods: (i) immediately prior to the demolition of the dam (the results of which are presented in this paper), (ii) during the duration and (iii) 1 year after the completion of decommissioning works. One outcome of the work will be the development of a methodology for monitoring the social and ecological environment for the decommissioning of dams that takes into account national legal and social conditions. The purpose of this article is to present local community and stakeholder pre-demolition perceptions and the social implications of the decision to remove it. During investigations, we define beneficial stages of public debate and consultation during the life of the dam. The work extends the scope of the theoretical concept of place attachment by including in it the potential of the landscape or environment to deliver ecosystem and infrastructural services.

2 | MATERIALS AND METHODS

2.1 | Study area

The Wilkówka dam is situated in the Polish Western Carpathians (coordinates 49°45′37.57″N; 19°6′51.43″ E) and created a reservoir on the 3.79-km Wilkówka stream, which had a catchment area of over 4.48 km^2. It is a right-bank tributary of the Biała River that empties into the Vistula (Figure 1). The bedrock of the valley is sandstone with Cretaceous interbeddings of slates and conglomerates (Ostrowski & Lasocki, 2019). The slope formations comprise eluvial clay and fluvial covers. The catchment area of the stream is mostly forested. Due to its high slopes and limited permeability, and the resultant rapid runoff response, it is subject to flash floods after intensive rainfalls, which

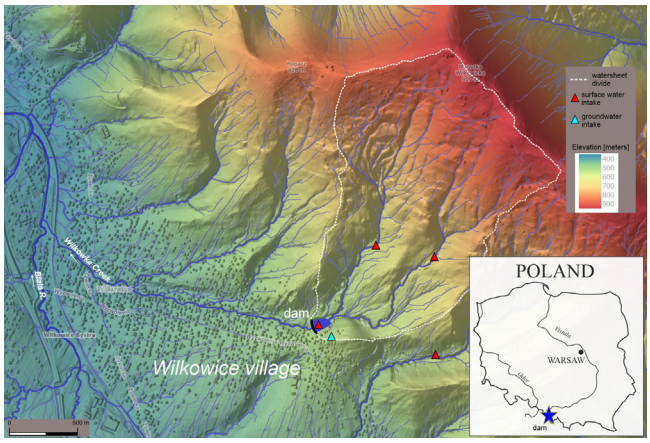


FIGURE 1 Location of Wilkówka dam on digital elevation model, showing surface water network and drinking water intakes; *insert*, location on map of Poland. [Colour figure can be viewed at wileyonlinelibrary.com]

can result in considerable damage to property (Kiedrzyńska et al., 2021). Such events may intensify and happen more often due to the ongoing climate change (Clarkson et al., 2022). Water is supplied to residents from three surface water intakes (on streams in the Wilkówka catchment and the Zimnik stream), though this supply is unstable, and one deep underground water intake. However, water shortages are quite common, as is typical of mountain catchments. In crisis situations, water is purchased from the private company AQUA SA from another source 15 km away in the city of Bielsko-Biała, based on a contractual agreement connecting the water supplies. During periods of water shortage in the stream, the fire department must travel several kilometres to obtain firefighting water. In Wilkowice, water shortages occur most often in December and January, when the river has no water or freezes and the waterworks are also operating on lower supply. To address these water supply and flooding issues, a 10.2-m-tall and 106-m-long earth-filled dam was built in 2009–12, creating a 26,500 m^3 reservoir (Więzik et al., 2002; Figure 1). The cost of its construction, including supporting EU funds, amounted to about EUR 1.2 million (Halama, 2015). According to the *Polish National Census of 2021* (GUS, 2021), the Wilkowice Commune in which the Wilkówka dam is located comprises three villages: Bystra, Meszna and Wilkowice. It has a population of 13,334, of which 51.4% are female and 48.6% male. In the last 20 years, the number of inhabitants has increased by 12.4% from 11,862 to 13,342 due to a positive migration balance accompanied by a real decrease (−8.97‰). The average age of inhabitants is 42.7 years, which is comparable to the national average. Official unemployment in the Wilkowice commune in 2021 was 3.3% (5.4% national level). In 2021, the average annual gross salary in the municipality was EUR 13,200, which corresponds to 39.4% of the average annual remuneration of full-time employees in the European Union (EUR 33,500), which is more than 86.7% of the average annual gross remuneration in Poland. Of the economically active inhabitants of the commune, 17.6% work in the agricultural sector, 45.5% in industry and construction, 17.2% in the service sector and 1.5% in the financial sector. The breakdown of

adult residents by education is higher 22.5%, secondary 34.9%, vocational 27.2% and primary 12% (GUS, 2021).

2.2 | The environmental problem

The Wilkówka dam was primarily designed to ensure flood control and support the supply of water to the local community; although hydropower and recreational functions were considered, they were not included in the final design (Halama, 2016; Więzik et al., 2002). Upon completion of construction works, numerous defects in design and workmanship were discovered by geotechnical supervisors and the owner's representatives (Kostecki et al., 2017). A major defect included a drainage layer at the bottom of the frontal earth-fill dam that negatively impacted its stability, allowing for excessive seepage and preventing the filling of the reservoir (Rybacka et al., 2018). Over the next 5 years, unsuccessful attempts were made to fill the reservoir with water—it was only partially filled with water between 2017 and 2019 up to a 'safe level' and, occasionally (during leakage tests), up to the maximum level. To fix the problem, several repairs were conducted, including replacing the geomembrane in the entire reservoir bowl and sealing the earth-filled dam and the right shore of the reservoir (Kostecki et al., 2017). The cost of interim repairs and as-built expert opinions in 2012–2019 totalled about EUR 0.4 million. In addition, in May 2019, a defect was discovered in the dam that consisted of bottom outlets and the outlet tower having insufficient throughput capacity, which made the reservoir impossible to empty during intensive runoff from the catchment area and inflow of water to the reservoir. This lack of capacity risked catastrophic dam failure in the event of the floods that the dam was originally intended to manage (Kostecki et al., 2017). The accumulation of multiple technical issues and the dam manager's unwillingness to undertake alternative repair works led to the administrator of the dam requesting its urgent removal. Thus, the administrator asked the General Office of Building Control to initiate the decommissioning procedure, which did not require that a consultation process be conducted. In the technical studies that accompanied the repair attempts, it had been discovered that the attempts to seal the lower dam face and reservoir had utilised a large amount of hydrated lime, which constituted about 3% of the mass of the frontal dam's earthen infill (Kostecki et al., 2017). With such a large quantity of hydrated lime, the potential for leaching led to concerns about significant alkalisation of the Wilkówka stream both during and after removal activities; this was one of the primary motivations for monitoring water quality during and after removal. The removal works and the condition of the stream were photographed on an ongoing basis (Photo 1).

2.3 | Identification of stakeholders and opinion polling

For the purpose of this study, stakeholders were identified following methods used in environmental and resources management (Colvin et al., 2016; Ling et al., 2019). All available information from scientific sources, social media and other channels was employed to identify potential stakeholders in the dam. The spatial range of the dam's impact was also established as an area of interest to stakeholders. As a result, it was established that the stakeholders were residents, public administration, local businesses, environmental protection organisations, politicians and scientists. Past problems caused by the dam were analysed based on data collected from official documents containing administrative decisions, through research reports, to posts on Internet forums. The most important are listed in the 'Knowledge Base' tab on the website we created at www.projekt-wilkowka.pl. All this was done to identify the group of opponents to or advocates for the dam. Access to the research team was kept open through chats with interested stakeholders via a messenger function on our website (www.projekt-wilkowka.pl) and by facilitating and responding to comments from stakeholders in Facebook posts. The Wilkowice commune also shared our posts on its Facebook profile. The identified stakeholders were quantified based on the intuitive approach and the 'Onion model' described by Donaldson and Preston (1995), as modified by Alexander (2005), which allowed us to determine the points of view of various stakeholder groups. This approach made it possible to reveal all groups and their characteristics and to visualise the relationships between them. Key stakeholders (the 'Local' group) are shown closer to the centre of the model, and the outer circles represent groups of gradually decreasing significance (the 'National' group).

From November 2020 to January 2021, research was conducted amongst the 13,421 inhabitants of the commune of Wilkowice. A survey was conducted using a database of household addresses obtained from the commune office. Each of the 2200 households received a survey questionnaire (with attachments) in their mailbox. For a confidence level of 95%, a fraction size of 0.5 and a maximum error of 5%, the number of households required in the study would be 327. The researchers received a return of 323 surveys—almost 15% coverage—which indicates a low measurement error.

The formulated questions allowed specific opinions to be obtained from respondents according to the phenomenological approach (Guest et al., 2013). Due to the SARS-CoV-2 pandemic, the surveys were conducted by mail only. As a result, each questionnaire was designed for residents of a single household. When delivering the survey to all 2200 households (all mailboxes were delivered in person), the researchers attached a cover letter clearly stating that household surveys were being conducted and that the household owner should respond (Data S1). Household surveys are widely used in social research (Meyer et al., 2015; Nathan, 2001). Residents returned the completed surveys in person to two collection boxes placed in public buildings. Two groups were classified based on the period of residence of the respondents in the study area: (1) dam construction (2007–2012) and (2) dam removal (2019–2021), (Data S1).

In addition, in 2021, Individual In-depth Interviews were held with other identified stakeholders, that is, public administration, local businesses, environmental protection organisations, politicians and scientists. They were conducted by phone, according to an interview rubric modelled on the questions from the household questionnaire (Data S2).

PHOTO 1 Course of Wilkówka dam removal and stream condition after removal: (a) decommissioning works begin, November 2021; (b) demolishing the tower chute, November 2021; (c) earthworks on the former dam and reservoir in February 2022; (d) area after completion of demolition works, June 2023; (e) barrier in riverbed (remnant of frontal dam), June 2023 and (f) debris dam in the former reservoir backwater, February 2023 (phot. M. Habel). [Colour figure can be viewed at wileyonlinelibrary.com]

The positions of the institutions were based on their administrative decisions and the arguments they presented.

2.4 | Data analyses

Analyses were based on 323 returned questionnaires containing feedback from a total of 749 residents and on 105 questionnaires in which information on the number of residents in the household was not provided. For the remaining 217 surveys, the average number of people in a household was calculated to be 3.4. The households surveyed had mostly been living in the area for more than 7 years (92.3%), and 16.7% indicated that they lived in an area of immediate flood risk. The first stage was inductive thematic analysis classifying the values, observations and feedback of respondents about the services provided by the dam and the river (Data S1). Then, the themes were analysed quantitatively using matrices (Data S3) and were represented graphically as chord diagrams using 'R' software, version 4.0.5. Quantitative results on the contingency matrix were described by colour tones (i.e., percentage of response pairs). Quantitative data were visually represented on chord diagrams to illustrate the power of relations/flows between pairs of variables from a pool of more than ten variables (Holten, 2006). In addition, the survey data were aggregated and compiled as a contingency matrix and a perception matrix. This allowed us to determine the relative ratios of pairs of responses and thus to draw the correlations between the perceptions of the impact that the construction and the removal each had on the types of services provided by the river (ecosystem services) and the dam (infrastructure services). For the classification of the two types of services, we applied the classification proposed in the *Millennium Ecosystem Assessment* report (Reid et al., 2005), which is used commonly for ecosystem services. The analysed services provided by the ecosystem and infrastructure included:

- Provisioning services: provision of drinking water and of water for firefighting.
- Cultural services: landscape attractiveness and recreational potential.
- Supporting services: fish migration, plant and animal habitats.
- Regulating services: flood protection, water quality and microclimate regulation.

By visually representing each aspect of the perception matrix individually we were able to indicate the direction and scale of the dam's impact, and the responses were ordered by gradient: from high ($-0.5 \leq x \leq -1.0$ or $0.5 \leq x \leq 1.0$), through insignificant (<-0.5 or <0.5) to no impact at all (0.0). The pairing of responses for each aspect allowed the percentage of respondents who mentioned the impact of both the construction and removal of the dam to be evaluated. Furthermore, the survey data were aggregated and cross-tabulated to show the relative ratios of pairs of answers. The relationships between answers to specific questions were analysed using the Chi-square test (Pearson's Chi-square and likelihood function; likelihood ratio [goodness of fit] and likelihood ratio chi-square [G^2]).

Ecosystem and infrastructure services were also used as a framework for assessing the needs of the stakeholders in the dam construction and removal processes. Their assessment was based exclusively on determining the probable change as either positive or negative.

3 | RESULTS

The surveys and interviews allowed 18 groups of stakeholders and institutions potentially interested in the fate of the dam to be identified, and these were further grouped into the following categories as (1) households; (2) local, regional and national public administration; (3) local community enterprises including the Water Supply Company, Volunteer Fire Department and businesses; (4) environmental protection organisations (ENGOs); (5) scientists; (6) politicians.

3.1 | Reservoir-related services and expected consequences of removal

The first part of the questionnaire related to the construction of the dam and was therefore considered in this research to investigate respondent opinions about the services provided by the hydrotechnical infrastructure (i.e., infrastructure services). Most respondents (92.3%) were long-term residents of the village of Wilkowice (>7 years). About 3% of the respondents had lived in the commune for 4–7 years, so they know the status, from the dam's construction to the demonstration of irregularities in its functioning. Four percent of the respondents had lived locally for less than 4 years and so only knew the status since the dam defects were detected. Respondents also specified whether they live in flood-prone areas. The majority (76.1%) indicated that they did not live in areas at risk, whilst 16.7% indicated that they lived in areas with an immediate threat of flooding and 7.2% were unsure. The most important services of the Wilkówka dam were identified as water supply services (48% of respondents) and fire protection (8.3%), followed by protection against the consequences of extreme weather (i.e., flood control—31% of respondents) (Figure 2). The services deemed to be least significant were cultural (recreation) (indicated by 69% of respondents), followed by protection against the consequences of extreme weather (by 7%) and water supply services and fire protection (each by 6% of respondents). Households were asked about the frequency with which they spent time at the reservoir; in 31.8% of cases, respondents declared that they did not use it at all for recreational purposes. A larger group of 42.1% of respondents visited the facility occasionally (less than once a month) whilst the rest spent time on it regularly: 17.9% several times a month, 6.3% several times a week and 1.9% daily. The predominant activities were walking (65.9%), cycling (23.2%), socialising (11.5%) and jogging (6.5%). As expected, no one indicated fishing or water sports, which were prohibited due to the condition of the reservoir. Some respondents (4.3%) indicated additional activities, such as participating in special events and passing the dam on the way to work or on a weekend hike to a popular nearby mountain peak. People spending time at the reservoir indicated a single activity type in most cases (61.8%), whilst the rest pursued two (28.6%), three (6.3%) or four (3.4%) forms of activity. Nearly 20% of respondents indicated the dam's potential in regulating flow, flood protection and microclimate; creating new habitats; landscape enrichment and supporting recreation and tourism. In the comments that respondents added to the surveys, some respondents highlighted that the dam was the biggest amenity in the commune but that, as the reservoir is usually not filled with water, its socio-economic potential was not fully exploited. A high ranking was assigned to water supply services by long-term residents and to services protecting against extreme events by short-term residents. Respondents living the shortest time (who had not experienced the flood situation that had revealed the technical problems with the dam) more often declared the function of flood protection as important.

Figure 3 shows the evaluation of the commune households' perception of benefits or threats related to the dam's construction. It reveals the belief that there was a very low relationship between the construction of the dam and a deterioration in water quality (73.4% indicated 'no changes'); biodiversity (64.8%); the number of plant and animal habitats (58.8%) and the microclimate (58%). The most positive impacts were deemed to be on (in descending order of percentage of respondents selecting each area of improvement): the state of infrastructure (flood protection 53.8%), freshwater supply and fire safety (56%) or cultural services (landscape, 60.6%; recreation, 55.4%) (Figure 3a).

The second part of the questionnaire related to the removal of the dam and the attempt to return the river to its previous, more 'natural' state. This part was considered to investigate the respondents' opinions about the services provided by the river ecosystem (i.e., ecosystem services). As regards dam removal, the majority of respondents expect 'no changes' in the area's potential related to regulating services (water quality—71.8%, microclimate—56.3%), and supporting services (biodiversity and habitat) (Figure 3b). By contrast, the risk of deterioration in services was indicated by a majority of respondents: 69.3% of respondents for potential water supply capacity (provisioning service); 64.5% for mitigation of flood potential (regulating services) and cultural services (aesthetic value—60.0% and tourism—57.6%). Significant correlations amongst households' perceptions of the reservoir were obtained through a cross-analysis of responses. People who indicated that they spent no time at the reservoir more often omitted the part of the survey focusing on its individual functions, in particular recreational functions, and were also more neutral in their assessments of the construction of the dam itself. In turn, the

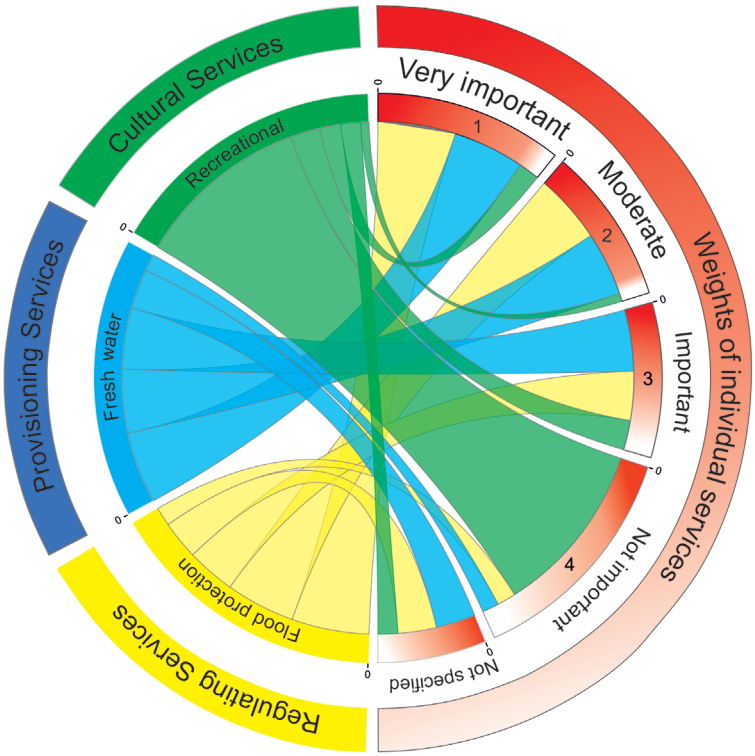


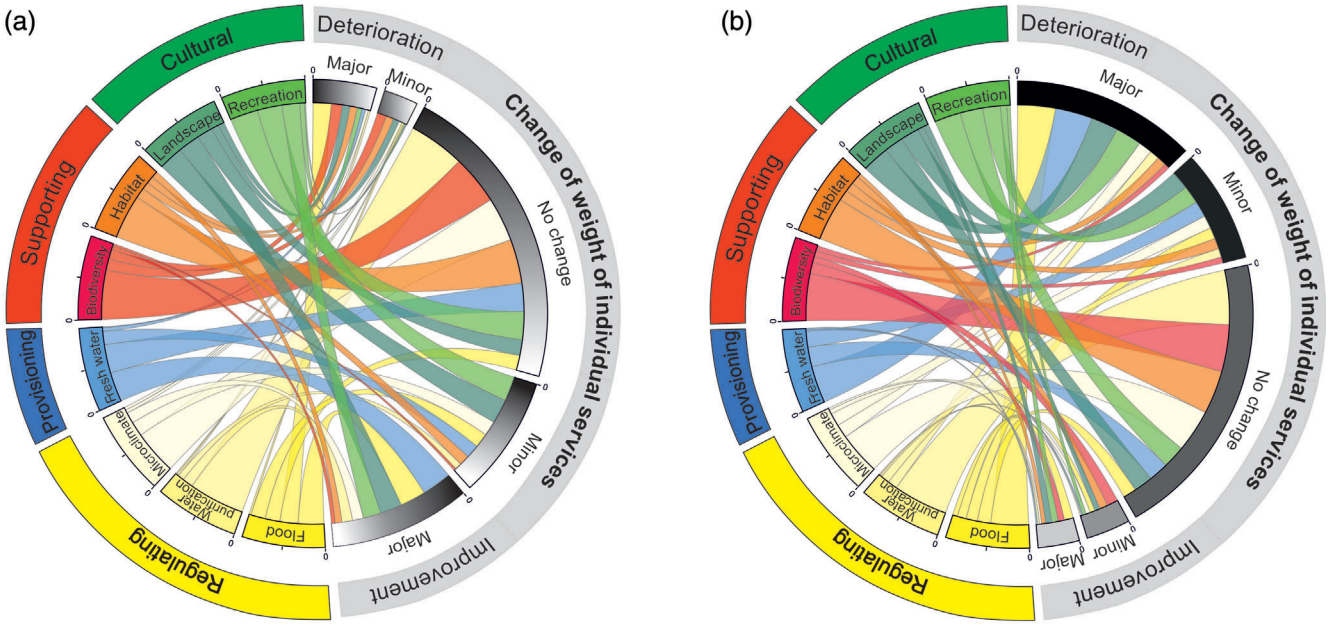
FIGURE 2 Diagram presenting major functions of Wilkówka dam, according to opinions of residents of Wilkowice commune versus weights assigned to them from most important (1) to least important (4) and 'not specified' and tabled summary of results (generalised). [Colour figure can be viewed at wileyonlinelibrary.com]

Summary of results (%)	Very important	Moderate	Important	Not important	Not specified
Regulating services: flood protection	30.7	**27.4**	**19.3**	7.4	15.2
Provisioning services: fresh water	**48.1**	13.4	12.7	5.8	**19.9**
Cultural services: recreation	8.3	3.3	11.7	**68.8**	7.9

greater the regularity of visits, the more often additional functions of the facility were noted. Even occasional recreational use was associated with more positive assessments of the impact of dam construction on most of the aspects studied. Also, indicating a variety of ways of spending time at the dam was associated with a more positive reception of the construction. Similarly, in the case of the expected effects of demolition, people who did not spend time at the reservoir were neutral towards the demolition more often than those who spent time at the dam. Frequent users of the surrounding space expected negative effects from the demolition. Also, indicating a variety of activities was associated with a more negative perception of demolition. Interesting relationships can be observed in the evaluation of the state of accompanying infrastructure, such as roads, bridges, pipelines, and so on, that—according to many respondents – had been improved by the construction of the dam and would not deteriorate after its removal, thereby leaving the commune with an infrastructure that was better than before the dam construction.

Supplementary information for chord diagrams is provided by the assessment of the perception of the impact that the dam and its planned removal would have on related types of infrastructure and ecosystem services (Figure 4). This comparison revealed that respondents attribute a greater negative impact to the demolition of the dam than they attribute benefits to it having been built. Taken at face value, this might suggest that they expect almost all aspects of the situation post-demolition to be worse than the original condition from before the dam was built. However, assuming that the phenomenon of loss aversion is at play here (Kahneman & Tversky, 1984), it would be more accurate to say that (despite the dam having failed to properly perform its functions) households perceived the negatives of losing the dam more strongly than they felt the gains from its construction. For water supply (drinking water and fire safety) and regulating services (flood control), the negative effects of dam removal were contrasted against the benefits of its existence (Figure 4). Respondents' answers were clearly influenced by their behaviour or aesthetic sense, for example, whether they spent their spare time by the reservoir and whether they thought the area around the reservoir was well managed. The most frequently expressed opinions were related to cultural services regarding improvements in the aesthetic value of the area.

As regards respondents' preferred fate for the Wilkówka dam and reservoir, most selected reconstruction or repair to ensure that the structure was safe and that the intended provisioning and regulating services could still be provided, with a simultaneous increase in the significance of cultural services related to the dam. Respondents who had



Summary of results (%)

		Construction (A)			Removal (B)		
		Deterioration	No change	Improvement	Deterioration	No change	Improvement
Regulating	Flood	26.5	19.3	**53.8**	**64.5**	17.4	18.1
	Water purification	4.3	**73.4**	22.3	24.1	**71.8**	4.1
	Microclimate	8.3	**58.0**	33.7	35.2	**56.3**	8.5
Provisioning	Fresh water	5.8	38.2	**56.0**	**69.3**	26.9	3.8
Supporting	Biodiversity	27.0	**64.8**	8.6	14.6	**62.5**	22.9
	Habitat	19.3	**58.8**	22.3	26.4	**57.5**	16.1
Cultural	Landscape	17.8	20.8	**60.6**	**60.0**	25.0	15.0
	Recreation	7.9	36.7	**55.4**	**57.6**	29.7	12.7

FIGURE 3 Diagrams presenting Wilkowice commune households' evaluations of environmental, social, economic and spatial changes in the provision of selected types of ecosystem services: (a) after the construction of the dam and (b) after its removal; and tabled summary of results (generalised). [Colour figure can be viewed at wileyonlinelibrary.com]

a negative opinion of the dam expected it to be removed, and households who saw a positive role in the dam were afraid of the consequences of its removal and opted to spare the dam. In the comments to the surveys, almost half of respondents demanded action be taken against the parties responsible for the poor condition and technical errors preventing its use. They criticised inappropriate spending on both the construction and repairs that had not provided a solution.

3.2 | Involvement, positions and priorities of stakeholders in the decision-making process

There were 18 groups of stakeholders involved in the decision-making process, and these differed in their level of engagement (Table 1). The level of engagement of most of the stakeholders was low or very low. Only two stakeholders were involved very

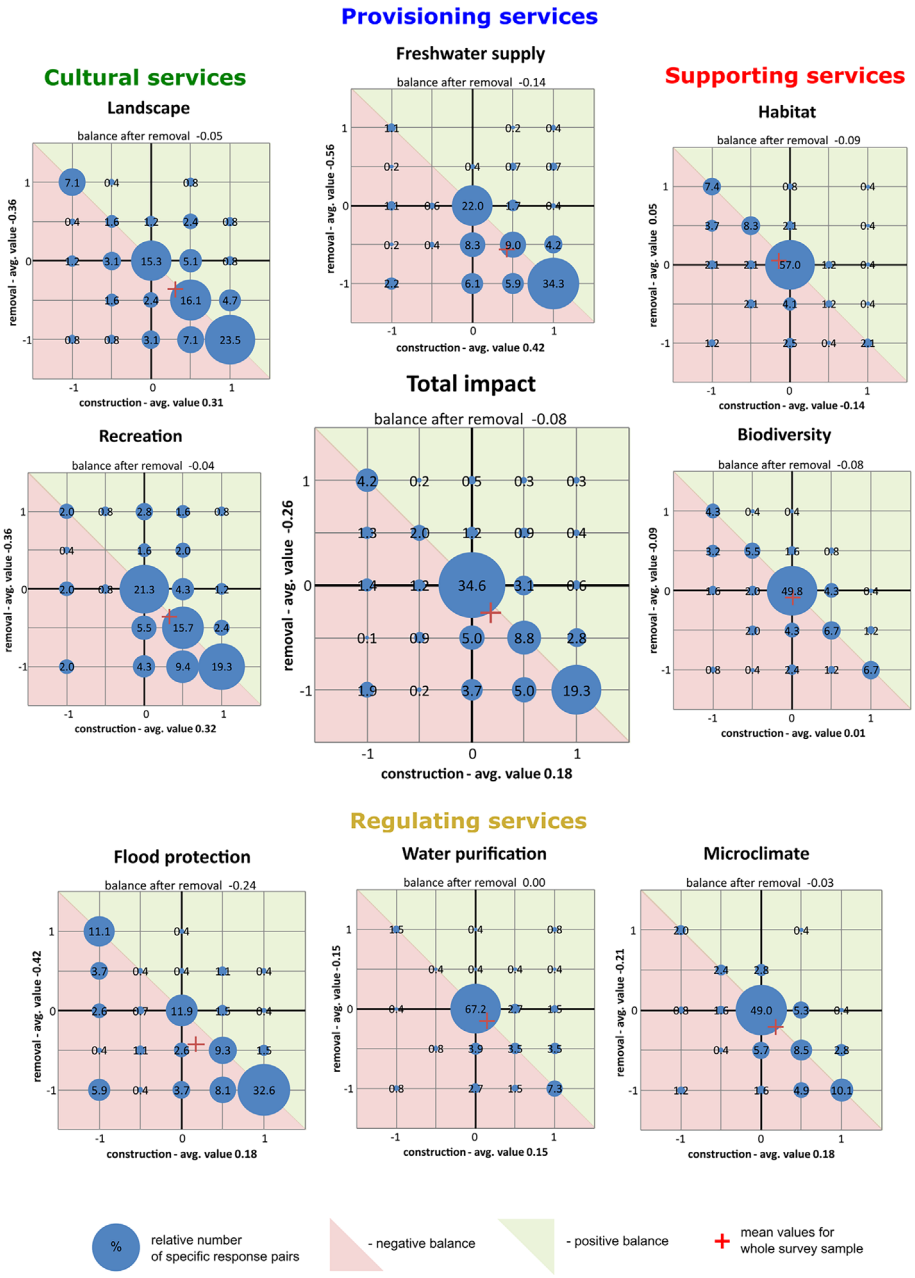


FIGURE 4 Perception matrix illustrating the balance of perceived profits and losses/pros and cons of construction and removal of Wilkówka dam in selected environmental, social, economic and spatial aspects according to households. Explanation: the 'X' axis corresponds to the perceived impact of dam construction, and the 'Y' axis – of dam removal; the impact value was assigned to respective figures on the axes, i.e.,: high impact −1 and 1; insignificant impact −0.5 and 0.5 and no impact 0; size of bubbles shows relative number of specific response pairs with their % value and red cross denotes mean values for the whole survey sample. [Colour figure can be viewed at wileyonlinelibrary.com]

actively, that is, the local public administration (the Commune of Wilkowice) and a scientist (a hydrologist). Surprisingly, even households of the municipality where the dam was located were very inactive in the decision-making process. Furthermore, most were not aware of there having been a public consultation prior to the dam's construction. The survey confirmed that nearly half of the respondents felt that the planned removal of the dam had involved no public consultation, with some being unsure, and only 1.3% claiming that there had been consultation. A large majority of respondents (83.9%) confirmed that they were aware of the planned removal of the Wilkówka dam, but that the main source of this information was the media. However, for the purposes of this study, this form of communication was not accepted as constituting consultation; contact by local government officials (i.e., the Commune of Wilkowice) was deemed to be the criterion for consultation to have taken place.

The manager of the dam, the National Water Management Authority in Warsaw, submitted an application for the dam's demolition to the General Office of Building Control in Warsaw, arguing that it saw no possibility of effectively securing the structure against catastrophic failure. The decision was taken at the national level, and the mayor of the Wilkowice commune and residents learned about it from the media. On 6 June 2019, the General Office of Building Control issued an executive decision to demolish the dam according to the provisions of Art. 67 section 1 of the *Construction Law*, on the grounds that the technical condition of the head dam was insufficient and that water filtration was excessive, threatening the stability of the dam and thus posing a threat to the safety of people and property.

TABLE 1 Level of engagement in the decision-making process, by stakeholder group.

Level of engagement		Very low	Low	High
Public administration				
National	General Office of Building Control		√	
	Dam owner—National Water Management Authority 'Wody Polskie'		√	
Regional	Regional Director of Environmental Protection in Katowice	√		
	Provincial Office in Katowice		√	
	State Forests—Forest Inspectorate Bielsko	√		
Local	Commune of Wilkowice			√
	Poviat Office in Bielsko-Biała		√	
Local society				
Water Supply Company in Wilkowice			√	
Residents			√	
Volunteer Fire Department in Wilkowice			√	
Polish Fishing Association—Bielsko-Biała District		√		
Local businesses				
AQUA Water Supply Company			√	
Environmental protection organisations				
'Pracownia na rzecz Wszystkich Istot' Association			√	
ENGOs 'Klub Gaja'		√		
Politicians				
Member of parliament			√	
Scientists				
Economist		√		
Hydrologist				√
Hydrotechnician		√		
Total: number of stakeholders engaged at different levels in the decision-making process		**6**	**10**	**2**

Additionally, the Regional Director for Environmental Protection in Katowice waived a requirement to hold a relevant Environmental Impact Assessment (EIA) or prepare an *Environmental Impact Assessment* report, thereby conclusively ensuring that the Wilkowice commune authorities, ecological organisations and residents were excluded from the decision-making process.

National agencies prioritised the avoidance of a potential catastrophic construction failure (Table 2). In contrast, regional and local authorities most often mentioned the need to reinforce the regulating services (flood control) and provisioning services (water supply for fire safety purposes) that the dam provided. The Commune of Wilkowice took an active part in the decision-making process. This included campaigning directly amongst residents or in the media for the dam to be saved, encouraging residents to object to the demolition, and supporting scientists trying to find alternative remedial solutions. Other stakeholders in the public administration group (including the administrator of the dam) were weakly involved in the public debate on the removal of the dam. The national and regional public administration exhibited low or very low activity and limited themselves to issuing the documents required in the removal process. The scientists most often referred to the possible deterioration in environmental potential. This group raised the issue of a potential catastrophic technical failure less frequently than any other group (Table 1). Of particular importance to the local community was concern that the dam's removal would be followed by problems with water supply (provisioning services) – 70% of respondents indicated that this would be worse after removal. Residents knew about the poor condition of the dam from the media, but nevertheless perceived that the demolition would decrease their welfare, and thus their overall assessment of the demolition was negative (Figure 4). According to the Water Supply Company in Wilkowice, the most important function of the reservoir is to maintain the quality of groundwater resources, and the decision to remove the dam was taken arbitrarily without consulting them. Local business representatives did not see any problem with the supply of water to residents. ENGOs unanimously mentioned the risk of negative impacts related to the dam removal operation. They advocated sparing the dam, as they were afraid that removal would have an adverse effect on the environment due to the presence of hydrated lime in the earth masses filling the frontal dam. Because residents were unaware that the earthen infill contained potentially harmful substances, ~60% of all respondents had indicated 'no changes' to the environment, and

TABLE 2 Main arguments concerning the removal of Wilkówka dam, by stakeholder group.

Stakeholders		Ecosystem services				Infrastructure services	
		Regulating	Provisioning	Supporting	Cultural	Avoiding a potential catastrophic failure	Condition of technical infrastructure
National	General Office of Building Control					√	
	Dam owner – National Water Management Authority 'Wody Polskie'					√	
Regional	Regional Director of Environmental Protection in Katowice			√			
	Provincial Office in Katowice	√	√		√	√	√
	State Forests—Forest Inspectorate Bielsko	√					
Local	Commune of Wilkowice	√	√	√	√	√	√
	Poviat Office in Bielsko-Biała	√					√
	Water Supply Company in Wilkowice	√	√	√	√	√	√
	Residents		√	√	√	√	√
	Volunteer Fire Department in Wilkowice		√	√	√	√	√
	Polish Fishing Association—Bielsko-Biała District			√			
	Water Supply Company AQUA	√	√				
	Association 'Pracownia na rzecz Wszystkich Istot'	√		√			√
	ENGOs 'Klub Gaja'			√			
	Member of Parliament	√	√			√	
	Economist	√	√	√	√	√	√
	Hydrologist	√	√	√			
	Hydrotechnician					√	
Summary		**12**	**9**	**10**	**6**	**10**	**8**

so their assessments of the impacts of demolition on biodiversity and habitat were disregarded (Figures 3 and 4). Our field observations indicate that the release of hydrated lime during the dam's demolition temporarily increased the pH value to 10–12 in November and December 2021. This factor must also have had a critical impact on the biotic conditions in the Wilkówka Stream and in the Biała River below the mouth of the stream. In the Beskidy watercourses, the pH values of the water are generally below 7.0 (Kosmowska et al., 2018) and, in the spring sections like Wilkówka, often below 6.0 (Jasik & Biber, 2022) or even 5.0 (Małek et al., 2006).

However, none of the ENGOs took an active part in the decision-making process. The involvement of the scientific community was limited to the presented studies and expert monographs, whilst the activity of politicians was limited to filing a petition to audit the construction and removal of the water dam in Wilkowice with the Polish National Inspection Authority's Supreme Audit Office.

4 | DISCUSSION

4.1 | Local community versus water ecosystems and infrastructure

Despite the dam in Wilkowice having been built quite recently (in 2012) and the reservoir not having been filled with water for most of the time (and thus not fulfilling its function), households had a positive opinion of its existence and were hoping it could be exploited in the future. This case study demonstrated that the households had a strong attachment to the hydrotechnical infrastructure and the related hope for its water supply and flood regulation services, both of which were perceived to be negatively impacted by removal (Figures 3 and 4). This makes it likely that there were real needs that the Wilkówka reservoir could have fulfilled, as reflected in the perceived improvement in local community welfare (Cohen et al., 2014). The attitude of the local community may also imply that social life and tourism were

expected to generally improve in connection with the dam's existence. This interest in tourism development can be deemed a stage in creating a community that is involved in local matters connected with reducing land degradation. To date, this has been observed more in the United States and countries of Western Europe, where the presence of dams is greatest and objections to their removal have been strongest. Keilty et al. (2016) and Fox et al. (2016) found that local communities adapt to changes caused by the construction of dams and—in the case of removal—their strong attachment is due to the provision of cultural services (identity, aesthetics, recreation and tourism). Similar findings were made regarding the removal of the 50-year-old Mactaquac dam in Canada (Keilty et al., 2016) and the removal of older dams in France (Germaine & Lespez, 2017), Sweden (Jørgensen & Renöfält, 2013) and Finland (Valtonen, 2017). All these studies indicate that the fear of losing recreational benefits and cultural values leads to protests against dam removal. This was also clear in our study, where ~60% of respondents attributed improved landscape and recreation to the construction of the dam, whereas ~60% of respondents also attributed a deterioration in the same to its removal (Figure 3). However, when ENGOs are involved, environmental aspects and alternative recreation activities on free-flowing rivers can become more important (Gosnell & Kelly, 2010; Guarino, 2013). In the states of Oregon and Washington (USA), visions of restoring the continuity of rivers led to the development of political coalitions between native residents, local residents and recreational organisations (Grabowski et al., 2017).

Irrespective of the possibility of satisfying their essential needs, residents believe that the removal of the dam will reduce their quality of life and increase social injustice in access to water. This is because, to date, the system supplying water to the residents of Wilkowice comprised three water intakes that are unstable in output. These perceptions are not surprising, as the public perceives the dam to play a key role in supporting other infrastructure systems (Grabowski et al., 2017), and the potential to provide ecosystem services is often a product of interactions between built, social and natural forms of capital (Jones et al., 2016). This rapid attachment has resulted in residents perceiving the demolition project to threaten their sense of place, which creates an additional reluctance to carry out works that would significantly change their immediate surroundings (Devine-Wright, 2009; Stedman, 2003). In the estimation of the households of Wilkowice, the total balance of perceived profits and losses of construction and removal is negative (Figure 4). The centrality of hydraulic infrastructures to modern societies is a major reason why many dams that are disused or in poor technical condition are often not removed but are instead reconstructed or repurposed (Habel et al., 2020). When looking at the balance of income and costs of infrastructures, removal is often considered an unreasonable expense due to the loss of income-generating services, even though removing a big dam is 10–30 times cheaper than adapting it to contemporary standards, for example, regarding the migration of migratory fish species (Poff & Hart, 2002). For the dam in Wilkowice, the initial cost of removal was about 50% of its construction. At the same time, the post-removal cost to the environment is not known.

4.2 | Ecological aspects of the dam removal

Ecologically conscious societies care for preserving, restoring and enhancing existing hydroecological systems in degraded landscapes. The literature implies that an understanding of the significance of environmental processes is often developed by long-term participation in decision-making processes based on high-quality environmental knowledge and open discussion of the value of alternative courses of action (Gowan et al., 2006). Nevertheless, different attitudes to the value of ecosystem services than those found in this study can be seen in Northern America and Western Europe, where society is more ecologically aware and paradoxically has many more hydraulic infrastructure investments. In the first place, they can see benefits in restoring river continuity that exceed the potential losses in certain cultural services (Gosnell & Kelly, 2010; Germaine & Lespez, 2017). However, one cannot generalise about the relationship between ecological awareness and acceptance of the liquidation of all dams. As presented by Keilty et al. (2016) and Fox et al. (2016), there are also exceptions showing that the attachment of a local community to a dam can outweigh ecological or economic arguments—especially when dams and their reservoirs become an important feature of the local landscape and identity. Households prefer the structure to remain in place, even after energy generation ceases.

The surveys amongst the households of the local commune did not show a high level of ecological awareness. The services provided by the dam that the households valued most highly were: access to water for drinking and fire protection purposes; flood protection; and—to a lesser extent—reservoir-related recreation, most likely due to the reservoir having been filled with water for only a short time) (Figure 2). The impact that the dam's construction and removal had on the quality of the natural environment, including changes in habitats and biodiversity, were not considered to be important (Figure 4). According to respondents, neither the construction nor the removal of the dam was expected to result in changes in supporting ecosystem services (Figure 3). Regarding the impact of the building of the dam, the meeting of economic needs (of the suburban community) and flood safety needs (the town lies along a mountain stream) may have reduced sensitivity to environmental aspects. Regarding the dam's removal, households had no awareness or knowledge of potential threats (e.g., to the aquatic environment) associated with the release of masses of earth containing hydrated lime. The households fairly assumed that flood control might be diminished by the dam's removal, as the potential of mountain river ecosystems to provide this regulatory service is limited by high catchment and valley slopes, the impermeable bedrock and the intense runoffs, as in the case of the Wilkówka stream. Similarly, according to the households, the cultural services such as landscape attractiveness and recreation benefited significantly from the dam construction (an improvement according to ~60% of respondents), whilst they would be adversely affected by the dam's removal (Figure 3), which shows high social expectations towards these services.

It can already be concluded that the demolition of the Wilkówka dam has been a great 'failure' in terms of implementing the 'river

defragmentation' promoted in EU policy (Belletti et al., 2020). Because the original geometric and morphological conditions of the riverbed were not reconstructed and no ecohydrological solutions were implemented. The removal of this dam cannot be considered to be an example of river restoration or rejuvenation. Only after removal works had been completed did it turn out that the streambed had not been returned to its original course and the barriers to fish migration had not been removed (Photo 1d–f). Because the debris barrier and the sill of the demolished dam were left in place, the construction of the dam and its subsequent demolition reduced the hydrological and biological connectivity of the river (Photos 1e, ff). The surroundings of the liquidated dam and reservoir are still sealed by a steel fence, preventing the river from serving as an ecological corridor and preventing residents and tourists from accessing the river. In European countries, the basins of rivers are strongly transformed, so dams are hybrid facilities combining natural and artificial elements (Germaine & Lespez, 2017). Thus, it should not be expected that without wider interventions in the catchment area and the evolution of other infrastructures interacting with ecological systems (Grabowski et al., 2017), the removal of the dam would lead to the substantial ecological improvement of the Wilkówka stream valley.

It should also be noted that the dam in Wilkowice was a new facility, and hence the requirement for provisioning services dominated households' expectations (Figure 2). As demonstrated by Sarakinos and Johnson (2002), Fox et al. (2016) and Sherren et al. (2016), over time, a local community can perceive the historical and cultural value of a facility to increase, although communities are rarely fully united in their attachment to dams. As underlined by Muller et al. (2015), existing hydraulic infrastructures are often deeply intertwined with the development of local communities, other infrastructures, industries and general trajectories of 'modernisation'.

4.3 | The role of public debate

The construction of the Wilkówka dam in its current location, although its capacity to perform the functions it was supposed to have been brought into question, was not necessarily a mistake. Had the public been consulted and the dam designed and constructed differently, a reservoir could have been a success in this location. However, the general public was not involved at the design stage to, for example, consider the recreational needs (cultural services) that are often expressed in surveys. Involving the public in the investment process as a partner allows additional needs to be considered and increases the social legitimacy of hydraulic infrastructure projects (Dietz & Stern, 2008). Case studies developed in the United States over the years show that social conflicts, including local residents' objections to removing dams, can be neutralised by collaborative and inclusive decision-making regarding dam rehabilitation or removal (Habel et al., 2020).

In the process of removing the Wilkówka dam, the national regulatory agencies overseeing the dam made unilateral decisions without social consultation. The demolition of this dam was decided upon at the national level with the minimum consultation required by law. It is worth mentioning here the stakeholder interview with the Office of the Mayor of the Wilkowice Commune and the results of surveys for the households of Wilkowice, in which 60.5% of responses expressed that there had been no consultations on the dam removal (with the remaining respondents being uncertain).

As mentioned earlier, two-thirds of respondents indicated that they had learned about the decision from the media. No alternative solutions or compensation for the local community were proposed, leaving the actors with a sense of negative impact on their welfare, further increasing their negative opinion of the project (Cohen et al., 2014). The dam removal project was not made public, and this was inconsistent with the principles of procedural justice (Sovacool et al., 2016).

Ordinarily, the course of the dam removal decision-making process depends on the activity of stakeholders participating in a public debate (Buijs, 2009; Duda et al., 2008; Fox et al., 2016; Germaine & Lespez, 2017; Gosnell & Kelly, 2010; Jørgensen & Renöfält, 2013; Sarakinos & Johnson, 2002). The Wilkówka dam removal differs in this respect, as no public debate at all was held regarding possible solutions. The owner's only alternative was to remove the dam, although proposals for specific remedial actions were formulated by independent experts. Officially, the dam owner decided that the expert opinions formulated to date had not provided a solution that would make the reservoir safe to operate. The rapidity of dam removal proceedings was dictated by the need to adhere to administrative time limits and the strong desire to avoid a catastrophic failure. However, our findings show that the speed of the removal resulted solely from the need to meet a deadline set by the General Office of Building Control. The dam owner failed to show goodwill in terms of public consultations, in that it did not agree to a public debate (meeting) with residents or independent experts. Such a meeting was supposed to have been moderated by our team in January 2021. It transpires that the dam's owner was not obliged to involve the public in the decision-making process because the facility had never formally been commissioned into use. The technical demolition project that was prepared was limited to consultations with experts employed by the dam owner. Dietz and Stern (2008) underline that the public should be included in analysis and decision processes each time, to improve their quality and validity and to increase their social capital. Public participation should be regarded by decision-makers as a basis for efficient action and not merely a procedural requirement. An evaluation of the quality of the public debate should also take into account the duration of the decision-making process. For the Wilkówka dam, it commenced almost immediately after the first problems arose during attempts to fill the reservoir with water (2017) and at a critical moment in 2019 when water threatened to spill over the crest of the dam. Therefore, the activity of stakeholders was relatively brief in comparison to other cases described in the literature, for example, Elwha (>20 years—Guarino, 2013), five dams on the Klamath River (>10 years) and the Vezins and Roche-qui-Boit dams on the Sélune River in France (>20 years—Germaine & Lespez, 2017).

4.4 | Active stakeholders as a key to an agreement

Examining the activity of stakeholders in decision-making processes regarding dam removals, low levels of public engagement correlate with the dams to be removed being perceived as having only limited functionality (Habel et al., 2020); the removal having a local range of impact or regulatory constraints on topics of debate being imposed by public administration (Buijs, 2009). The example of the removal of dams in the basin of the Klamath River (Gosnell & Kelly, 2010) and the Elwha River (Guarino, 2013) illustrated the significance of the non-governmental organisations working to support other stakeholders in the decision-making process or making it possible to establish alliances, for example, between native people and farmers. In the case of the Wilkówka dam, stakeholders did not engage in dialogue together or coordinate their actions or even work in opposition to one another. For instance, some stakeholders perceived the local authorities as attempting to win political support (in particular, the dam owner tried to argue that there had been a high level of engagement from the Wilkowice commune). Similarly, ENGOs did not act together and even threw accusations at one another, alleging that the environmental impact report that led to the creation of the dam contained erroneous claims or assessments. The decision-making process was unilateral and the questionnaire survey for this paper was simply an opportunity for the local community to express their opinions about the expected functions of the dam. At the same time, residents, ENGOs or other informal groups objected to the removal largely passively, with no organised opposition movement or protests. This may be because, despite the high expectations that building the dam would ensure provisioning, regulating and cultural services (Figure 3a), it had not ultimately brought measurable benefits. Cohen et al. (2014) state that a lack of expected improvement in welfare favoured a neutral public attitude to a project. The behaviour of the local community in Wilkowice may also be affected by their feeling of helplessness in the face of the dam administrator's fiat. Decidedly the most active group was the local authorities, who took action on behalf of the local community. It is worth emphasising that only four stakeholders representing the public administration were formally involved in the dam removal process, and only the local town government showed higher involvement than other parties in the public sphere (Table 1).

Apart from stakeholders included in and excluded from the decision-making process, there is a clear division into groups representing a broad and specialised scope of interests. It should be noted that only the stakeholders who have direct links with the local authorities raised various issues regarding the operation and removal of the dam, whilst organisations for which Wilkowice is only one of many areas of activity confined themselves to commenting on aspects falling exclusively within their specific scope of interest (Table 1). This shows that local communities can see the impact of the projects on their direct environment and everyday life more clearly than non-local administrative institutions (Fox et al., 2016). The only group of stakeholders outside the commune of Wilkowice to take multiple aspects into account is scientists, many of whom adopt an interdisciplinary or cross-disciplinary approach in their work (Duda et al., 2019).

5 | CONCLUSIONS

1. The Wilkówka dam is the first dam in Poland to be removed (the removal was conducted from November 2021 to March 2022) and is a unique case of the removal of a modern dam that had been flawed from the beginning of its installation. According to the administrator of the dam, due to its condition, removal was the only option.
2. The decision to remove the dam did not involve public consultation. No alternative solutions were presented to the public, and all stakeholders involved as parties in the case of removal were exclusively national-level agencies.
3. In the perception of the local community, the service benefits of removing the dam do not exceed the losses incurred, mainly in provisioning and regulating services provided by the infrastructure. Despite the threat of a catastrophic technical failure, most households opposed the dam removal and expected that removing the dam would entail more negative effects than the benefits of the dam's construction. Households wish to maintain the *status quo*; that is, they hope for a stable water supply (provisioning service). The local community's high expectations of urgent needs being met contributed to their unusually quick attachment to the dam, as revealed by respondents' survey responses.
4. In the light of above, the passive attitude of stakeholders representing the local community and local ENGOs is a surprising situation. The decision-making path in the dam removal process only took into consideration the formal participation of the public (without open access to knowledge), so there was no real participation.
5. Ecological aspects were considered only within the basic scope of an environmental impact assessment provided for by the legal framework. Benefits related to ecosystem services were assessed superficially, and their economic valuation was entirely disregarded. Therefore, environmental arguments were not truly presented in the discussion.
6. For local households, the removal of the dam is not perceived to be a positive environmental intervention with an impact on habitats and biodiversity. These issues are likely a result of insufficient general awareness of how ecosystems – and, notably, fluvial systems – work, the instrumental treatment of natural resources (mainly for provisioning and cultural ecosystem services), and the general public belief in the advantage of technology-based solutions over nature-based solutions, as well as the public's rapid attachment to the dam and identification of it with their sense of place.
7. The preference for technological over nature-based solution approaches amongst both the decision makers and the public is especially valid, as dam removals might be increasingly considered within the EU to meet the *Water Framework Directive* and other environmental initiatives. To reduce social conflict, consultative processes should be elaborated that spread ecological awareness and foster creative and collaborative solutions to evolving hydraulic infrastructure systems in relation to the shifting needs of society and impending climate change.

ACKNOWLEDGMENTS

The authors are grateful to Tim Brombley for comments on the manuscript and Mikołaj Matela (Kazimierz Wielki University, Bydgoszcz) for support and technical assistance. This work was co-financed by the Polish Minister of Science subsidy for maintaining the research potential of the Kazimierz Wielki University.

CONFLICT OF INTEREST STATEMENT

All authors declare no financial or commercial conflicts of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Michał Habel https://orcid.org/0000-0002-4661-6498
Dawid Szatten https://orcid.org/0000-0003-2858-5699
Krystian Obolewski https://orcid.org/0000-0001-9361-0286

REFERENCES

Adger, W. N., Barnett, J., Brown, K., Marshall, N., & O'Brien, K. (2013). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change*, *3*(2), 112–117. https://doi.org/10.1038/nclimate1666

Alexander, I. F. (2005). A taxonomy of stakeholders: Human roles in system development. *International Journal of Technology and Human Interaction*, *1*(1), 23–59. https://doi.org/10.4018/jthi.2005010102

Auerbach, D. A., Deisenroth, D. B., McShane, R. R., McCluney, K. E., & Poff, N. L. (2014). Beyond the concrete: Accounting for ecosystem services from free-flowing rivers. *Ecosystem Services*, *10*, 1–5. https://doi.org/10.1016/j.ecoser.2014.07.005

Belletti, B., Garcia de Leaniz, C., Jones, J., Bizzi, S., Börger, L., Segura, G., Castelletti, A., van de Bund, W., Aarestrup, K., Barry, J., Belka, K., Berkhuysen, A., Birnie-Gauvin, K., Bussettini, M., Carolli, M., Consuegra, S., Dopico, E., Feierfeil, T., Fernández, S., … Zalewski, M. (2020). More than one million barriers fragment Europe's rivers. *Nature*, *588*, 436–441. https://doi.org/10.1038/s41586-020-3005-2

Bellmore, R., Duda, J. J., Craig, L. S., Greene, S. L., Torgersen, C. E., Collins, M. J., & Vittum, K. (2017). Status and trends of dam removal research in the United States. *Wiley Interdisciplinary Reviews: Water*, *4*(2), e1164.

Buijs, A. E. (2009). Public support for river restoration. A mixed-method study into local residents' support for and framing of river management and ecological restoration in the Dutch floodplains. *Journal of Environmental Management*, *90*(8), 2680–2689. https://doi.org/10.1016/j.jenvman.2009.02.006

Clarke, D., Murphy, C., & Lorenzoni, I. (2018). Place attachment, disruption and transformative adaptation. *Journal of Environmental Psychology*, *55*, 81–89. https://doi.org/10.1016/j.jenvp.2017.12.006

Clarkson, C., Scott, H. R., Hegarty, S., Souliouet, E., Bhundia, R., Gnanapragasam, S., Docherty, M. J., Raine, R., Stevelink, S. A., Greenberg, N., Hotopf, M., Wessely, S., Madan, I., Rafferty, A. M., & Lamb, D. (2022). 'You get looked at like you're failing': A reflexive thematic analysis of experiences of mental health and wellbeing support for NHS staff. *Journal of Health Psychology*, *28*(9), 818–831. https://doi.org/10.1177/13591053221140255

Cohen, J. J., Reichl, J., & Schmidthaler, M. (2014). Re-focusing research efforts on the public acceptance of energy infrastructure: A critical review. *Energy*, *76*, 4–9. https://doi.org/10.1016/j.energy.2013.12.056

Colvin, R. M., Witt, B., & Lacey, J. (2016). Approaches to identifying stakeholders in environmental management: Insights from practitioners to go beyond the 'usual suspects'. *Land Use Policy*, *52*, 266–276. https://doi.org/10.1016/j.landusepol.2015.12.032

De Dominicis, S., Fornara, F., Ganucci Cancellieri, U., Twigger-Ross, C., & Bonaiuto, M. (2015). We are at risk, and so what? Place attachment, environmental risk perceptions and preventive coping behaviours. *Journal of Environmental Psychology*, *43*, 66–78. https://doi.org/10.1016/j.jenvp.2015.05.010

Devine-Wright, P. (2009). Rethinking NIMBYism: The role of place attachment and place identity in explaining place-protective action. *Journal of Community and Applied Social Psychology*, *19*(6), 426–441. https://doi.org/10.1002/casp.1004

Dietz, T., & Stern, P. C. (2008). *Public participation in environmental assessment and decision making*. The National Academies Press.

Donaldson, T., & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. *Academy of Management Review*, *20*(1), 65–91.

Duda, J. J., Anderson, J. H., Beirne, M., Brenkman, S., Crain, P., Mahan, J., McHenry, M., Pess, G., Peters, R., & Winter, B. (2019). Complexities, context, and new information about the Elwha River. *Frontiers in Ecology and the Environment*, *17*(1), 10–11. https://doi.org/10.1002/fee.1989

Duda, J. J., Freilich, J. E., & Schreiner, E. G. (2008). Baseline studies in the Elwha river ecosystem prior to dam removal: Introduction to the special issue. *Northwest Science*, *82*, 1–12.

Duda, J. J., Torgersen, C. E., Brenkman, S. J., Peters, R. J., Sutton, K. T., Connor, H. A., Kennedy, P., Corbett, S. C., Welty, E. Z., Geffre, A., Geffre, J., Crain, P., Shreffler, D., McMillan, J. R., McHenry, M., & Pess, G. R. (2021). Reconnecting the Elwha River: Spatial patterns of fish response to dam removal. *Frontiers in Ecology and the Environment*, *9*, 765488. https://doi.org/10.3389/fevo.2021.765488

Fox, C. A., Magilligan, F. J., & Sneddon, C. S. (2016). "You kill the dam, you are killing a part of me": Dam removal and the environmental politics of river restoration. *Geoforum*, *70*, 93–104. https://doi.org/10.1016/j.geoforum.2016.02.013

Germaine, M. A., & Lespez, L. (2017). The failure of the largest project to dismantle hydroelectric dams in Europe? (Sélune River, France, 2009-2017). *Water Alternatives*, *10*(3), 655–676.

Gosnell, H., & Kelly, E. C. (2010). Peace on the river? Social-ecological restoration and large dam removal in the Klamath Basin, USA. *Water Alternatives*, *3*(2), 361–383.

Gowan, C., Stephenson, K., & Shabman, L. (2006). The role of ecosystem valuation in environmental decision making: Hydropower relicensing and dam removal on the Elwha River. *Ecological Economics*, *56*(4), 508–523. https://doi.org/10.1016/j.ecolecon.2005.03.018

Graber, B. (2002). Potential economic benefits of small dam removal. In W. L. Graf (Ed.), *Dam removal research: Status and prospects*. Economics and the Environment Press.

Grabowski, Z. J., Chang, H., & Granek, E. F. (2018). Fracturing dams, fractured data: Empirical trends and characteristics of existing and removed dams in the United States. *River Research and Applications*, *34*(6), 526–537.

Grabowski, Z. J., Denton, A., Rozance, M. A., Matsler, M., & Kidd, S. (2017). Removing dams, constructing science: Coproduction of undammed river scopes by politics, finance, environment, society and technology. *Water Alternatives*, *3*(3), 769.

Guarino, J. (2013). Tribal advocacy and the art of dam removal: The lower Elwha Klallam and the Elwha dams. *American Indian Law Journal*, *2*(I), 114–145.

Guest, G., Namey, E. E., & Mitchell, M. L. (2013). Qualitative research: Defining and designing. In *Collecting qualitative data*. SAGE Publications. https://doi.org/10.4135/9781506374680

GUS. (2021). *Preliminary results of the National Population and housing census 2021*. Statistics Poland. Retrieved from https://stat.gov.pl/en/national-census/national-population-and-housing-census-2021/national-population-and-housing-census-2021/preliminary-results-of-the-na

tional-population-and-housing-census-2021,1,1.html (Accessed in 19.03.2023)

Habel, M., Mechkin, K., Podgorska, K., Saunes, M., Babiński, Z., Chalov, S., Absalon, D., Podgórski, Z., & Obolewski, K. (2020). Dam and reservoir removal projects: A mix of social-ecological trends and cost-cutting attitudes. *Scientific Reports*, *10*, 19210. https://doi.org/10.1038/s41598-020-76158-3

Halama, A. (2015). Evaluation of economic effectiveness of construction and exploitation of the Wilkówka retention reservoir, economic studies. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach*, *232*, 72–80. (in Polish).

Halama, A. (2016). Assessment of the recreational value of the Wilkówka reservoir. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, *428*, 99–106. (in Polish).

Ho, M., Lall, U., Allaire, M., Devineni, N., Kwon, H. H., Pal, I., Raff, D., & Wegner, D. (2017). The future role of dams in The United States of America. *Water Resources Research*, *53*(2), 982–998. https://doi.org/10.1002/2016WR019905

Holten, D. (2006). Hierarchical edge bundles: Visualization of adjacency relations in hierarchical data. *IEEE Transactions on Visualization and Computer Graphics*, *12*(5), 741–748. https://doi.org/10.1109/TVCG.2006.147

Jørgensen, D., & Renöfält, B. M. (2013). Damned if you do dammed if you don't: Debates on dam removal in the Swedish media. *Ecology and Society*, *18*(1), 18. https://doi.org/10.5751/ES-05364-180118

Jasik, M., & Biber, M. (2022). Diversity of physicochemical parameters of waters in Vistula River headwater area after spruce dieback in the Beskidy Mountains. *Sylwan*, *166*(9), 579–592.

Jones, L., Norton, L., Austin, Z., Browne, A. L., Donovan, D., Emmett, B. A., Grabowski, Z. J., Howard, D. C., Jones, J. P. G., Kenter, J. O., Manley, W., Morris, C., Robinson, D. A., Short, C., Siriwardena, G. M., Stevens, C. J., Storkey, J., Waters, R. D., & Willis, G. F. (2016). Stocks and flows of natural and human-derived capital in ecosystem services. *Land Use Policy*, *52*, 151–162. 10.1016/j.landusepol.2015.12.014.

Kahneman, D., & Tversky, A. (1984). Choices, values, and frames. *American Psychologist*, *39*(4), 341–350.

Kalantari, S., Xu, T. B., Mostafavi, A., Lee, A., Barankevich, R., Boot, W. R., & Czaja, S. J. (2022). Using a nature-based virtual reality environment for improving mood states and cognitive engagement in older adults: A mixed-method feasibility study. *Innovation in Aging*, *6*, igac015. https://doi.org/10.1093/geroni/igac015

Keilty, K., Beckley, T. M., & Sherren, K. (2016). Baselines of acceptability and generational change on the Mactaquac hydroelectric dam headpond (New Brunswick, Canada). *Geoforum*, *75*, 234–248. https://doi.org/10.1016/j.geoforum.2016.08.001

Kiedrzyńska, E., Belka, K., Jarosiewicz, P., Kiedrzyński, M., & Zalewski, M. (2021). The enhancement of valley water retentiveness in climate change conditions. *Science of the Total Environment*, *799*, 149427. https://doi.org/10.1016/j.scitotenv.2021.149427

Kosmowska, A., Żelazny, M., Małek, S., & Stańczyk, T. (2018). Impact of deforestation on water chemistry in the western Tatras and Beskid Śląski range in the Polish Carpathians. *Acta Scientiarum Polonorum Formatio Circumiectus*, *3*(17), 89–99. https://doi.org/10.15576/ASP.FC/2018.17.3.89

Kostecki, S., Machajski, J., Batog, A., & Maniecki, Ł. (2017). Assessment and identification of causes of unfavourable phenomena occurring in the Wilkówka reservoir during its operation, together with identification of measures aimed at bringing the facility to the required technical condition. Raport SPR 8/2017, Politechnika Wrocławska, Wrocław (in Polish).

Lejon, A., Malm Renöfält, B., & Nilsson, C. (2009). Conflicts associated with dam removal in Sweden. *Ecology and Society*, *14*(2), 4. https://www.ecologyandsociety.org/vol14/iss2/art4/

Ling, H., Yan, J., Guo, B., Xu, H., Li, X., & Deng, X. (2019). Evaluation of water and land exploitation based on the ecosystem service value in a hyper-arid region with intensifying basin management. *Land Degradation and Development*, *30*(18), 2165–2176. https://doi.org/10.1002/ldr.3406

Małek, S., Niemtur, S., & Staszewski, T. (2006). Seasonal changeability of water features from watersheds with artificial Norway spruce stands in the Silesian Beskid. *Ekológia (Bratislava)*, *25*(3), 289–297.

Meyer, B. D., Mok, W. K., & Sullivan, J. X. (2015). Badania gospodarstw domowych w kryzysie. *Journal of Economic Perspectives*, *29*(4), 199–226.

Muller, M., Biswas, A., Martin-Hurtado, R., & Tortajada, C. (2015). Built infrastructure is essential. *Science*, *349*(6248), 585–586. https://doi.org/10.1126/science.aac7606

Nathan, G. (2001). Telesurvey methodologies for household surveys—a review and some thoughts for the future? *Survey Methodology*, *27*(1), 7–32.

National Performance of Dams Program. (2018). Dam failures in the US, NPDP-01 V1, Report by Department of Civil & Environmental Engineering Stanford University.

Ostrowski, S., & Lasocki, M. (2019). Seismic studies in the assessment of the subsoil and the condition of the Wilkówka dam structures. In *Monitoring and safety of hydraulic structures* (pp. 193–204). Instytut Meteorologii i Gospodarki Wodnej (in Polish).

Poff, N. L., & Hart, D. D. (2002). How dams vary and why it matters for the emerging science of dam removal: An ecological classification of dams is needed to characterize how the tremendous variation in the size, operational mode, age, and number of dams in a river basin influences the potential for restoring regulated rivers via dam removal. *Bioscience*, *52*(8), 659–668. https://doi.org/10.1641/0006-3568(2002)052[0659:HDVAWI]2.0.CO;2

Reid, W. V., Mooney, H. A., Cropper, A., Capistrano, D., Carpenter, S. R., Chopra, K., Dasgupta, P., Dietz, T., Duraiappah, A. K., Hassan, R., Kasperson, R., Leemans, R., May, R. M., McMichael, T. A. J., Pingali, P., Samper, C., Scholes, R., Watson, R. T., Zakri, A. H., … Zurek, M. B. (2005). *The millennium ecosystem assessment: Ecosystems and human well-being: Synthesis*. World Resources Institute.

Rybacka, M., Majewska-Durjasz, I., Szuba, M., & Olszak, M. (2018). Assessment of geotechnical soils in the area of the reservoir dam in Wilkowice. EKOID Katowice, unpublished report. (in Polish).

Sarakinos, H., & Johnson, S. E. (2002). Social perspectives on dam removal. In W. L. Graf (Ed.), *Dam removal research: status and prospects*. Economics and the Environment, the Heinz Center.

Sherren, K., Beckley, T. M., Parkins, J. R., Stedman, R. C., Keitly, K., & Morin, I. (2016). Learning (or living) to love the landscapes of hydroelectricity in Canada: Eliciting local perspectives on the Mactaquac dam via headpond boat tours. *Energy Research & Social Science*, *14*, 102–110.

Sovacool, B. K., Heffron, R. J., McCauley, D., & Goldthau, A. (2016). Energy decisions reframed as justice and ethical concerns. *Nature Energy*, *1*, 16024. https://doi.org/10.1038/nenergy.2016.24

Stedman, R. C. (2003). Is it really just a social construction?: The contribution of the physical environment to sense of place. *Society & Natural Resources*, *16*(8), 671–685. https://doi.org/10.1080/08941920309189

Vahedifard, F., Madani, K., Kouchak, A., & Kumar, S. (2021). Are we ready for more dam removals in the United States? *Environmental Research: Infrastructure and Sustainability*, *1*, 013001. https://doi.org/10.1088/2634-4505/abe639

Valtonen, T. (2017). *The removal of a culture-historical dam for improved resilience of urban nature*. University of Applied Sciences.

von Wirth, T., Grêt-Regamey, A., Moser, C., & Stauffacher, M. (2016). Exploring the influence of perceived urban change on residents' place attachment. *Journal of Environmental Psychology*, *46*, 67–82. https://doi.org/10.1016/j.jenvp.2016.03.001

Waldman, J., Sharma, S., Afshari, S., & Fakete, B. (2019). Solar-power replacement as a solution for hydropower foregone in US dam

removals. *Nature Sustainability*, *2*, 872–878. https://doi.org/10.1038/s41893-019-0362-7

Więzik, B., Wątroba, R., & Biel, B. (2002). Water rights assessment - Dam and retention reservoir on the Wilkówka stream in the Wilkowice municipality. *STAAND sp. z o.o. Kraków*, 143.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Habel, M., Mechkin, K., Wagner, I., Grabowski, Z., Kaczkowski, Z., Absalon, D., Szatten, D., Matysik, M., Pytel, S., Jurczak, T., & Obolewski, K. (2024). Dammed context: Community perspectives on ecosystem service changes following Poland's first dam removal. *Land Degradation & Development*, 1–17. https://doi.org/10.1002/ldr.5053