Geoforum 147 (2023) 103906

Contents lists available at ScienceDirect

Geoforum

journal homepage: www.elsevier.com/locate/geoforum

Troubled waters: Riparian ecosystem services and community opposition to the largest dam removal project in Europe, Vezins Dam, France

Zayane Boucher [a], Paul F. Hudson [b,*]

[a] Université Paris-Dauphine, PSL Research University, Paris, France
[b] Program in Earth, Energy, & Sustainability, Leiden University College, Leiden University, The Netherlands

ARTICLE INFO

Keywords:
Dam removal
Sélune River
Local opposition
France
Riparian ecosystem services
Vezins Dam

ABSTRACT

The largest Dam removal project in Europe occurred in 2019 with removal of the Vezins Dam on the Sélune River in Normandy, France. The French State ordered removal of the 36-m high Vezins Dam and the 16-m high la Roche-qui-Boit Dam along the Sélune River to restore ecological and longitudinal connectivity to improve riparian water quality, and especially to restore migratory species of Atlantic salmon (*Salmo salar*) and eel (*Anguilla anguilla*). We examine community opposition to removal of the Vezins Dam through the lens of riparian ecosystem services and stakeholder values. Primary data sources includes fieldwork, interviews, and an online survey of local stakeholders. Text analysis and interview coding occurred with ATLAS.ti 22, and highlight themes related to federal-local communication and riparian ecosystem services. The French State ineffectively communicated with local communities regarding dam removal benefits and riparian stakeholder values. While the state focused on biophysical ecosystem services, experiential ecosystem services, such as place attachment, were more important to riparian stakeholders. Often portrayed as a positive benefit, here dam removal lacked community support. Failure of government authorities to effectively incorporate stakeholder values along a continuum of ecosystem services substantially compromises future large-scale federal environmental management projects dependent upon local community support. By examining how local actors experienced dam removal, study results increase understanding of environmental governance and the local consequences of national policy decisions, of use in future dam removal projects – including for large dams – in France and internationally.

1. Research context

Recognition that dams degrade downstream riparian environments has stimulated government authorities to engage with the practice of dam removal. Dam removal is viewed as an effective solution to improve water quality, restore longitudinal and lateral hydrologic connectivity, and increase public safety (Born et al., 1998; Bednarek, 2001; Johnson and Graber, 2002; Stanley and Doyle, 2003; Thieme et al., 2021). Removal of dams has become a staple in the practice of "river restoration," which in itself has become a major socio-scientific enterprise (Doyle et al., 2003; Walter and Merritts, 2008; Magilligan et al., 2017; Sneddon et al., 2022).

We examine the friction of dam removal imposed by federal scale authorities upon local riparian communities related to removal of the century old 36-m high Vezins Dam, France, the largest dam removal project in Europe. Despite ecological benefits championed by dam removal proponents and the state, historic dams and associated artificially constructed environments also include a range of riparian ecosystem services highly valued by local communities (Arthington et al., 2010; Fox et al., 2016; Yeakley et al., 2016; Jørgensen, 2017; Reilly and Adamowski, 2017; Flood et al., 2021; Sneddon et al., 2022). Thus, great tension can exist between federal and local governments concerning dam removal due to stakeholder values not being effectively incorporated into project design.

Our research focus concerns why local communities opposed removal of Vezins Dam. Three study objectives includes (i) developing a comprehensive timeline and background understanding to the chronology of events leading up to removal, (ii) interviews with key local riparian stakeholders, and (iii) a formal online survey to gauge anonymous responses and views from local stakeholders concerning dam removal. While a substantial body of research highlights ecological benefits and successes of dam removal projects, local community

* Corresponding author.
E-mail address: p.f.hudson@luc.leidenuniv.nl (P.F. Hudson).

https://doi.org/10.1016/j.geoforum.2023.103906
Received 30 October 2022; Received in revised form 24 October 2023; Accepted 6 November 2023
Available online 23 November 2023
0016-7185/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC license (http://creativecommons.org/licenses/by-nc/4.0/).

perspectives related to riparian ecosystem services have been far less documented for dam removal, particularly for large projects. Understanding expectations and concerns of local populations is crucial to the success or failure of dam removal projects (Born et al., 1998; Lejon et al., 2009; Jørgensen and Renöfält, 2013; Fox et al., 2016; Reilly and Adamowski, 2017; Hommes, 2022). And in view of larger dam removal projects becoming more common, the Vezins Dam removal project provides specific "lessons learned" that can be applied to other case studies within France, and internationally.

Governmental stewardship of freshwater resources has gained renewed attention in past decades and riparian management is high on the political agenda, particularly in Europe (Lejon et al., 2009; Kornei, 2020). Globally, European rivers are the most impounded and degraded (Belletti et al., 2020). The 2000 European Union Water Framework Directive (WFD) aims to ensure the good ecological status of European rivers (EC, 2000; Lejon et al., 2009; Habel et al., 2020; Hommes, 2022). River environments within EU member states have until 2027 to reach sufficient ecological quality and hydrologic functioning (EC, 2000). Combined with the EU Biodiversity Strategy for 2030 (EC, 2020), which will restore hydrologic connectivity to at least 25,000 km of European rivers, Europe has reinforced its commitment to restoring riparian ecosystems with robust policy tools. This will largely occur due to increased sponsorship of dam removal projects (Hudson, 2021, pg. 119; Thieme et al., 2021; Dam Removal EU, 2021).

The Vezins Dam removal project along the Sélune River, France (Fig. 1) provides a unique opportunity to examine community opposition to a large federally driven infrastructure project. Larger dam removal projects are likely to become more common as protocols and 'lessons learned' from smaller dam removal projects are scaled-up (Heinz Center, 2002; Doyle et al., 2003; Jørgensen and Renöfält, 2013; Magilligan et al., 2017; Duda et al., 2021; Sneddon et al., 2022). However, each dammed river has its own unique history, structural characteristics, socioeconomic context, and riparian ecosystem services. Through a case study of the Vezins Dam removal project in Normandy, France, the largest dam removal project within Europe, we contribute to the growing literature on local opposition to dam removal through the lens of riparian ecosystem services, which offers a framework to improve coordination of dam removal efforts between national and local scales, and, more generally, large infrastructure projects.

2. Community opposition and riparian ecosystem services

Broadly, our study situates dam removal within a conceptual framework that links ecosystem services and community opposition to large infrastructure projects (e.g., Wolsink, 2010; Goedkoop and Devine-Wright, 2016; Reilly and Adamowski, 2017; Harrison, 2019; Short and Szolucha, 2019; Flood et al., 2021; Susskind et al., 2022). While most commonly considered as discreet themes, herein we link opposition to infrastructure projects and ecosystem services together - under the umbrella of stakeholder values.

Large externally driven infrastructure projects can compromise peoples relationship to the environment and galvanize local stakeholders to oppose such projects (Reilly and Adamowski, 2017), whether projects are associated with construction (Valentin et al., 2012; Sibertin-

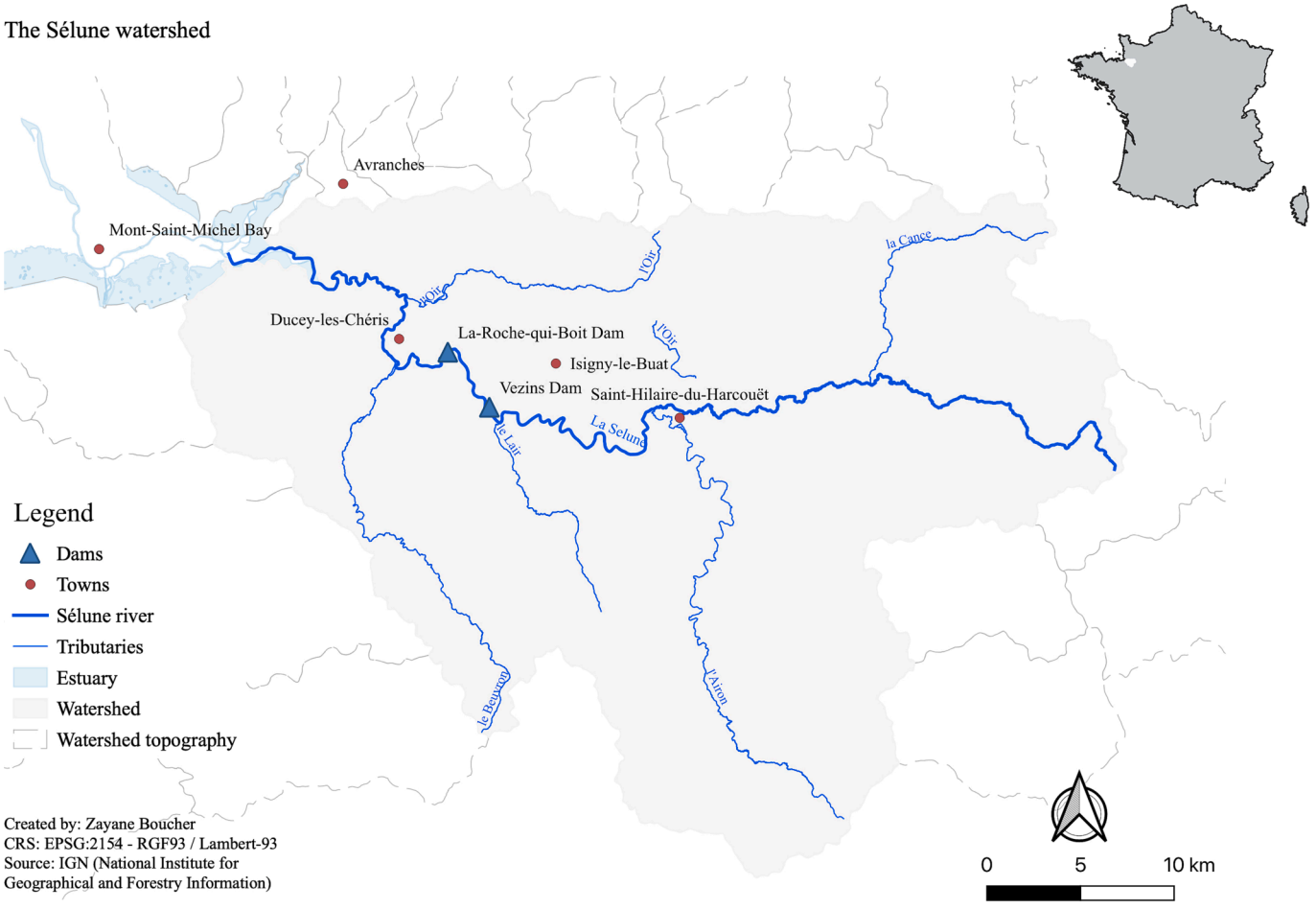


Fig. 1. Sélune River watershed and location of the Vezins Dam (breached June 2019), La Roche-qui-Boit Dam (breached June 2022), and local communities of riparian stakeholders. The study area extends from Saint Hilaire-du-Harcouët to Ducey-les-Chéris and includes Isigny-le-Buat. *Source: Authors. (QGIS 3.16.11-Hannover).*

Blanc, 2019; Susskind et al., 2022) or removal (Fox et al., 2016; Germaine and Lespez, 2017; Hommes, 2022; Sneddon et al., 2022). An ecosystem services framework provides a basis to consider peoples sense of well-being derived from the environment (MEA, 2005; Flood et al., 2021), and is useful for understanding how stakeholder interests link to different infrastructure types (e.g., wind turbine, transportation, hydropower, etc…) embedded within diverse biophysical environments. Approaching dam removal through the lens of ecosystem services provides a way to disentangle specific reasons for local stakeholders to oppose externally driven infrastructure projects, according to how they value their association with dammed environment (e.g., Jørgensen and Renöfält, 2013; Sherren et al., 2017; Sibertin-Blanc, 2019).

Much local opposition to large infrastructure projects is rooted in site-specific stakeholder values and emotions that link them to the environment (Devine-Wright, 2013; Harrison, 2019). How local stakeholders value different facets of ecological services influences place attachment, which is usually associated with support for the status-quo rather than environmental change (Born et al., 1998; Devine-Wright, 2013; Germaine and Lespez, 2017; Jørgensen, 2017; Habel et al., 2020). Local opposition, therefore, commonly occurs when stakeholders perceive that a project will disrupt their place attachment due to modifying the environment (Flood et al., 2021). The power of place attachment is so strong, however, that local stakeholders may also support some level of environmental disruption if their values are respected. Devine-Wright (2011), for example, studying tidal power infrastructure in Northern Ireland, found that place attachment could be harnessed by the state to garner local stakeholder support for disruption to their familiar environment. Hence the importance of contextualizing case studies relative to local ecosystem services and stakeholder values (i.e., Wolsink, 2010; Devine-Wright, 2013; Fox et al., 2016; Giordono et al., 2018; Germaine and Lespez, 2017; Flood et al., 2021; Hommes, 2022; Sneddon et al., 2022).

We specifically engage with community opposition to dam removal through the lens of riparian ecosystem services (Fig. 2), which illustrates the cascading effects of ineffective top-down communication. Riparian ecosystem services contribute to human well-being and benefits that are associated with riverine environments (MEA, 2005; Reilly and Adamowski, 2017; Riis et al., 2020). Riparian services are considered from the perspective of stakeholder values (Small et al., 2017; Summers et al., 2018), and specifically how they are linked to the Vezins Dam environments. Many humanized riparian environments rely upon hydraulic infrastructure managed by robust government institutions (Graf, 2006). Such landscapes, while being highly anthropogenic, are nevertheless characterized by a continuum of riparian ecosystem services valued by local stakeholders (Reilly and Adamowski, 2017).

Classical ecosystem service approaches categorize each service according to whether its provisioning, regulating, cultural, or a supporting ecosystem service (i.e., MEA, 2005; Riis et al., 2020). Here we are focused on how stakeholders value different riparian services, whether they are biophysical, utilitarian, or experiential values, or some combination. Riparian ecosystem services tightly linked to biophysical processes constitutes one endpoint of the riparian continuum (Fig. 2). Related phenomena may be highly valued by local stakeholders, such as restoration of anadromous fish migrations (i.e., river rewilding for salmon) and natural hydro-geomorphic processes. Nevertheless, such efforts also very much represent a humanized environment because of being valued as a "natural" setting, and accordingly managed by specific organizations. Indeed, people enjoy the experience of walking or sitting along a river knowing that it's biophysical processes, flora and fauna, are functioning as (near) natural (Arthington et al., 2010; Riis et al., 2020).

On the other side of the spectrum are experiential riparian ecosystem services, which are less objectifiable. This includes riparian services associated with cultural heritage, including aesthetics, feeling, history, nostalgia, and memory (Small et al., 2017; Flood et al., 2021; Blettler et al., 2023). While biophysical and economic ecosystem services receive much attention, in part because of being more quantifiable (MEA, 2005), experiential riparian ecosystem services, such as those linked to place attachment, may be just as powerful as concerns harnessing community opposition (Small et al., 2017; Summers et al., 2018). Flood et al. (2021), for example, note that for some Irish wetlands, memory and nostalgia held by local stakeholders were the most important drivers for development of new plans to manage peatlands. Indeed, riparian cultural heritage has widely been leveraged to alter and cancel large hydraulic infrastructure projects (Meyer, 2020; Wantzen et al., 2023), and as a driver of dam removal (Foley et al., 2017).

Between these two end-points are a range of more utilitarian (Fig. 2) oriented riparian phenomena beholding varying levels of biophysical and experiential values. This includes services that deliver economic goods (i.e., commercial and industry), and includes different levels of experiential and biophysical qualities. Water security, for example, relates to human dependence and exploitation of water resources (UNEP, 2009). In the context of dammed environments water security may include having adequate reservoir water storage for agriculture, natural processes, emergency services, hydropower, drinking, industry, and recreation (Grigg, 2019; Drapier et al., 2018). Other utilitarian oriented riparian ecosystem services valued by local stakeholders includes flood risk, pollution reduction, and economic development associated with riparian landscapes (Wantzen et al., 2023).

We examine community opposition to the Vezins Dam removal project organized along a continuum of riparian ecosystem services. While external organizations involved in dam removal may have altruistic intentions, failure to understand local riparian values can jeopardize support (Summers et al., 2018). Our analysis shows that the key reason for the lack of riparian stakeholder support for a project with broader environmental goals was due to ineffective communication from - and between - federal to local stakeholders. The outcome, whether unintended or deliberate, effectively yielded power to the State.

3. Case study context: Environment, socio-economic, and governance

3.1. Study setting

The Sélune is a moderate energy river with a mixed bedrock-alluvial channel in northwestern France (Fig. 1) with a mean discharge of 8 m^3/s. The basin drains 1,083 km^2 of Normandy and flows 68-km from Saint-Cyr-Sur-Bailleul (140-m elev.) into the UNESCO site of the bay of Mont-Saint-Michel (Syndicat Mixte du Bassin de la Sélune, n.d.b; DREAL Normandie, 2020; Fovet et al., 2023. Land use is dominated by agriculture (94 %), with minor forest cover located mainly along riparian corridors (3 %) (SAGE Sélune, 2017). The river has excellent fish potential, especially for amphihaline species such as Atlantic salmon (*Salmo salar*) and eel (*Anguilla anguilla*) (DDTM de la Manche, 2013a; DREAL Normandie, 2020). Importantly, salmon and eel are key species prioritized for conservation and restoration by national and international organizations driving removal of Vezins and La Roche-Qui-Boit Dams (Germaine and Lespez, 2017; NASCO, 2019).

The Vezins and La Roche-Qui-Boit Dams were constructed between WWI and WWII to meet demand for electricity to supply the growing textile industry in Fougères (Germaine and Lespez, 2014). Combined, the two dams produce a modest 27 GWh, sufficient to supply ~15,000 inhabitants with electricity (Germaine and Lespez, 2017). Vezins Dam is the larger dam within the complex, being 36-m in height and 278-m across (SM Table S1). Both reservoirs require sediment management as part of the dam removal procedure, with Vezins Dam requiring some 330,000 m^3 of sediment to be removed by machinery from the drained reservoir (Fig. 3).

3.2. Governance context

Watershed management in France is organized within a nested

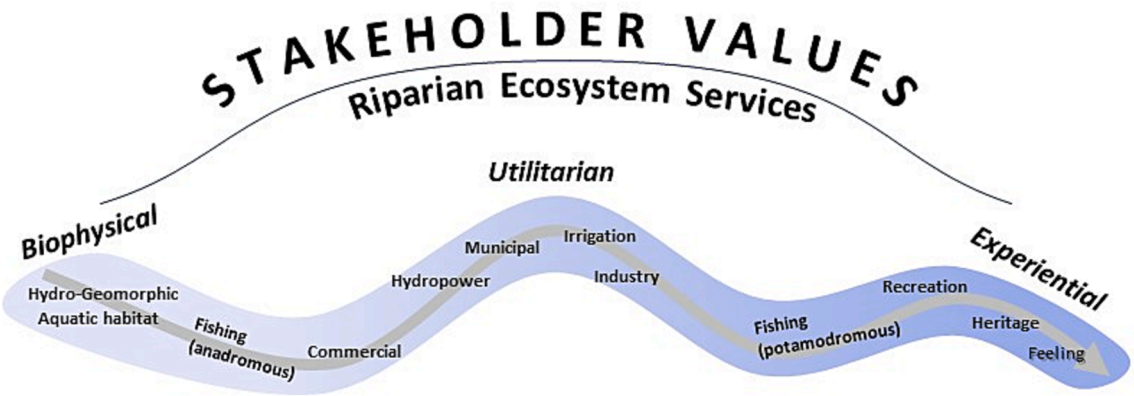


Fig. 2. Riparian ecosystem service continuum, illustrating a transition in services characterized as pure biophysical, to utilitarian, to experiential qualities as stakeholder values. Noted examples of riparian ecosystem services (e.g., recreation, commercial, fishing, feeling, etc…) are context specific and placed relative to stakeholder values of the Vezins Dam case study.



Fig. 3. Storage and management of polluted sediment in large geotubes ("pockets") along the Sélune River, within the lake bed of the former reservoir behind Vezins Dam. *Photo source: Authors (July, 2021).*

hierarchical structure, ranging from 12 national scale watersheds to basin committees to local sub-basin committees and municipal scale management (Table S2). French water governance is articulated around four major water laws, and since 2000 is especially framed by the European Union Water Framework Directive (2000/EC). For the Sélune River it was the SDAGE[1] of the Seine Normandie basin that worked on the dam removal project.

3.3. Drivers of dam removal: External perspectives

International, national, and regional-scale actors played influential roles in the decision of France to impose the dam removal project upon the local population of the Sélune basin (Table 1). French regional agencies, including Water Agency Seine Normandie , oversaw the Vezins Dam removal and restoration project to comply with national and EU environmental priorities and requirements (Fig. 4), including the EU WFD, Grenelle Environment Forum, Commitment Agreement for the Development of Sustainable Hydroelectricity, and National Eel Management Plan (EC, 2000; Borloo, 2010; Artelia, 2014a; Germaine and Lespez, 2017). Notably, the Grenelle Environment Forum[2] pointed to the two Sélune dams as obstacles to ecological continuity and the National Eel Management Plan classified the two dams as priority action areas and set the deadline for developing or removing the hydraulic structures to 2015 (Borloo, 2010; Artelia, 2014a; Germaine and Lespez, 2017). Within a defined legal framework France has committed to making the renaturation of the Sélune Valley an exemplary operation for

Table 1
List of key drivers (stakeholders, policy, officials) for and against dam removal along the Sélune River (organized by scale). * = actor with nuanced role (dominant position).

Scale	For	Against
International	Friends of the Sélune (includes 36 organizations, including European Rivers Network, North Atlantic Salmon Foundation, Sustainable Eels Group, see Supporting materials Table S4 for complete list) Dam Removal.EU European Union (Water Framework Directive 2000/60/EC)	
National	French Agency for Biodiversity, Departmental Directorate of Territories, and the Sea (DDTM) Électricité de France Grenelle Environment Forum National Fishing Federation (composed of many regional and local fishing associations (AAPPMA) Nicolas Hulot and his foundation: Fonds Humus pour la biodiversité (also included in the Friends of the Dam organization)	
Regional	Water Agency Seine Normandie SDAGE Seine Normandie	
Local	Association de la Sélune de l'Amont à l'Aval (BS2A). Recreational fishers (limited number, mainly in favor of salmon in river)* Syndicat Mixte du Bassin de la Sélune (SAGE) CLE du bassin de la Sélune	Recreational fishers (mainly for white fish in reservoirs)* Local communities (residents, businesses) Local elected officials* les Amis du Barrage (ADB, aka Friends of the Dam) Between Lakes and Sea

[1] Schémas Directeurs de'Aménagement et de Gestion des Eaux.

[2] Grenelle de l'environnement initiated by President Sarkozy in 2007 brought together diverse governmental and non-governmental stakeholders for developing action plans to tackle environmental issues.

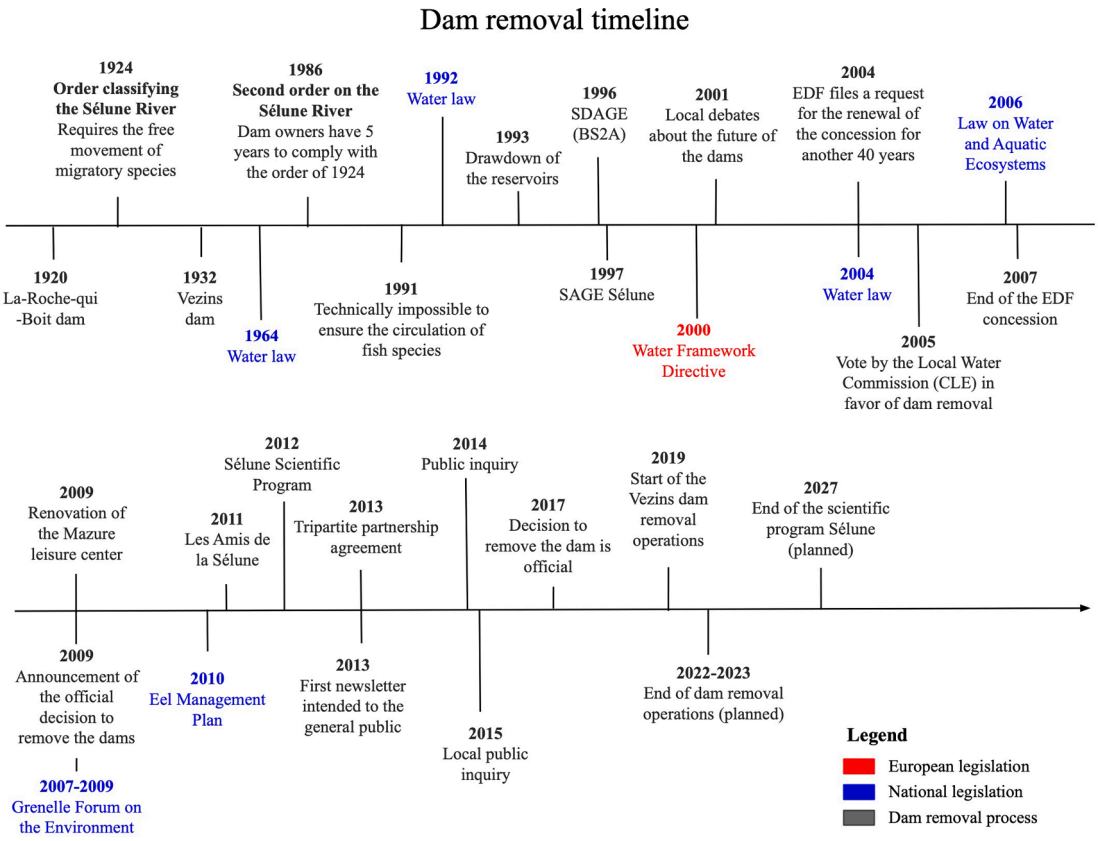


Fig. 4. Dam removal process timeline. In red is European legislation, in blue, National legislation, and grey, the chain of events related to the dam removal process (based on Germaine and Lespez, 2014; Ministère de la Transition écologique, 2021; ERN, n.d. with author modifications). (See Table S3 and Table S4 in Supporting Materials for summary of distribution for specific responsibilities for dam removal operations). (For interpretation of the references in colour in the figure legend, the reader is referred to the web version of this article.)

sustainable development (Artelia, 2014a). Finally, it should be noted that international influences on aquatic conservation, especially for Atlantic salmon (*Salmo salar*), have long pressured France to remove dams under the guise of migratory fish conservation measures. The North Atlantic Salmon Conservation Organization, for example, was influential in France finally passing a national plan in December 2021 to support marine migratory fish (PNMA, 2022). The plan was co-financed by the European Union and in support of the International Year of the Salmon (Office Français de la Biodiversité, 2022).

As the deadline approached for renewal of the Vezins Dam operations license to Electricité de France (EDF), concern about environmental problems heightened (Artelia, 2014a). In 2009, the French State decided not to renew EDF's permit to operate Vezins dam for two stated reasons: (i) the impossibility of finding solutions to guarantee the free movement of migratory species, particularly Atlantic salmon and eel, and (ii) poor water quality (Autorité Environnementale, 2013; Artelia, 2014a). Indeed, high reservoir pollution levels contributed to appreciably low oxygens levels and prolific algae blooms (Leynaud et al., 1993; Commission Locale de l'Eau du SAGE de la Sélune, 2007). Sediments of the Vezins reservoir (i.e., Fig. 3), especially at its confluence with the Yvrande River tributary, contain heavy metals (Cadmium, Chromium, Copper, Nickel, Lead, Zinc) and cyanides (Leynaud et al., 1993; Proulhac, 2012). Pollutants originate from the Electropoli metal treatment factory within the Yvrande River tributary (Leynaud et al., 1993; Proulhac, 2012; Autorité Environnementale, 2013). Upstream nitrate and pesticide leaching from agriculture and poorly treated wastewater (insufficient treatment of nitrogenous matter and phosphorus) further contributed to reservoir pollution (SAGE Sélune, 2009; Autorité Environnementale, 2013; Syndicat Mixte du Bassin de la Sélune, n.d.a). Yvrande River tributary nitrate concentrations exceeded national standards (>50 mg/l) between 2012 and 2017 (SAGE Sélune, 2017). Thus, the dam removal project was primarily initiated to renature the Sélune Valley and restore ecological continuity, increase purification capacity of water bodies, and extend natural flood storage areas (DREAL Normandie, 2020), all goals consistent with EU's WFD.

3.4. Opposition to dam removal: Local perspectives

Opponents of dam removal included a range of local stakeholders such as politicians, recreational (fishing) interests, small industry, and nature enthusiasts (Table 1). The association les Amis du Barrage (ADB) (Friends of the Dam) promoted cultural activities and information sharing of the dams, upon its inception in 1993 (ADB, 2011). Its organizational mission changed, however, after the French State imposed its decision to remove the dams and is now focused to defending and preserving the dams and their associated water reserves (ADB, 2011) and they directly oppose a powerful locally-based organization that supports dam removal, Friends of the Sélune.[3] The impoundments supported a range of valuable local environmental services and economic activities, including nautical, hiking, climbing, photography, firefighter and rescue training, fishing (carp, common roach, northern pike), and drinking water, all highly valued by local opponents to dam removal (Germaine, 2010; ADB, 2011). Moreover, the humanized environments (flora and fauna) that evolved within the dam and reservoir area over the last century are diverse and rich. Economic developments (e.g., bed &

[3] An umbrella organization that accommodates 36 organizations ranging in scale from international to regional in favor of Sélune River dam removal (see Table S4 in supporting materials for full list of organizations).

breakfast, fishing shops) have become part of the local socioeconomic riparian landscape (ADB, 2011).

At the core of the opposition is a desire for local stakeholders to work together to clarify concerns that emerged as opponents questioned the consequences of the proposed dam removal based on their local knowledge and lived experiences. The lack of feedback on these concerns and the withholding of information (due to a lack of consultation) crystallized local opposition (Fig. 5).

4. Materials and methods

4.1. Data collection and sampling strategies

We adapt a qualitative approach that combines empirical field work and surveys with discourse analysis. Field research initially occurred in summer 2021 to review the biophysical context of the Sélune River and dam removal site, and to refine key research questions. Subsequently, primary field data was collected in January 2022, followed by two rounds of interviews remotely conducted with key local stakeholders in February and April 2022. Finally, an online survey was distributed over March and April 2022. Additionally, documents issued by local authorities and local oppositional groups were analyzed to (i) construct a timeline for the project, (ii) obtain contextual information and responses, and (iii) identify the main discourses used by proponents and opponents of the project.

Primary field data collection involved collection of testimonies from six local residents (in Ducey and Isigny-le-Buat) through a preliminary survey and open-ended interviews (see Text S1 in the Supporting Materials) (Rubin and Rubin, 2005c; Bernard, 2017a). These measured respondents' demographics, awareness, positions, and concerns about the dam removal project and served to provide a broad overview of the status of the dam removal process in the region (Born et al., 1998; Rubin and Rubin, 2005c; Fox et al., 2016). Prior studies suggest that interviewing participants in the field benefits the quality of the investigation as participants are in their own social and physical contexts, and are then more at ease and prompted to reflect on details (Shuy, 2001; Rubin and Rubin, 2005b; Hitchings and Latham, 2020; Quandt, 2022).

Remote interviews conducted with eight local actors (Table 2) between February and April 2022 explored how local stakeholders experienced the decision-making process associated with dam removal (Rubin and Rubin, 2005b; Quandt, 2022). Open-ended interviews were adopted because participants played an active role in the decision-making process of the dam removal project and could guide the conversation productively as key informants (Johnson, 2001; Rubin and Rubin, 2005b; Bernard, 2017b).

An online survey of locals within the study area was conducted through the distribution of posters by post to eighteen businesses within three local villages and produced a total of thirteen replies (Isigny-le-Buat, Ducey-les-Chéris, Saint-Hilaire-du-Harcouët, Fig. 1). The posters displayed a QR (Quick Response) code to an online survey with questions about participants' position on dam removal, concerns, awareness, and experience of the consultation process, as well as a letter explaining the research purpose (Lee and Jang, 2021). Survey questions were adapted from previous case study research on dam removal (Born et al.,

Table 2
Characteristics of participants for in-depth interviews.

Participant	Status	Date
(A)	Resident	26th February 2022
(B)	Former elected official	28th February 2022
(C)	Former governmental agent & member of the Mont-Saint-Michel community	1st March 2022
(D)	Former elected official	8th March 2022
(E)*	Members of the Mont-Saint Michel community	14th March 2022
(F)*	agglomeration	
(G)	Elected official	11th April 2022
(H)	Member of the scientific program	13th April 2022

* Participants interviewed together.



Fig. 5. Opposition banner. Translation: "Exemplary State undertaking! Lakes emptied, hydroelectric dam destroyed, abandoned valley, Vezins annihilated, Drinking water shortage, flooding. Who will be responsible? Who will pay? "*Photo source: Authors (January 2022).*

1998; Jørgensen and Renöfält, 2013) and tailored to the local context using feedback from the preceding fieldwork. As the question on participants position on dam removal is dichotomous (for or against) it could miss some information relative to the strength of a participant's position. Nevertheless, we consider it an appropriate question in the context of dam removal because the issue is finite. Dam impoundments are either removed or they remain (i.e., there effectively is no middle status).

Participant selection occurred using three non-probabilistic sampling strategies, (i) convenience sampling, (ii) exponential non-discriminative snowball sampling, and (iii) area-based stratified non-random sampling (Tansey, 2007; Noy, 2008; Etikan et al., 2016; Bernard, 2017b; Howell et al., 2020; Stratton, 2021). Participant input, representativeness, quality of response, homogeneity, and redundancy informed the sampling strategies (Alvesson and Ashcraft, 2012; Saunders and Townsend, 2016). Convenience sampling served to reach residents in the field (through visits to local businesses) and refine study objectives (Tansey, 2007). Snowball sampling served to reach participants with a statute of "social elites", trace social networks, and identify power relations between interview participants (Tansey, 2007; Noy, 2008; Cohen and Arieli, 2011). By transferring considerable control over the research design to participants, the researcher ensured that the study's research design is relevant and grounded in the local context (Noy, 2008; Fox et al., 2016). Finally, area-based stratified non-random sampling, adapted from Howell et al. (2020), served to survey local populations anonymously for the online survey and involved (i) division of the sampling area into towns (Ducey, Isigny-le-Buat, and Saint-Hilaire-du-Harcouët) based on proximity to the dam removal sites and participants' input, (ii) non-random selection of small local businesses (i.e. bakeries, pharmacies, cafés) to whom to send a QR code link to the online survey, and (iii) random and non-random selection of respondents. All identified surveys were returned from Isigny-le-Buat.

4.2. Data analysis

Thematic analysis was used to analyze the interview contents, and consisted of identifying repeated patterns of meaning across the datasets (Rubin and Rubin, 2005a; Braun and Clarke, 2006; Nowell et al., 2017; Bernard, 2017c). Interviews were recorded upon approval by participants and then transcribed by the researcher. A collection of selected quotes from participants as well as the full transcripts can be obtained upon request and after authorization from participants. Transcripts of interviews were analyzed first through open coding (descriptive coding), which involved annotating the transcripts within ATLAS.ti 22 Mac software (ATLAS, 2022) to record all relevant information (Merriam, 2009, pg. 178; Bernard, 2017c). Inductive coding did not involve pre-existing coding frames. A total of 215 open codes were assigned across the seven interview transcripts. Grouping of individual open codes (analytical coding) produced 42 categories (units of analysis) (Merriam, 2009, pg. 180; Bernard, 2017c). Thirty categories emerged from interpretation of how open codes were related to forming recurring patterns across the datasets (Rubin and Rubin, 2005a; Braun and Clarke, 2006; Merriam, 2009, pg. 178; Bernard, 2017c). A summary of the thirty categories and the frequency at which participants mentioned them is reported in SM Table 3.

5. Riparian stakeholder opposition to Vezins Dam removal

5.1. Sapping support: Poor communication and top-down exchange

Our analysis reveals that providing effective information to local constituents is crucial for federal authorities to gain support for large public works projects, particularly to obtain consensus from diverse local stakeholders (i.e., Fox et al., 2016; Harrison, 2019; Hommes, 2022; Sneddon et al., 2022). Syntheses of dam removal projects in the U.S. and Europe supports that communication linkages across scales are essential to gain local support for dam removal (Doyle et al., 2003, 2008; Sneddon et al., 2017; Habel et al., 2020). This includes complex actor networks that exchange information within and across scales (Germaine et al., 2015; Drapier et al., 2018; Sneddon et al., 2022). In the case of the Vezins Dam removal project, participant observations reveals that communication was completely ineffective between national and local levels, as well as between local government bodies and riparian stakeholders (Table 3). This had the effect of undermining local networks; sapping support for the project. In some instances there was strong (violent) local opposition to removing the dams (Fig. 6). Participants B, G, and H deemed it essential to hire a mediator to facilitate communication across governance and knowledge levels. Participants proposed various solutions to improve communication, including (i) nominating a local elected official to communicate policy outcomes between the different actors and (ii) hiring a popularizer to disseminate scientific information among stakeholders (G, H). Interviews with participants reveal that, on numerous occasions, federal government authorities failed to exploit defined communication structures (such as the scientific project "*Programme Sélune*" documenting the dam removal project) to promote the project and facilitate its adoption.

Poor communication also exacerbates structural power imbalances between national and local levels, further undermining local community cohesion. Local support wanes when participants feel powerless to influence the State imposed planning process (Heinz Center, 2002; Jørgensen and Renöfält, 2013; Habel et al., 2020). This sentiment is not restricted to dam removal and is common across a range of infrastructure project types, including transportation (Coppens et al., 2018) and energy (Giordono et al., 2018; Harrison, 2019). Effective communication to involve local stakeholders in large state driven infrastructure projects is not only crucial for support (Erkul et al., 2020), but it may also improve their effectiveness (Maddaloni and Davis, 2017). Further, ineffective top-down communication characterized by long lapses in follow-up saps local support, triggering frustration and apathy as regards public support (Perlaviciute et al., 2018). This is clearly the case with the Vezins Dam removal project, as some local actors (A, D) eventually lost interest in the project, and simply gave up.

The State's influence over the dam removal decision-making process is a defining character of water governance in France, with local actors having few opportunities to influence a resolution. Residents did not feel listened to and questioned the willingness of the French State to follow up on their concerns. Participant A bluntly comments*, "I don't know if they will takepeople's opinions into account."* Additionally, the lack of communication had the effect of complicating the ability of local elected officials to understand the removal process, making it difficult for residents to take ownership of the project. Indeed, Participant G noted that it was *"…unfortunate …that the French State has done its thing… on its own,*

Table 3
Responses to the online survey.

Question	Responses (%)	
	Against	Neutral
Are you for or against the removal of the Vezins and La Roche-Qui-Boit dams?	78.6 %	21.4 %
	Yes	**No**
Are you aware of the removal of the Vezins and/or La Roche-Qui-Boit dams?	100 %	0 %
Did you feel concerned by the dam removal project?	71.4 %	28.6 %
Do you consider that you were sufficiently informed about the dam demolition project?	21.4 %	78.6 %
Have you had the opportunity to express your opinion about the demolition of the dams?	21.4 %	78.6 %
Do you think you influenced the decision to remove the dams?	0 %	100 %
Did you know that a scientific program is studying the dam removal project?	28.6 %	71.4 %
Would you like to access more information on the dam demolition project via a QR code available in local shops?	50 %	50 %



Fig. 6. Vandalism of sign related to the dam removal project. Every information sign and kiosk in the lake recreation area was vandalized. *Photo source: Authors (July 2021).*

without us."

State power is increasingly seen as relying upon complex personal relations between different community actors. Research on dam removal in New England (US) shows that community support is strengthened where state actors intermingle with local actors (Drapier et al., 2018). The "environmental state," as described by Sneddon et al. (2022), relies upon nuanced linkages between key actors across governmental scales and social/public spaces to gain support and wield influence. With the Vezins Dam removal project, state actors failed to recognize the positive potential their role would have had on local adoption if they had embedded themselves more into the local community. The ability of the French environmental state to leverage support in the Vezins Dam removal project, therefore, was futile.

Local stakeholder perceptions of state actors competencies and intentions strongly influence the viability of dam removal projects (Tuckerman and Zawiski, 2007; Reilly and Adamowski, 2017). The state's scientific program was stymied by slow and ineffective communication because of turnover in key personnel due to retirement or staff being moved into other administrative roles. This further disrupted decision-making. According to one interviewee, the program has not been well promoted to the public due to a lack of support and training in communicating with local people. Some state actors visited the dam site, but did not feel welcome. In actuality there was little dialogue with locals, as state actors mainly visited the site to announce decisions already taken. Specifically, one member of the scientific program (H) noted difficulties encountered when interacting with the local population: *"… we've been pigeonholed as Rennais who don't move… many of the scientists… are based in Rennes…when we're asked to come, well, we come; but we're not solicited much." (Member of the Scientific Program "Programme Sélune").* The State had a specific position to remove the dam, although communication was completely ineffective at gaining support from local stakeholders who were vocally against removal. This highlights the importance of sustained dialogue between key actors (Sneddon et al., 2022). And indeed, this was also evident to community stakeholders, who provided suggestions for how dialogue could be improved. Participants B and G, for example, recommended that project leaders who are well-experienced with speaking to communities, respected within local organizations, and had access to crucial information, be appointed to earn public interaction and trust.

Geographical divisions of power between the national/international and local levels (dichotomy of local here vs. distant capital Paris) amplified feelings of powerlessness and detachment experienced by local populations. They see the French State as an entity removed from the local context: "*I think those who are in charge in Paris, they never came here to see what was going on.*" (A) Exacerbating the local feeling of detachment was announcement of the official State decision in 2009 being made in the village of Lisieux, actually outside of the Sélune basin, by the Minister for the Ecological and Inclusive Transition. It was a complete surprise to local officials, who only learned of the event the night prior (B). After the Minister's visit there followed a *two-year* period of silence during which the French State did not communicate with local elected officials (B). However, the French State had not abandoned its initial project and was working to remove the first dam in 2019 *without* a local development project. Local players deplored the lack of support from government authorities.

> *"We can't say that the French State invests a lot. We have little in financial means, few in technical means and even in accompaniment on what costs nothing, we have no support from the French State."* (C)

Survey results (Table 3) are congruent with stakeholder interviews and support the contention that an ineffective top-down communication style to the local community, who initially held keen interest in the project, ultimately resulted in disinterest and a lack of knowledge about the dam removal project. Initially there was a high awareness about the actual dam removal project, with 100 % of respondents aware of its occurrence. Respondents, however, did not feel informed about subsequent dam removal plans, and also did not have an opportunity to express their views and opinions about various stages of the project (77 % response for both questions). Indeed, all respondents (100 %) reported not feeling any influence on the decision to remove the dam (Table 3).

Dam removal actions require trade-offs between economic, environmental, political, and personal interests (Lejon et al., 2009; Fox et al., 2016; Hommes, 2022). An assessment of the quality and effectiveness of the consultation process of the Vezins Dam removal project sheds light on the unequal distribution of power over who gets to make these compromises and who decides how to make them (Magilligan et al., 2017; Hommes, 2022). Results from our case study also provides nuance to previous dam removal studies, as well as other forms of large infrastructure projects, that found the State exercises its power through coordinated formal channels and personal relationships referred to as the "environmental state" (i.e., Sneddon et al., 2022). Interviews with local stakeholders revealed that a wide range of actors (political and non-political) consisting of specific institutional and political networks were operating at different levels (i.e., Germaine, 2010; Foley et al., 2017; Sneddon et al., 2022). However, the interviews and surveys for the Vezins case study reveals that they were ineffectively coordinated, giving rise to asymmetries of information and power imbalances across governance levels.

We find that political and institutional processes leading to the decision to remove dams are the most time consuming (i.e., Heinz Center, 2002; Doyle et al., 2008; Drapier et al., 2018). The complete dam removal process on the Sélune River has lasted for almost two decades, which is common (Habel et al., 2020), and remains ongoing (at time of writing). Institutional discontinuities and fragmentation in decision

making due to changes in government, extended periods of non-communication, and personnel turnover of professional staff also help to explain why the removal process took so long. Additionally, the project's technical complexity related to the size of the dams and the large quantity of polluted sediments (i.e., Evans, 2015) were factors that delayed the removal process. Finally, exogenous shocks, such as the covid-19 pandemic were also responsible for delays and ineffective communication (i.e., Hommes, 2022).

Local opposition to large infrastructure projects is more effective when different stakeholders coordinate efforts and resources (Giordono et al., 2018; Dopico et al., 2022). Strong competing stakeholder interests, however, can completely neutralize local opposition and work against community interests. Habel et al. (2020), in a synthesis of U.S. and European dam removal projects, reports that the end result of key local stakeholders having competing visions of dam removal is to effectively yield power to the State, a conclusion supported by our present research. Stakeholder interviews and surveys of the Vezins Dam removal case study revealed that local actors initially felt well equipped to establish local initiatives around the restored riparian environment, understood local populations' concerns, and showed a willingness to redevelop the riparian landscape in accord with local priorities and values (i.e., Summers et al., 2018). However, without State-level support, these actors were limited in their power to undertake any actions and cohesion splintered. The apparent unwillingness of the French State to invest in local matters is manifest in the lack of communication between national and local levels – asymmetries of information that derive from poor communication contribute to polarization of discourses and fuels opposition (Germaine and Lespez, 2017).

5.2. Riparian ecosystem services: Environment, heritage, and place attachment

Ineffective top-down communication illustrates the importance of the state leveraging an effective 'framework' in which to communicate and contextualize local stakeholder values. Here we examine local stakeholder concerns along a continuum of riparian ecosystem services – from biophysical oriented services such as native fish reintroduction to experiential oriented services associated with place attachment to the dammed waterscapes (Fig. 2). Good intentions aside, poor top-down communication tainted the water, resulting in broader (federal) environmental objectives becoming toxic to local riparian communities.

In accord with the main justification for removing the dams, namely the return of migrating Atlantic salmon and eels, a number of environmental and safety actions were embedded into the federal strategy. This included (i) integrating flood risk for an extreme event (millennial flood event of ~475 m^3/s) into the planning phase, (ii) setting a maximum volume of downstream sediment transport below La Roche-Qui-Boit Dam at 4,000 m^3 to limit environmental risks associated with the release of polluted sediments, and (iii) initiating operations to recover fish from reservoirs to limit loss of valuable species (Artelia, 2014b).

Flooding is among the most important riparian ecosystem services, from an environmental perspective (Arthington et al. 2010), and a risk to riparian stakeholders. Despite actions taken to limit flood risk as part of the federal strategy, local riparian stakeholders were especially concerned about increased flood risk downstream of the dams (C). The association ADB had raised the issue of increased flood risk in court, although they were unsuccessful (Fig. SM5). The association *Between Lakes and Sea* presently leverages flood risk as a political tool, as the association ADB is no longer active (B, C) (Fig. 7). While flood risk is a legitimate concern, stakeholder views on river flooding was rooted in a traditional engineering perspective. Modern perspectives on river-floodplain hydrologic connectivity reveals that downstream flood risk can be attenuated by allowing upstream flood water storage, simulating natural processes and providing vital ecological services (Foley et al., 2017; Gough et al., 2018; Gilet et al., 2021). Indeed, here we see a key example of the ineffective French strategy and top-down



Fig. 7. "The lakes of the Sélune protect us". Painting in front of the castle of Montgommery in Ducey set up by the association "Entre Lacs et Mer" (*Between Lakes and Sea*) with prominent reservoir in foreground and Mount Saint Michel in background. *Photo source: Authors (January 2022).*

communication from federal to local riparian stakeholders. In contrast to the Sélune case study, just several years prior federal organizations in the Netherlands were very effective in their communication approach to get local riparian stakeholders to accept increased inundation of specific floodplain segments (Buijs, 2009).

A key overarching concern with dam removal occurs when rapid reservoir (lake) drawdown results in hydraulic flushing and associated scour of polluted reservoir sedimentary deposits (Diamond, 2006, pg. 40; Kondolf et al., 2014; Evans, 2015; Collins et al., 2017; Conlon et al., 2017; Gilet et al., 2021). The ensuing abrupt sedimentary pulse can bury critical downstream aquatic habitat utilized for spawning and feeding, and harm coastal waters. Hence, effective sediment management during the drawdown phase is essential, and is the most delicate and costly aspect of dam removal projects (McCaffery et al., 2018; Morley et al., 2020; Randle and Bountry, 2017; Ritchie et al., 2018; Ravot et al., 2020; Hudson, 2021, p. 117). These issues manifest in stakeholder surveys and interviews, showing that local population was both apprehensive and uncertain as to who was responsible for environmental management during the removal phase, particularly the key steps of reservoir drawdown and polluted sediment management. These concerns take root historically in an event described by locals as the "catastrophic" 1993 reservoir drawdown in which suspended sediment concentrations reached 100 g per liter (B, C) (Artelia, 2014a). A lack of clarity on the distribution of responsibility resulted in local stakeholders being cautious and noncommittal about dam removal operations (A, C, D). Notably, participant C was critical of the French State's capacity to ensure the long-term safety of the removal operations, especially since reservoir bottom sediments are known to be heavily polluted. The lack of communication between local actors reinforced a sentiment of confusion regarding environmental management of the project. For participant B, community efforts to implore the French State to act are woefully insufficient.

> *"Nothing's happening. We don't even know who is responsible. No one is taking care of the project since the French State will do its job and bring up the sediments to the sediment pockets [i.e., Fig. 3]. And then… nothing will happen; nature will take back its rights. It's going to be a wasteland… … and the French State isn't doing its job…" (B)*

Despite strong feelings about the top-down driven approach, local actors attach a high value to a clean riparian environment and unanimously agreed that the French State should remove toxic reservoir sediments (B, C, E, F, G). Indeed, the location and physical configuration

of the Vezins reservoir requires onsite management of polluted sedimentary deposits (i.e., Fig. 3), concentrating pressure around Isigny-le-Buat (Artelia, 2014b). Clustering of online survey responses in Isigny-le-Buat (Figs. 8 and 9), rather than small communities located somewhat farther afield, suggests that riparian environmental issues associated with dam removal are of greater concern than in neighboring towns. This is illustrative of distance decay, commonly associated with community opposition to large infrastructure projects (Stępniak and Rosik, 2018). More generally, community opposition is very much a spatial geographical phenomenon whereby, as in the case of dam removal, the disproportionate burdens associated with the infrastructure project diminish sharply with distance from the project site (i.e., Nelson et al., 2021).

Interests of local stakeholders to preserve Vezins Dam speaks to the ubiquitous issue of water security (e.g., UNEP, 2009; Grigg, 2019). When water security is an issue to local stakeholders, whether in a dry or wet climate, riparian communities tend to be against dam removal (Dopico et al., 2022). According to participant C, there was a dispute over the potential loss of water reserves. The dams were seen as representing critical infrastructure to protect against water *insecurity* (i.e., Grigg, 2019; Dopico et al., 2022). Participant A, for example, recalled local firefighters pumping water into the lake in case of fire, and farmers fetching water in times of drought, and worried that removal of the Vezins Dam would increase water stress. For this participant, the decision to remove the two reservoirs represents a glaring contradiction with national policies aimed at developing environmentally friendly clean energy and water supplies: *"We need to conserve and store water because we will have problems, and here, we are doing the exact opposite of what should be happening."* (A).

Despite taking measures to ensure safety of the deconstruction works, federal authorities were unsuccessful in addressing concerns about degradation of riparian ecosystem services – comprehensively. Specifically, this relates to human constructed environments and place attachment associated with artificial riparian landscapes, among the most important factors related to community opposition to dam removal (Fox et al., 2016; Summers et al., 2018; Jørgensen, 2017; Dopico et al., 2022; Hommes, 2022; Wantzen et al., 2023).

While "natural" benefits of dam removal projects are often highlighted (Arthington et al., 2010; Foley et al., 2017; Jørgensen, 2017), dam removal also concerns abrupt disruption to place attachment associated with humanized riparian ecosystem services created by impoundment (Dufour and Piégay 2009, Fox et al., 2016; Hommes, 2022; Reilly and Adamowski, 2017). Despite being a type of artificial nature, after extended periods, human transformed landscapes often become highly valued in their own right (Amin, 2014; Habel et al., 2020; Flood et al., 2021; Dopico et al., 2022). The study of everyday landscapes reinforces the notion they are not only important for environmental services, but also aesthetics, history, and sense of place they provide to local communities (Wolsink, 2010; Amin, 2014; Germaine, 2015; Jørgensen, 2017; Sneddon et al., 2022; Wantzen et al., 2023). While these qualities were highly valued by local stakeholders, the French environmental state did not effectively recognize the importance of experiential riparian ecosystem services (Fig. 2) in its decision to remove Vezins Dam.

Changes to landscape structure and riparian activities caused by the Vezins Dam removal have complicated local perception of the project. Local respondents were most concerned about loss of aesthetic landscape value and flood risk (12 responses out of 13). Loss of identity, tourist attraction, and economic activity are also important areas of concern (9 responses out of 13) (Fig. 8). Activities respondents most associate with the dammed riparian landscapes includes ecosystem services related to experiences with family and friend gatherings, picnics, and walking/hiking (11, 9, and 8 responses at out 13, respectively) (Fig. 9). Indeed, participants A and G explained that local populations had very much been attached to the dams and lakes, which constituted an essential part of their living environment and the source of many familial memories. Participants' descriptions of the dams and associated lakes are positive and often related to the notion of pleasure and pride (A, D):

"For us, it was a pleasure to have this lake. It was a place to go out when we had people over, it was the pleasure of taking them to see the dam." (A)

The modified riparian environment associated with the impounded lakes is linked to the dominant cultural activities and community practices (leisure centers, fishing cabinets etc…) (Fig. 9). According to participant G, the French State has not respected the strong affection and emotional attachments that locals had tied to the dammed riparian landscape, which reminded them of holiday memories, people no longer here, and grandparents with whom to go fishing. Thus, participants expressed apprehension and uncertainty about what the post-dam environment and emergent riparian landscape would look like after dam removal. Participants descriptions of the post-dam removal landscape are negative, and their desire to visit the site is low (A, B). They note that vegetation is re-establishing itself in the place of the former lake, but it is wild and unorganized (i.e., Ravot et al., 2020) (Fig. 3).

According to participant C, change is a major concern with dam removal, since communities have been used to the dams being part of their living (physical and cultural) environment for close to a century (C). According to participant B, accessibility and openness could help

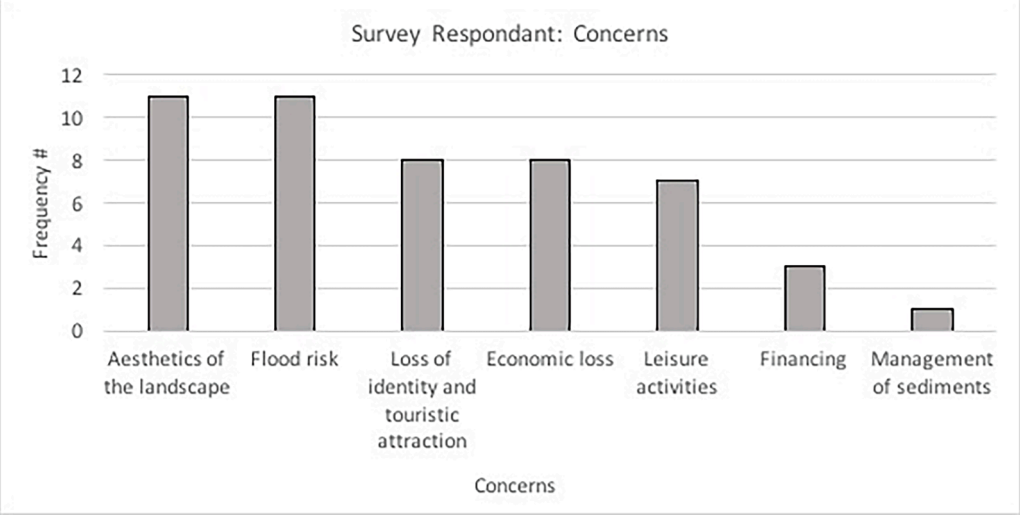


Fig. 8. Survey respondents' concerns about the removal of the dams.

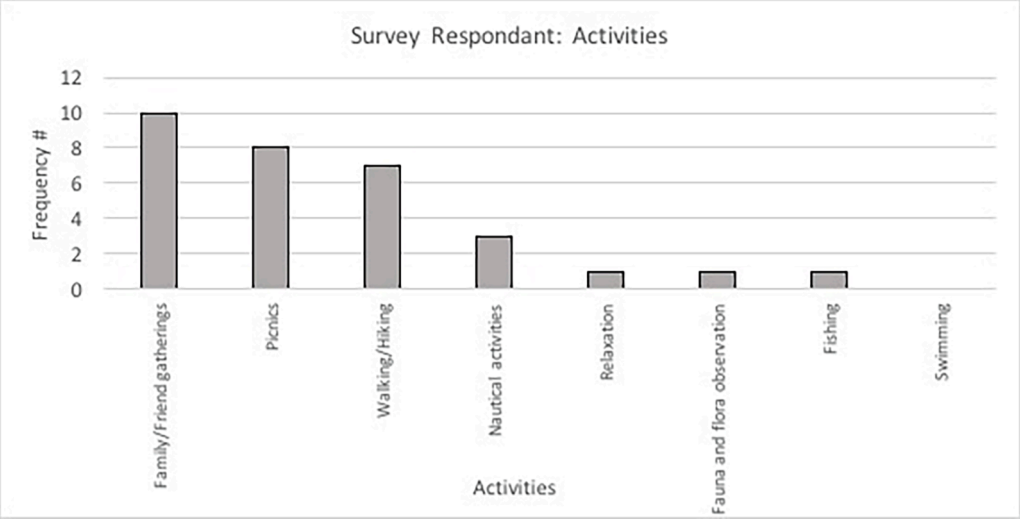


Fig. 9. Survey respondents' activities around the lakes.

locals see themselves interacting within a landscape without the dam and re-identify with the river valley (i.e., Parkinson, 2013). But in the post-dam removal management scheme, opportunities to connect with the new riparian ecosystem services are very limited, and poorly conceptualized by the State: "*We had put aside money for cultural events and to get people to come to the valley to walk around. The state prohibits under pain of a fine to go to the Sélune Valley." (B)*.

The prime objective of the dam removal project on the Sélune River was to restore its ecological and sedimentary continuity to meet the requirements set by the EU WFD (i.e., Fovet et al., 2023), and yet a myriad range of local unintended consequences are also occurring that conflict with riparian stakeholder values. Removal of the dams results in a loss of economic activity, a vital ecosystem service. Specifically this includes services that have considerable value to local riparian stakeholders, and can be expected to objectively impact the leisure and tourism industry (144 permanent jobs) (ADB, 2011; DDTM de la Manche, 2013b). Perhaps more substantially, Vezins Dam removal reduced stakeholder support due to diminishing local place attachment caused by degradation of the aesthetic riparian landscape (i.e., Reilly and Adamowski, 2017; Flood et al., 2021). The site's attractiveness was reduced because of the loss of lakes and scenic views (DDTM de la Manche, 2013b).

This sentiment is not too surprising when the Vezins Dam removal project is considered relative to other large infrastructure projects, whether related to dam removal or ecosystem services more generally (MEA, 2005). Strong local place attachment is seen as a key obstacle to federally driven infrastructure projects (Wolsink, 2010; Jørgensen and Renöfält, 2013; Harrison, 2019). Devine-Wright and Batel (2017), for example, report that acceptance of national (energy) infrastructure projects in the UK is reduced when local populations have a strong sense of local-place attachment. The Sélune Valley is experienced as remote and isolated by locals, in contrast with adjacent more populous riverine settings, which likely reinforced place attachment (i.e., Anton and Lawrence, 2014). Similarly, the local communities of the Vezins reservoir were intricately linked to their dammed riparian services. Thus, the French State likely had narrow margins in which to convince the local population of the project's virtues, and ultimately was unable to deliver.

The decision to remove the Sélune River dams is a loss of familiar and valued physical and cultural environment (Fig. 9), which some scholars have related to diminished place attachment and nostalgia (i.e., Dopico et al., 2022; Hommes, 2022). Nostalgia is fundamentally rooted in time, and commonly associated with historic landscapes (Drenthen, 2009). In the case of the Vezins Dam removal project, the historically anchored attachment that local communities had with riparian services of the dammed environment fueled a desire to protect it. Interestingly, Sélune Valley residents did not exhibit nostalgia for the free-flowing pre-dam Sélune riparian landscapes (prior to the 1920s), as it was too long ago. Symbolism exhibited by the local stakeholders only championed riparian ecosystem services of the dammed riparian landscape (i.e., Fig. 7). This contrasts with places where traditional experiences and lifeways were strongly dependent upon free flowing rivers. Native North Americans strongly espouse, and effectively leverage, nostalgia and place attachment with free flowing riparian landscapes over periods exceeding many centuries (Foley et al., 2017; Sherren et al., 2017; Crane , 2009; Fox et al., 2022). The Vezins Dam removal project therefore illustrates that the importance of nostalgia and place attachment to dam removal may be temporally constrained (<100 yrs), although dependent upon cultural values and histories of riparian stakeholders.

6. Conclusions

We examined local opposition in relation to riparian ecosystem services for a large and complex dam removal project in northwestern France imposed by federal organizations for environmental reasons. Study findings suggest that the key measure to assure community support of an endeavor's success is being aware of local stakeholder values – through continuous timely communication, dialogue, and exchanges with local riparian actors. To gain local support the French State incorrectly emphasized biophysical dimensions of riparian ecosystem services whereas it should have prioritized experiential ecosystem services. Further, it is essential that state authorities report – in explicit terms - how local concerns regarding riparian ecosystem services were integrated into the dam removal process. Indeed, discontinuities in decision-making processes and a lack of communication created considerable uncertainty around the project among local actors, who felt that trust had been compromised. In the final stages of the dam removal project local riparian stakeholders have lost interest, are unaware of its current status, and have given up.

Review of the above general conceptual themes in relation to the specific Vezins Dam case study highlights two important points relative to community opposition. First, they are usually related to 'construction' of infrastructure projects, whereas dam removal is literally about destruction of large infrastructure projects. Thus, that these general themes remain key to understanding community opposition suggests that they are much broader, and indeed represent generic concepts relevant to infrastructure and community opposition to potential lost ecosystem services. Relatedly, dam removal is not a niche topic limited to a sub-category of 'hydraulic infrastructure projects.' It is very much

interwoven and interlinked with a range of stakeholder values, power relations, communication, and place attachment; as are infrastructure projects associated with energy and transportation.

Findings suggest that employing a riparian ecosystem services framework linked to stakeholder values could help to provide more focused communication between federal and local actors. By examining how local actors experienced the dam removal project through the conceptual framework of community opposition and riparian ecosystem services, study findings increase understanding of human-environmental linkages with large infrastructure projects, as well as the local consequences of State imposed decisions more generally. Study results are of use in future dam removal projects – as well as other types of large infrastructure projects – in France and internationally.

7. Credit statement

Conceptualization: ZB (40 %) and PH (60 %), Data curation: ZB (80 %) and PH (20 %), Methodology: ZB (50%) and PH (50%), Formal analysis: ZB (80 %) and PH (20 %), Writing - original draft: ZB (70%) and PH (30%), Writing - review and editing: ZB (30%) and PH (70%), Supervision: ZB (0%) and PH (100%). .

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data available upon request.

Acknowledgements

We greatly appreciate constructive comments and criticism from two anonymous reviewers and the editor, which helped to improve the quality of the manuscript. We're especially thankful to the generosity extended by residents in the Sélune River basin and the scientific team studying the impacts of the Vezins Dam removal.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.geoforum.2023.103906.

References

Alvesson, M., Ashcraft, K.L., 2012. Interviews. In: Symon, G., Cassell, C. (Eds.), Qualitative Organizational Research: Core Methods and Current Challenges. Sage, London, pp. 239–257.

Amin, A., 2014. Lively Infrastructure. Theory Cult. Soc. 31 (7–8), 137–161. https://doi.org/10.1177/0263276414548490.

Anton, C.E., Lawrence, C., 2014. Home is where the heart is: The effect of place of residence on place attachment and community participation. J. Environ. Psychol. 40, 451–461.

Artelia, 2014b, July. Nature, consistance, volume et objet des travaux rubriques de la nomenclature concernées. DREAL Normandie. Retrieved May 14, 2022, from https://www.manche.gouv.fr/content/download/19490/126844/file/3_Nature, %20consistance, %20volume %20et %20objet %20des %20travaux.pdf.

Artelia, 2014a, October. Dossier de demande de dérogation au titre des articles L.411-2 et R.411-6 à 14 du Code de l'Environnement. DREAL Normandie. Retrieved April 29, 2022, from https://www.normandie.developpement-durable.gouv.fr/IMG/pdf/barrage_vezins_-_dossier_derogation.pdf.

Arthington, A.H., Naiman, R.J., McClain, M.E., Nilsson, C., 2010. Preserving the biodiversity and ecological services of rivers: new challenges and research opportunities. Freshw. Biol. 55, 1–16. https://doi.org/10.1111/j.1365-2427.2009.02340.x.

Autorité Environnementale, 2013, February 13. Avis délibéré de l'Autorité environnementale concernant la demande de cadrage préalable sur le projet de démantèlement du barrage de Vezins (50). CGEDD. Retrieved April 27, 2022, from https://www.igedd.developpement-durable.gouv.fr/IMG/pdf/008254-01_avis-delibere_ae_cle19f78f.pdf.

Bednarek, A.T., 2001. Undamming rivers: a review of the ecological impacts of dam removal. Environ. Manag. 27 (6), 803–814. https://doi.org/10.1007/s002670010189.

Bernard, H.R., 2017a. Interviewing I Unstructured and Semi-structured. In: Research Methods in Anthropology: Qualitative and Quantitative Approaches. Rowman & Littlefield.

Bernard, H.R., 2017b. Sampling III nonprobability samples and choosing informants analysis II schema analysis, grounded theory, content analysis, and analytical induction. In: Research Methods in Anthropology: Qualitative and Quantitative Approaches. Rowman & Littlefield.

Bernard, H.R., 2017c. Text analysis II schema analysis, grounded theory, content analysis, and analytical induction. In: Research Methods in Anthropology: Qualitative and Quantitative Approaches. Rowman & Littlefield.

Blettler, M., Espínola, L.A., Berros, V., 2023. Bio- and cultural diversity in the Middle Paraná River. In: Wantzen, K.M. (Ed.), River Culture – Life as a Dance to the Rhythm of the Waters. UNESCO Publishing, Paris, pp. 537–559. https://doi.org/10.54677/ZTDD9.

Borloo, J., 2010, June 23. DP Final. France Hydro Electricité. Retrieved May 4, 2022, from https://www.france-hydro-electricite.fr/wp-content/uploads/2019/09/convention-pour-une-hydrolectricite-durable-DP-100623.pdf.

Born, S.M., Genskow, K.D., Filbert, T.L., Hernandez-Mora, N., Keefer, M.L., White, K.A., 1998. Socioeconomic and institutional dimensions of dam removals: the Wisconsin experience. Environ. Manag. 22 (3), 359–370. https://doi.org/10.1007/s002679900111.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

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'. J. Environ. Manage. https://doi.org/10.1016/j.jenvman.2009.02.006.

Cohen, N., Arieli, T., 2011. Field research in conflict environments: methodological challenges and snowball sampling. J. Peace Res. 48 (4), 423–435. https://doi.org/10.1177/0022343311405698.

Collins, M.J., Snyder, N.P., Boardman, G., Banks, W.S.L., Andrews, M., Baker, M.E., Conlon, M., Gellis, A., McClain, S., Miller, A., Wilcock, P., 2017. Channel response to sediment release: insights from a paired analysis of dam removal. Earth Surf. Proc. Land. https://doi.org/10.1002/esp.4108.

Commission Locale de l'Eau du SAGE de la Sélune, 2007, November 27. Pour une gestion équilibrée de l'eau et des milieux aquatiques. gesteau. Retrieved July 23, 2022, from https://www.gesteau.fr/sites/default/files/doc_SAGE03005-1295278104.pdf.

Conlon, M., Gellis, A., McClain, S., Miller, A., Wilcock, P., 2017. Channel response to sediment release: insights from a paired analysis of dam removal. Earth Surf. Proc. Land. 42 (11), 1636–1651.

Coppens, T., Van Dooren, W., Thijssen, P., 2018. Public opposition and the neighborhood effect: how social interaction explains protest against a large infrastructure project. Land Use Policy 79, 633–640.

Crane, J., 2009. "Setting the river free": the removal of the Edwards dam and the restoration of the Kennebec River. Water History 1 (2), 131–148.

Dam Removal Europe, 2021, June 21. Dam Removal progress in 2020. Dam Removal Europe. Retrieved May 6, 2022, from https://damremoval.eu/dam-removal-progress-in-2020/.

DDTM de la Manche, 2013a, March 26. C- Ressources piscicoles. Les services de l'État dans la Manche. Retrieved May 10, 2022, from https://www.manche.gouv.fr/content/download/13605/80373/file/Patrimoine %20piscicole.pdf.

DDTM de la Manche, 2013b, March 26. C- Economie. Les services de l'État dans la Manche. Retrieved April 26, 2022, from https://www.manche.gouv.fr/content/download/13610/80393/file/Economie.pdf.

Devine-Wright, P., 2011. Place attachment and public acceptance of renewable energy: a tidal energy case study. J. Environ. Psychol. 31, 336–343.

Devine-Wright, P., 2013. Think global, act local? The relevance of place attachments and place identities in a climate changed world. Glob. Environ. Chang. 23, 61–69.

Devine-Wright, P., Batel, S., 2017. My neighbourhood, my country or my planet? The influence of multiple place attachments and climate change concern on social acceptance of energy infrastructure. Glob. Environ. Chang. 47, 110–120.

Diamond, J., 2006. Collapse: How Societies Choose to Fail or Succeed. Penguin, New York.

Dopico, E., Arboleya, E., Fernandez, S., et al., 2022. Water security determines social attitudes about dams and reservoirs in South Europe. Sci. Rep. 12, 6148. https://doi.org/10.1038/s41598-022-10170-7.

Doyle, M., Harbor, J., Stanley, E., 2003. Toward policies and decision-making for dam removal. Environ. Manag. 31, 0453–0465. https://doi.org/10.1007/s00267-002-2819-z.

Doyle, M.W., Stanley, E., Havlick, D., et al., 2008. Aging infrastructure and ecosystem restoration. Science 319 (5861), 286–287.

Drapier, L., Germaine, M.-A., Lespez, L., 2018. Politique environnementale et territoire: Le démantèlement des ouvrages hydrauliques en France à l'épreuve du modèle nord-américain. Annales de geographie N° 722 (4), 339–368.

DREAL Normandie, 2020, January 10. Basse vallée de la Sélune. DREAL Normandie. Retrieved April 25, 2022, from https://www.normandie.developpement-durable.gouv.fr/IMG/pdf/basse_vallee_de_la_selune.pdf.

Drenthen, M., 2009. Ecological restoration and place attachment: Emplacing non-places? Environ. Values 18, 285–312.

Duda, J.J., Torgersen, C.E., Brenkman, S.J., et al., 2021. Reconnecting the Elwha River: spatial patterns of fish response to dam removal. Front. Ecol. Evol. 9 https://doi.org/10.3389/fevo.2021.765488.

Dufour, S., Piégay, H., 2009. From the myth of a lost paradise to targeted river restoration: forget natural references and focus on human benefits. River Res. Appl. 25 (5), 568–581. https://doi.org/10.1002/rra.1239.
Erkul, M., Yitmen, I., Celik, T., 2020. Dynamics of stakeholder engagement in mega transport infrastructure projects. Int. J. Manag. Proj. Bus. 13, 1465–1495. https://doi.org/10.1108/IJMPB-09-2018-0175.
ERN, n.d. Sélune libre archive – European Rivers Network. European Rivers Network. Retrieved July 30, 2022, from https://www.ern.org/en/selune-libre-archive/.
Etikan, I., Alkassim, R., Abubakar, S., 2016. Comparison of snowball sampling and sequential sampling technique. Biom. Biostat. Int. J. 3 (1), 55.
European Commission, 2000. EU Water Framework Directive 2000/60/EC of 22 December 2000 on integrated river basin management for Europe. European Commission, Brussels, Belgium.
European Commission, 2020. EU Biodiversity Strategy for 2030. Bringing nature back into our lives. Communication from the Commission to the European Parliament, Miu et al. (2020), PeerJ, DOI 10.7717/peerj.10067 16/20 the Council, the European Economic and Social Committee and the Committee of the Regions. Available at https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:52020DC0380.
Evans, J.E., 2015. Contaminated sediment and dam removal: problem or opportunity? Eos 96. https://doi.org/10.1029/2015EO036835.
Flood, K., Mahon, M., McDonagh, J., 2021. Assigning value to cultural ecosystem services: the significance of memory and imagination in the conservation of Irish peatlands. Ecosyst. Serv. 50, 101326.
Foley, M.M., Bellmore, J.R., O'Connor, et al., 2017. Dam removal: listening in. Water Resour. Res. 53(7), 5229–5246. doi: 10.1002/2017WR020457.
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. doi: 10.1016/j.geoforum.2016.02.013.
Fovet, O., Meric, F., Crave, A., Cador, J.-M., Rollet, A.-J., 2023. Early assessment of effects of dam removal on abiotic fluxes of the Selune River, France. Frontiers in Environmental Science 11, 1231721. https://doi.org/10.3389/fenvs.2023.1231721.
Fox, C.A., Reo, N.J., Fessell, B., Dituri, F., 2022. In: Native American Tribes and dam removal: restoring the Ottaway, Penobscot and Elwha rivers. Water Alternatives15,13–37.
Germaine, M.-A., Lespez, L., 2014. Le démantèlement des barrages de la Sélune (Manche). Des réseaux d'acteurs au projet de territoire ? Développement durable et territoires. Économie, géographie, politique, droit, sociologie 5(3). doi: 10.4000/developpementdurable.10525.
Germaine, M.A., Le Lay, Y.F., Lespez, L., Montreuil, J., Menozzi, M.J., Roulet, B., Viry, M., 2015. Volet socio-économique du programme scientifique de suivi de l'arasement des ouvrages de la Sélune [Rapport intermédiare/Mars 2015 (Doctoral dissertation, Agence de l'Eau Seine-Normandie). https://programme-selune.com/wp-content/uploads/2019/11/2016_sociog %C3 %A9ographique_1_compressed.pdf.
Germaine, M.A., Lespez, L., 2017. The failure of the largest project to dismantle hydroelectric dams in Europe? (Sélune River, France, 2009–2017). Water Altern. 10, 655–676.
Germaine, M.A., 2010. De l'environnement au paysage: de nouvelles fonctions pour les vallées ordinaires rurales? L'exemple de la trajectoire des politiques publiques en Basse-Normandie. In 135ème congrès des sociétés scientifiques et historiques, Paysages.
Germaine, M.-A., 2015. Restauration écologique de la rivière Sélune. Paysage, usages, représentations: Quels changements après l'arasement des barrages de Vezins et La Roche-qui-Boit ? HAL INRAe. Retrieved May 19, 2022, from https://hal.inrae.fr/hal-03378997/document.
Gilet, L., Gob, F., Virmoux, C., Gautier, E., Thommeret, N., Jacob-Rousseau, N., 2021. Morpho-sedimentary dynamics associated to dam removal. The Pierre Glissotte dam (central France). Sci. Total Environ. 784, 147079 https://doi.org/10.1016/j.scitotenv.2021.147079.
Giordono, L.S., Boudet, H.S., Karmazina, A., Taylor, C.L., Steel, B.S., 2018. Opposition "overblown"? Community response to wind energy siting in the Western United States. Energy Res. Soc. Sci. 43, 119–131.
Goedkoop, F., Devine-Wright, P., 2016. Partnership or placation? The role of trust and justice in the shared ownership of renewable energy projects. Energy Res. Soc. Sci. 17, 135–146.
Gough, P., Fernández Garrido, P., Van Herk, J., 2018. Dam removal: a viable solution for the future of our European rivers. Retrieved January 23, 2020, from https://damremoval.eu/wp-content/uploads/2018/07/Dam-Removal-Europe-Report-2018-DEF-1.pdf.
Graf, W.L., 2006. Downstream hydrologic and geomorphic effects of large dams on American rivers. Geomorphology 79 (3), 336–360.
Grigg, N.S., 2019. Global water infrastructure: state of the art review. Int. J. Water Resour. Dev. 35, 181–205. https://doi.org/10.1080/07900627.2017.1401919.
Habel, M., Mechkin, K., Podgorska, K., et al., 2020. Dam and reservoir removal projects: a mix of social-ecological trends and cost-cutting attitudes. Sci. Rep. 10 (1), 19210. https://doi.org/10.1038/s41598-020-76158-3.
Harrison, E., 2019. 'They are treating us with contempt': the complexities of opposition in an English village. J. Rural. Stud. 68, 54–62.
Heinz Center, 2002. Dam removal: science and decision making. Final Report. The H. John Heinz III Center for Science, Economics, and the Environment.
Hitchings, R., Latham, A., 2020. Qualitative methods I: on current conventions in interview research. Prog. Hum. Geogr. 44 (2), 389–398. https://doi.org/10.1177/0309132519856412.
Hommes, L., 2022. The ageing of infrastructure and ideologies: contestations around dam removal in Spain. Water Altern. 15, 592–613.
Howell, C.R., Su, W., Nassel, A.F., Agne, A.A., Cherrington, A.L., 2020. Area based stratified random sampling using geospatial technology in a community-based survey. BMC Public Health 20 (1), 1–9.
Hudson, P.F., 2021. Dams, rivers, and the environment, Ch. 6. In: Flooding and Management of Large Fluvial Lowlands: A Global Environmental Perspective. Cambridge University Press, Cambridge, pp. 80–137. doi: 10.1017/9781139015738.005.
Johnson, J., 2001. In-depth interviewing. In: Gubrium, J.F., Holstein, J.A. (Eds.), Handbook of Interview Research. SAGE Publications Inc, pp. 103–119. https://doi.org/10.4135/9781412973588.n8.
Johnson, S.E., Graber, B.E., 2002. Enlisting the social sciences in decisions about dam removal. Bioscience 52 (8), 731. https://doi.org/10.1641/0006-3568(2002)052[0731:ETSSID]2.0.CO;2.
Jørgensen, D., 2017. Competing ideas of 'natural' in a dam removal controversy. Water Altern. 10, 840–852.
Jørgensen, D., Renöfält, B.M., 2013. Damned If You Do, Dammed If You Don't: Debates on Dam Removal in the Swedish Media. Ecol. Soc. 18 (1). https://www.jstor.org/stable/26269265.
Kondolf, G.M., Gao, Y., Annandale, G.W., et al., 2014. Sustainable sediment management in reservoirs and regulated rivers: experiences from five continents. Earth's Future 2 (5), 256–280. https://doi.org/10.1002/2013EF000184.
Kornei, K., 2020. Europe's rivers are the most obstructed on Earth. Eos 101 January 31: 2020. doi: 10.1029/2020EO139204.
Lee, E., Jang, J., 2021. Research trend analysis for sustainable QR code use—focus on big data analysis. KSII Trans. Internet Inf. Syst. (TIIS) 15 (9), 3221–3242.
Lejon, A.G.C., Renöfält, B.M., Nilsson, C., 2009. Conflicts associated with dam removal in Sweden. Ecol. Soc. 14 (2). https://www.jstor.org/stable/26268322.
Les Amis du Barrage (ADB), 2011, March. Dossier ADB (1.1). https://en.calameo.com/read/000227172ab7901c4e906.
Leynaud, G., Martin, Y., Seven, J., 1993) Rapport n° 93-137 sur les vidanges de barrages réservoirs. Vie publique. Retrieved July 23, 2022, from https://www.vie-publique.fr/sites/default/files/rapport/pdf/974053100.pdf.
Maddaloni, F.D., Davis, K., 2017. The influence of local community stakeholders in megaprojects: Rethinking their inclusiveness to improve project performance. Int. J. Proj. Manag. 35, 1537–1556.
Magilligan, F.J., Sneddon, C.S., Fox, C.A., 2017. The social, historical, and institutional contingencies of dam removal. Environ. Manag. 59 (6), 982–994.
McCaffery, R., McLaughlin, J., Sager-Fradkin, K., Jenkins, K.J., 2018. Terrestrial fauna are agents and endpoints in ecosystem restoration following dam removal. Ecol. Restor. 36 (2), 97–107.
Merriam, S.B., 2009. Qualitative Research: A Guide to Design and Implementation. Jossey-Bass, San Francisco, CA.
Meyer, H., 2020. Toward a cultural heritage of adaptation: a plea to embrace the heritage of a culture of risk, vulnerability and adaptation. In: Hein, C. (Ed.), Adaptive Strategies for Water Heritage. Springer, Cham, pp. 401–419.
Millennium Ecosystem Assessment (MEA), 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.
Ministère de la Transition écologique, 2021, January 22. Gestion de l'eau en France | Ministères Écologie Énergie Territoires. Ministère de la Transition écologique. Retrieved May 26, 2022, from https://www.ecologie.gouv.fr/gestion-leau-en-france.
Morley, S.A., Foley, M.M., Duda, J.J., Beirne, M.M., Paradis, R.L., Johnson, R.C., McHenry, M.L., Elofson, M., Sampson, E.M., McCoy, R.E., Stapleton, J., Pess, G.R., 2020. Shifting food web structure during dam removal—disturbance and recovery during a major restoration action. PLoS One 15 (9), e0239198. https://doi.org/10.1371/journal.pone.0239198.
NASCO, 2019. CNL(18)50 Projet de plan de gestion du saumon atlantique 2019-2024. NASCO. Retrieved September 15, 2022, from https://www.consultations-publiques.developpement-durable.gouv.fr/IMG/pdf/cnl_18_50_nasco_implementation_plan_for_the_period_2019_-_2024_gt_v6def.pdf.
Nelson, H.T., et al., 2021. Half-length and the FACT framework: distance-decay and citizen opposition to energy facilities. Land Use Policy 101, 105101.
Nowell, L.S., Norris, J.M., White, D.E., Moules, N.J., 2017. Thematic analysis: striving to meet the trustworthiness criteria. Int. J. Qual. Methods 16 (1), 1609406917733847. https://doi.org/10.1177/1609406917733847.
Noy, C., 2008. Sampling knowledge: the hermeneutics of snowball sampling in qualitative research. Int. J. Soc. Res. Methodol. 11 (4), 327–344. https://doi.org/10.1080/13645570701401305.
Office Français de la Biodiversité, 2022. https://professionnels.ofb.fr/fr/node/1240 (last accessed 1 sept.-22).
Parkinson, J.R., 2013. How is space public? Implications for spatial policy and democracy. Eviron. Plann. C. Gov. Policy 31 (4), 682–699. https://doi.org/10.1068/c11226r.
Perlaviciute, G., Schuitema, G., Devine-Wright, P., Ram, B., 2018. At the heart of a sustainable energy transition. IEEE Power Energ. Mag. 16, 49–55. https://doi.org/10.1109/MPE.2017.2759918.
PNMA, 2022. Draft National Plan in favour of Migratory Diadromous Species. Technical Document produced by Ministry of Ecological Transition and Ministry of Agriculture. https://professionnels.ofb.fr/fr/node/1240 (last accessed 2 September, 2022).
Proulhac, N., 2012, June. Effacement des barrages de la Sélune, gestion des sédiments contaminés et plan de gestion. Les services de l'État dans la Manche. Retrieved May 17, 2022, from https://www.manche.gouv.fr/content/download/13572/80166/file/R %C3 %A9sultats %20de %20la %20phase %201-synth %C3 %A8se %20des %20donn %C3 %A9es %20et %20 %C3 %A9tat %20des %20lieux %20du %20site_Partie1.pdf.

Quandt, A., 2022. The role of qualitative social science. Discussion of "Guiding principles for hydrologists conducting interdisciplinary research and fieldwork with participants". Hydrol. Sci. J. 67 (7), 1141–1144. https://doi.org/10.1080/02626667.2022.2060107.
Randle, T.J., Bountry, J., 2017. Dam Removal Analysis Guidelines for Sediment. U.S Bureau of Reclamation, Denver CO.
Ravot, C., Laslier, M., Hubert-Moy, L., Dufour, S., Le Coeur, D., Bernez, I., 2020. Large dam removal and early spontaneous riparian vegetation recruitment on alluvium in a former reservoir: lessons learned from the pre-removal phase of the Sélune River project (France). River Res. Appl. 36 (6), 894–906. https://doi.org/10.1002/rra.3535.
Reilly, K.H., Adamowski, J.F., 2017. Stakeholders' frames and ecosystem service use in the context of a debate over rebuilding or removing a dam in New Brunswick, Canada. Ecol. Soc. 22 (1), 17.
Riis, T., Kelly-Quinn, M., Aguiar, F.C., et al., 2020. Global overview of ecosystem services provided by riparian vegetation. Bioscience 70, 501–514.
Ritchie, A.C., Warrick, J.A., East, A.E., Magirl, C.S., Stevens, A.W., Bountry, J.A., Randle, T.J., Curran, C.A., Hilldale, R.C., Duda, J.J., Gelfenbaum, G.R., Miller, I.M., Pess, G.R., Foley, M.M., McCoy, R., Ogston, A.S., 2018. Morphodynamic evolution following sediment release from the world's largest dam removal. Sci. Rep. 8 (1), 13279. https://doi.org/10.1038/s41598-018-30817-8.
Rubin, H.J., Rubin, I.S., 2005a. Analyzing coded data. In: Qualitative interviewing (2nd ed.): The art of hearing data. SAGE Publications, Inc., pp. 224–245. doi: 10.4135/9781452226651.n11.
Rubin, H.J., Rubin, I.S., 2005b. Listening, hearing, and sharing social experiences. In Qualitative Interviewing (2nd ed.): The Art of Hearing Data. SAGE Publications, Inc., pp. 1–18. doi: 10.4135/9781452226651.n1.
Rubin, H.J., Rubin, I.S., 2005c. Structuring the interview. In: Qualitative Interviewing (2nd ed.): The Art of Hearing Data. SAGE Publications, Inc., pp. 129–151. doi: 10.4135/9781452226651.
SAGE Sélune, 2009, August 01. SAGE de la Sélune étude des ressources en eau souterraine du bassin de la Sélune. gesteau.fr. Retrieved April 22, 2022, from https://www.gesteau.fr/sites/default/files/gesteau/content_files/document/doc_SAGE03005-1251128932.pdf.
SAGE Sélune, 2017, December 07. Version provisoire du 07/12/2017. Syndicat Mixte du Bassin de la Sélune. Retrieved April 22, 2022, from http://bassin-selune.fr/sites/bassin-selune.fr/files/telechargement/SAGE/etat_des_lieux_v3.pdf.
Saunders, M.N.K., Townsend, K., 2016. Reporting and Justifying the Number of Interview Participants in Organization and Workplace Research. Br. J. Manag. 27 (4), 836–852. https://doi.org/10.1111/1467-8551.12182.
Sherren, K., Beckley, T.M., Greenland-Smith, S., Comeau, L., 2017. How provincial and local discourses aligned against the prospect of dam removal in New Brunswick, Canada. Water Alternatives 10, 697–723.
Short, D., Szolucha, A., 2019. Fracking Lancashire: the planning process, social harm and collective trauma. Geoforum 98, 264–276. https://www.sciencedirect.com/science/article/pii/S0016718517300519.
Shuy, R., 2001. In-person versus telephone interviewing. In: Gubrium, J.F., Holstein, J.A. (Eds.), Handbook of Interview Research. SAGE Publications Inc, pp. 536–555. https://doi.org/10.4135/9781412973588.n32.
Sibertin-Blanc, C., 2019. Formal analysis of the conflictive play of actors regarding the building of a dam. In: Boulet, R., Lajaunie, C., Mazzega, P. (Eds.), Law, Public Policies and Complex Systems: Networks in Action. Law, Governance and Technology Series, Vol. 42. Springer, Cham. doi: 10.1007/978-3-030-11506-7_9.
Small, N., Munday, M., Durance, I., 2017. The challenge of valuing ecosystem services that have no material benefits. Glob. Environ. Chang. 44, 57–67.
Sneddon, C.S., Barraud, R., Germaine, M.-A., 2017. Dam removals and river restoration in international perspective. Water-Alternatives 10 (3), 648–654.
Sneddon, C., Magilligan, F.J., Fox, C.A., 2022. Peopling the environmental state: river restoration and state power. Ann. Am. Assoc. Geogr. 112 (1), 1–18. https://doi.org/10.1080/24694452.2021.1913089.
Stanley, E.H., Doyle, M.W., 2003. Trading off: The ecological effects of dam removal. Front. Ecol. Environ. 1 (1), 15–22. https://doi.org/10.1890/1540-9295(2003)001[0015:TOTEEO]2.0.CO;2.
Stępniak, M., Rosik, P., 2018. The role of transport and population components in change in accessibility: the influence of the distance decay parameter. Netw. Spat. Econ. 18, 291–312. https://doi.org/10.1007/s11067-017-9376-8.
Stratton, S.J., 2021. Population research: convenience sampling strategies. Prehosp. Disaster Med. 36 (4), 373–374. https://doi.org/10.1017/S1049023X21000649.
Summers, J.K., Smith, L.M., Fulford, R.S., Crespo, R.J., 2018. The role of ecosystem services in community well-being. In: Ecosystem Services and Global Ecology. InTech. doi: 10.5772/intechopen.74068.
Susskind, L., Chun, J., Gant, A., Hodgkins, C., Cohen, J., Lohmar, S., 2022. Sources of opposition to renewable energy projects in the United States. Energy Policy 165, 112922.
Syndicat Mixte du Bassin de la Sélune, n.d.b. La Sélune et ses affluents | Syndicat Mixte du Bassin de la Sélune. Syndicat Mixte du Bassin de la Sélune |. Retrieved May 10, 2022, from http://bassin-selune.fr/bassin-versant/selune-affluents.
Tansey, O., 2007. Process tracing and elite interviewing: a case for non-probability sampling. Polit. Sci. Polit. 40 (4), 765–772. https://doi.org/10.1017/S1049096507071211.
Thieme, M.L., Tickner, D., Grill, G., Carvallo, J.P., et al., 2021. Navigating trade-offs between dams and river conservation. Glob. Sustain. 4, e17 https://doi.org/10.1017/sus.2021.15.
Tuckerman, S., Zawiski, B., 2007. Case studies of dam removal and TMDLs: process and results. J. Great Lakes Res. 33 (sp2), 103–116. https://doi.org/10.3394/0380-1330(2007)33[103:CSODRA]2.0.CO;2.
United Nations Environment Programme (UNEP), 2009. Water security and ecosystem services: The critical connection. Contribution to the United Nations World Water Assessment Programme, Nairobi, Kenya.
Valentin, V., Abraham, D., Mannering, F., Mostafavi, A., 2012. Assessment of Public Opposition to Infrastructure Developments: The Case of Nuclear Power Projects. Construction Research Congress 2012: Construction Challenges in a Flat World, USACE. doi: 10.1061/9780784412329.156.
Walter, R.C., Merritts, D.J., 2008. Natural streams and the legacy of water-powered mills. Science 319, 229–304.
Wantzen, K.M., Tharme, R.E., Pypaert, P., 2023. Life as a dance to the rhythm of the waters: An analysis of current trends and suggestions to restore river culture. In: Wantzen, K.M. (Ed.), River Culture – Life as a Dance to the Rhythm of the Waters. UNESCO Publishing, Paris, pp. 1–22. https://doi.org/10.54677/NIGG2511.
Wolsink, M., 2010. Contested environmental policy infrastructure: Socio-political acceptance of renewable energy, water, and waste facilities. Environ. Impact Assess. Rev. 30, 302–311.
Yeakley, J.A., Ervin, D., Chang, H., et al., 2016. Ecosystem services of streams and rivers, Ch. 17. In: Gilvear, D.J., Greenwood, M.T., Thoms, M.C., Wood, P.J. (Eds.), River Science: Research and Management for the 21st Century. John Wiley & Sons.

Further reading

European Environment Agency (EEA), 2018, July 3. European Waters: Assessment of Status and Pressures 2018. European Environmental Agency. EEA Report No 7/.
European Rivers Network, 2019, September. Colloque international – Renaissance de la Vallée de la Sélune – European Rivers Network. European Rivers Network. Retrieved May 6, 2022, from https://www.ern.org/fr/colloque-international-selune/.
Dethier, E.N., Renshaw, C.E., Magilligan, F.J., 2022. Rapid changes to global river suspended sediment flux by humans. Science 376(6600), 1447–1452.
ATLAS.ti Scientific Software Development GmbH [ATLAS.ti 22 Mac]. (2022). Retrieved May 26, 2022, from https://atlasti.com.
Bolis, A., 2010, June 23. L'arasement du barrage de Vezins, source de discorde locale. Le Monde. https://www.lemonde.fr/planete/article/2010/06/23/l-arasement-du-barrage-de-vezins-source-de-discorde-locale_1377431_3244.html.
Boniou, C., Dardaillon, B., Letournel, J., 2016, December 30. Dans le département de la Manche, des conditions de vie favorables mais quelques disparités territoriales. Insee. Retrieved April 25, 2022, from https://www.insee.fr/fr/statistiques/2535922#consulter.
Belletti, B., Garcia de Leaniz, C., Jones, J., et al., 2020. More than one million barriers fragment Europe's rivers. Nature 588, 436–441. https://doi.org/10.1038/s41586-020-3005-2.
Syndicat Mixte du Bassin de la Sélune, n.d.a. La qualité des eaux et la pluviométrie, la migration des poissons du bassin de la sélune. Syndicat Mixte du Bassin de la Sélune. Retrieved July 23, 2022, from http://bassin-selune.fr/bassin-versant/caracteristiques.
Maillard, M., Roger, P., 2019, September 3. Bilan démographique 2018: la population normande diminue. Insee. Retrieved July 27, 2022, from https://www.insee.fr/fr/statistiques/4204204.
Ministère de la transition écologique et solidaire, 2017, November 14. Nicolas Hulot, ministre d'État, ministre de la Transition écologique et solidaire, donne son feu vert au projet de restauration de la biodiversité de la vallée de la Sélune. Retrieved June 4, 2023, from https://www.ecologie.gouv.fr/sites/default/files/2017.11.14_cp_vallee_de_la_S %C3 %A9lune.pdf.
James, N., Busher, H., 2009. Three developing online research strategies: a methodological discussion. In: Online Interviewing. SAGE Publications Ltd., pp. 30–41. https://doi.org/10.4135/9780857024503.d6
Programme Sélune, n.d.a. Contexte. Selune. Retrieved May 7, 2022, from https://programme-selune.com/fr/le-programme-scientifique/contexte/.
Hansen, H.H., Forzono, E., Grams, A., et al., 2019. Exit here: Strategies for dealing with aging dams and reservoirs. Aquat. Sci. 82 (1), 2. https://doi.org/10.1007/s00027-019-0679-3.
Cholley, F., Perrin, T., Vindimian, E., Conseil général de l'Environnement et du Développement durable, & Conseil général de l'économie, de l'industrie, de l'énergie et des technologies, 2015, March 15. Expertise du projet d'effacement des ouvrages de Vezins et la Roche-qui-Boit sur la Sélune. Vie publique. Retrieved April 29, 2022, from https://www.vie-publique.fr/rapport/273604-expertise-projet-effacement-des-ouvrages-de-vezins-et-la-roche-qui-boit.
Guittard, M., 2021, May 15. Barrages du Sud-Manche: cinq questions sur la répartition des 60 millions d'euros du budget alloué. Ouest-France. https://www.ouest-france.fr/normandie/manche/barrages-du-sud-manche-cinq-questions-sur-la-repartition-des-60-millions-d-euros-du-budget-alloue-ab6bfffa-8be8-11eb-a71d-899479ea60d4.
Hubbard, P., 2005. Accommodating otherness: anti-asylum centre and the maintenance of white privilege. Trans. Inst. Br. Geogr. 30, 52–65.
UNFCCC. (2021, November 13). Glasgow Climate Change Conference – October-November 2021. UNFCCC. Retrieved May 15, 2022, from https://unfccc.int/conference/glasgow-climate-change-conference-october-november-2021.
Programme Sélune, n.d.b. Sélune—Restauration écologique du fleuve Sélune. Selune. Retrieved May 7, 2022, from https://programme-selune.com/fr/.
Subra, P., Attané, M., 2015, November 1. Notre-Dame-des-Landes, Sivens, Roybon: quand l'aménagement sème la discorde en France ! Les Cafés Géo. Retrieved June 4, 2023, from http://cafe-geo.net/zad-quand-l-amenagement-seme-la-discorde/.
McNeill, A., Zamparutti, T., 2020. Integrated water management and policy coherence in regions and cities. European Committee of the Regions. Retrieved April 26, 2022, from https://cor.europa.eu/en/engage/studies/Documents/Integrated %20water %20management.pdf.

Écologie.gouv.fr, 2023, April 3. Gestion de l'eau en France | Ministères Écologie Énergie Territoires. Ministère de la transition écologique. Retrieved June 1, 2023, from https://www.ecologie.gouv.fr/gestion-leau-en-france.

Les Amis de la Sélune, 2017, November 15. Arasement des barrages de Vezins et La-Roche-qui-Boit: la Sélune bientôt libérée ! Retrieved June 4, 2023, from https://www.fnh.org/wp-content/uploads/2020/10/171116_cp_selune.pdf.

Polve-Montmasson, D., 2014. Arrêté n°2014-16. Préfet de la Manche. https://www.manche.gouv.fr/content/download/19477/126768/file/selune %20barrage %20arq.pdf.

Lebourgeois, G., 2014, December 12. Barrages du Sud Manche: l'humeur change de camp après les déclarations de Ségolène Royal. La Gazette des communes. Retrieved June 4, 2023, from https://www.lagazettedescommunes.com/304246/barrages-du-sud-manche-lhumeur-change-de-camp-apres-les-declarations-de-segolene-royal/.

Germaine, M.-A., Drapier, L., Lespez, L., Menozzi, M.-J., Thomas, O., 2019. Entre désir de nature et peur de l'abandon: Quelles attentes paysagères après l'arasement des barrages hydroélectriques de la Sélune? Projets de paysage. Revue scientifique sur la conception et l'aménagement de l'espace 20: 20. doi: 10.4000/paysage.569.

Stephens, J.L., 2017. Short-term response of vegetation and the riparian bird community to dam removal on the Rogue River, Oregon. Ecol. Restor. 35 (4), 328–340. https://doi.org/10.3368/er.35.4.328.

Perrin, J., Tavares, L., 2015, December 2. Détruire les barrages? 18 309 voix contre. Ouest-France. Retrieved May 14, 2022, from https://www.ouest-france.fr/normandie/detruire-les-barrages-18-309-voix-contre-3890749.

QGIS Development Team, 2020. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

Kornijów, R., 2009. Controversies around dam reservoirs: benefits, costs and future. Ecohydrol. Hydrobiol. 9 (2), 141–148. https://doi.org/10.2478/v10104-010-0001-4.

Sénat, 2015, January 21. Projet de loi relatif à la transition énergétique pour la croissance verte. Sénat. Retrieved June 4, 2023, from https://www.senat.fr/rap/a14-244/a14-24414.html.

SEPIA Conseils, 2009, June 01. ETUDE DU DEVENIR DES BARRAGES DE LA SELUNE. Gest'eau. Retrieved July 23, 2022, from https://www.gesteau.fr/sites/default/files/gesteau/content_files/document/doc_SAGE03005-1251129414.pdf.

Latham, A., 2020. Thinking with method: qualitative research in human geography. Area 52 (4), 666–667.

Jourdaa, F., 2022, February 4. Barrages du Sud-Manche. Un nouveau recours des Amis du barrage face au Conseil d'État. Ouest-France. https://www.ouest-france.fr/pays-de-la-loire/vezins-49340/barrages-du-sud-manche-un-nouveau-recours-des-amis-du-barrage-face-au-conseil-d-etat-79ef3048-852d-11ec-a788-7c7e39d83197.

Niccolo, 2021, June 21. Dam Removal progress in 2020 - Dam Removal Europe. Retrieved December 2, 2021, from https://damremoval.eu/dam-removal-progress-in-2020/.

Seidl, R., Stauffacher, M., 2013. Evaluation of river restoration by local residents. Water Resour. Res. 49, 7077–7087. https://doi.org/10.1002/2013WR013988.