



Knowledge, uncertainty, and learning in freshwater governance: perspectives of environmental defenders at Lake Vättern

Downloaded from: <https://research.chalmers.se>, 2026-09-14 17:59 UTC

Citation for the original published paper (version of record):

Kanyama Carlsson, M., Dahlström, Å. (2026). Knowledge, uncertainty, and learning in freshwater governance: perspectives of environmental defenders at Lake Vättern. *Cogent Social Sciences*, 12(1).
<http://dx.doi.org/10.1080/23311886.2026.2719045>

N.B. When citing this work, cite the original published paper.

Knowledge, uncertainty, and learning in freshwater governance: perspectives of environmental defenders at Lake Vättern

Mariam Carlsson Kanyama & Åsa Nilsson Dahlström

To cite this article: Mariam Carlsson Kanyama & Åsa Nilsson Dahlström (2026) Knowledge, uncertainty, and learning in freshwater governance: perspectives of environmental defenders at Lake Vättern, Cogent Social Sciences, 12:1, 2719045, DOI: [10.1080/23311886.2026.2719045](https://doi.org/10.1080/23311886.2026.2719045)

To link to this article: <https://doi.org/10.1080/23311886.2026.2719045>



© 2026 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 22 Aug 2026.



[Submit your article to this journal](#)



Article views: 168



[View related articles](#)



[View Crossmark data](#)

Knowledge, uncertainty, and learning in freshwater governance: perspectives of environmental defenders at Lake Vättern

Mariam Carlsson Kanyama^a  and Åsa Nilsson Dahlström^b 

^aDepartment of Technology Management and Economics, Division of Science, Technology and Society, Chalmers University of Technology, Gothenburg, Sweden; ^bSchool of Education and Communication, Jönköping University, Jönköping, Sweden

ABSTRACT

Freshwater systems are increasingly threatened by climate change, pollution and competing societal demands, making their governance both complex and contested. This study examines how environmental defenders engaged in protecting Lake Vättern, Sweden's second-largest lake and an important drinking water source, understand knowledge, uncertainty and learning in freshwater governance. Drawing on an inductive qualitative analysis of twelve semi-structured interviews, complemented by documentary material, the study explores how environmental defenders interpret governance challenges associated with slow-moving and often invisible environmental change. Three interconnected themes emerged: uncertainty rooted in the interpretation and use of knowledge rather than its absence; competing understandings of ecological risk; and governance responses characterised by incremental rather than transformative learning. The findings suggest that governance challenges are shaped not only by scientific uncertainty but also by contested epistemic authority, institutional fragmentation and limited capacity for integrative learning. By foregrounding the perspectives of environmental defenders, the study contributes to freshwater governance scholarship by demonstrating how knowledge, uncertainty and learning shape responses to slow-moving environmental change, highlighting the need for more adaptive, participatory and reflexive approaches to freshwater governance.

ARTICLE HISTORY

Received 9 March 2026
Revised 8 August 2026
Accepted 11 August 2026

KEYWORDS

Freshwater governance;
environmental defenders;
epistemic uncertainty;
environmental
governance; learning

SUBJECTS

Socio-Legal Studies;
Anthropology; Sustainable
Development

Introduction

Freshwater ecosystems are under increasing pressure from climate change, pollution, habitat modification, resource extraction and competing societal demands (Dudgeon et al., 2006; IPCC, 2022; Reid et al., 2019; Vörösmarty et al., 2010). These interacting pressures affect not only ecological integrity but also drinking water security, biodiversity and the social and cultural values associated with freshwater systems (Johnston & Fiske, 2014; Krause & Strang, 2016). As environmental change accelerates, freshwater governance has become one of the most pressing sustainability challenges, requiring decisions under conditions of uncertainty, competing interests and long temporal horizons (Howard et al., 2024).

Moreover, freshwater governance is widely recognised as a 'wicked' problem because ecological processes are complex, knowledge is incomplete, and governance involves multiple actors with competing values, priorities and interpretations of environmental risk (Freeman, 2000; Head & Alford, 2015). These challenges are intensified by climate change, which introduces increasing variability, cumulative impacts and non-linear ecological responses that are difficult to predict or manage through conventional governance approaches (IPCC, 2022). As a result, freshwater governance extends beyond technical water management to encompass the social processes through which knowledge is produced, interpreted, negotiated and translated into collective action.

Within this context, knowledge, uncertainty and learning have become central to understanding freshwater governance because environmental decision-making rarely depends solely on the availability of

CONTACT Mariam Carlsson Kanyama  kanyama@chalmers.se  Department of Technology Management and Economics, Division of Science, Technology and Society, Chalmers University of Technology, Gothenburg, Sweden.

© 2026 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

scientific information. Rather, governance responses are shaped by how different actors interpret evidence, assign credibility and negotiate competing risks, values and priorities (Brugnach et al., 2008, 2011). As a result, governance outcomes depend not only on scientific knowledge itself but also on the social processes through which knowledge is interpreted, shared, contested and translated into collective action.

These challenges expose important limitations in prevailing freshwater governance frameworks, which often struggle to respond effectively to the temporal complexity, uncertainty and interconnected nature of freshwater ecosystems (Ahopelto et al., 2024). In response, non-state actors have assumed increasingly important roles in environmental governance. Among these, civil society actors – here understood as environmental defenders – have become increasingly influential in freshwater governance through advocacy, environmental monitoring, public engagement. Environmental defenders often challenge existing governance practices and draw attention to environmental risks that might otherwise remain politically marginal or insufficiently recognised (Global Witness, 2025; Zeng et al., 2022). Environmental defenders have also contributed to the development of alternative governance approaches, including rights-of-nature frameworks that recognise rivers and lakes as legal subjects (Yanquiling et al., 2024). Despite their growing importance, comparatively little research has examined how environmental defenders themselves understand knowledge, uncertainty and learning in freshwater governance, even though they frequently operate at the interface of scientific knowledge, public engagement and environmental advocacy (Martinez-Alier et al., 2016).

These questions are particularly relevant in the governance of Lake Vättern, Sweden's second-largest lake and a drinking water source for more than 250,000 people. Lake Vättern is characterised by multiple and interacting environmental pressures, including persistent pollutants such as PFAS, proposed mining activities, military exercises, historical industrial contamination and the growing impacts of climate change. The lake's exceptionally long water retention time of approximately 60 years means that contaminants may remain within the ecosystem for decades, making many environmental impacts cumulative, slow-moving and difficult to detect. At the same time, Lake Vättern constitutes a contested hydrosocial space (Linton & Budds, 2014) in which public authorities, industry, the military, local communities and environmental organisations hold differing understandings of the lake's ecological condition, environmental risks and appropriate governance responses. The lake is also characterised by an active network of environmental organisations, including Naturskyddsföreningen, Aktion Rädda Vättern and Urbergsgruppen, that have played a prominent role in environmental monitoring, public engagement and advocacy concerning the lake's future. These characteristics make Lake Vättern a valuable case for examining how environmental defenders understand knowledge, uncertainty and learning in freshwater governance.

Accordingly, this study examines how environmental defenders engaged in protecting Lake Vättern understand knowledge, uncertainty and learning in freshwater governance in relation to the slow-moving and often invisible environmental harms affecting the lake. Using semi-structured interviews, the study explores how participants interpret governance challenges, the role of scientific knowledge and opportunities for learning and institutional change. By focusing on environmental defenders, the study contributes to freshwater governance scholarship by providing an empirically grounded understanding of how one influential actor group conceptualises knowledge, uncertainty and governance in the protection of threatened freshwater ecosystems.

Theory

The theoretical perspectives presented below serve as interpretive lenses through which the findings are understood. Specifically, the study draws on literature on knowledge and uncertainty, multi-loop learning, slow violence and rights of nature. Rights-of-nature scholarship is included not only as an emerging approach to freshwater governance but also because the study forms part of a broader research project in which nine interview participants had previously participated in a transition lab on rights of nature. Although the interviews explored freshwater governance more broadly, this provided an important context for interpreting respondents' reflections on governance, knowledge, uncertainty and learning.

Knowledge and uncertainty

In environmental decision-making, uncertainty is often conceptualised in three analytically distinct forms. Epistemic uncertainty refers to incomplete knowledge – for example, limited data, insufficient monitoring, or gaps in scientific understanding – that may be reduced through further research and information gathering. Ontological uncertainty refers to inherent variability and unpredictability in complex social–ecological systems, where outcomes cannot be fully predicted even with more information. Ambiguity arises when multiple legitimate interpretations of a situation coexist, reflecting different problem framings and meanings among actors (Brugnach et al., 2008, 2011; Walker et al., 2003; Warmink et al., 2017). Importantly, ambiguity cannot be resolved through additional data alone, because it is rooted in divergent values, perspectives and interpretive frames (Brugnach et al., 2011). Consequently, managing uncertainty and disagreement often requires not only problem-solving and improved evidence bases, but also processes such as dialogue, negotiation and learning that are adapted to context (Brugnach et al., 2011).

Research further suggests that uncertainty in freshwater governance is addressed effectively only through social and organisational learning, in which actors revise practices, assumptions and problem definitions over time (Brugnach et al., 2011). Such learning is often pursued through knowledge arrangements that bring together public authorities, scientific experts and stakeholders (Cabello, 2024; Chambers et al., 2021; Lepenies et al., 2018).

Learning loops as uncertainty management

A useful way to analyse governance responses to uncertainty is multi-loop learning, originating in policymaking theory (Argyris & Schön, 1978; Hargrove, 2002) and further developed in environmental governance research (Pahl-Wostl, 2009; Pahl-Wostl et al., 2007), including applications to uncertainty in river governance (Warmink et al., 2017). Three learning loops are commonly distinguished. Single-loop learning improves performance through incremental adjustments to existing routines (e.g. more monitoring, improved procedures). Double-loop learning involves critical reflection on underlying assumptions, values and problem framings, potentially reframing strategies and goals. Triple-loop learning entails more fundamental transformation, including changes in governance structures, norms and responsibilities (Argyris & Schön, 1978; Pahl-Wostl, 2009; Warmink et al., 2017).

Warmink et al. (2017) argue that uncertainty management is inherently iterative. When incremental adjustments fail to address persistent or systemic challenges, governance may require reframing the problem or undertaking more fundamental change. In practice, however, policy responses often remain confined to more limited forms of learning. Uncertainty tends to be treated as something to minimise, leading to strategies centred on collecting additional information, refining models, or applying conservative, control-oriented approaches (Brugnach et al., 2011; Koppenjan & Klijn, 2004; Pahl-Wostl et al., 2011). At the same time, accumulating knowledge can sometimes heighten uncertainty by revealing new unknowns, rather than producing closure (Hommes et al., 2009). Moreover, when ambiguity is prominent, technically improved information may not reduce disagreement, because actors continue to interpret risks through different frames (Warmink et al., 2017). This has motivated calls for freshwater management approaches that integrate social, natural and technical sciences and that recognise the governance implications of uncertainty and contested meaning (Lund, 2015).

Finally, uncertainty is likely to intensify under climate change and other global pressures on social–ecological systems, which may produce surprises and non-linear dynamics (Rockström et al., 2009). Responding to such conditions may require multi-level governance arrangements that draw on diverse forms of knowledge and accommodate learning across scales and stakeholder groups (Boyd & Folke, 2012; Huitema et al., 2009).

Slow violence, governance limits and the rights of nature

Slow violence – defined as the gradual and often invisible environmental harms such as climate change, pollution and resource depletion that disproportionately affect marginalised communities (Nixon, 2011) – poses a significant challenge for environmental governance. Because these harms unfold slowly, are

difficult to observe directly, and involve complex causal chains, they often generate epistemic uncertainty and ambiguity regarding responsibility, risk and appropriate responses. Research shows that governance frameworks frequently overlook or inadequately address such diffuse harms, as institutions tend to privilege immediate crises over long-term degradation (O'Lear, 2016). In this sense, slow violence can also constrain learning processes within governance systems, as gradual environmental change may fail to trigger deeper reflection or institutional transformation. Such neglect can itself be understood as a mode of governance, in which state structures and policies perpetuate environmental injustices through inaction or incremental decision-making (Dehm, 2020).

These governance limitations are also increasingly reflected in the legal domain. Conventional anthropocentric environmental laws have often proven insufficient to protect aquatic ecosystems, prompting communities to pursue alternative and more transformative governance approaches, including the recognition of legal rights for nature (Macpherson, 2021). At the same time, such approaches challenge established hierarchies of epistemic authority by introducing new epistemic actors – such as guardians, Indigenous knowledge holders and community representatives – into governance processes (Yanquiling et al., 2024).

Rights-of-nature frameworks have been advanced globally, including Spain's Law 19/2022 granting personhood to the Mar Menor, New Zealand's Te Awa Tupua (Whanganui River Claims Settlement) Act 2017, and local ordinances in the United States (Moutrie, 2021). Environmental defenders, frequently drawn from local communities, have played a decisive role in these struggles (Zeng et al., 2022). In Sweden in 2019, Swedish Earth Rights Lawyers together with the U.S.-based Community Environmental Legal Defense Fund (CELDF), formulated a Declaration of the Rights of Lake Vättern, recognising its rights to exist, flourish, regenerate and evolve (International Rights of Nature Tribunal, 2019), but this 'soft law' has not been legally formalised.

Importantly, although rights of nature cases often inspire similar initiatives, their development in specific contexts is difficult to predict (Epstein & Andersen, 2024), as outcomes depend on broader social and political circumstances (Tănăsescu, 2021). A study of support for rights of nature laws across 23 EU member states found that Sweden had the lowest level of support, despite 49% supporting, 11% opposing and 39% being neutral or unsure; overall, the results remain inconclusive regarding whether such support will lead to broader legal recognition in the EU (Epstein et al., 2024). However, the Mar Menor case – currently the only EU legislation based on rights-of-nature principles – shows that actors with divergent knowledge claims may nonetheless share concerns about insufficient public governance (Cabello & Brugnach, 2023). While such proposals may emerge when dissatisfaction with existing management models grows, they also raise concerns: a recent Swedish study suggests that rights-of-nature frameworks may risk undermining social cohesion, straining institutions and centralising power in ways that could exacerbate conflict (Epstein & Andersen, 2024).

Methods and materials

Research design

This study employs a qualitative case study design to examine how environmental defenders understand knowledge, uncertainty and learning in freshwater governance. An inductive analytical strategy was adopted because the aim was to explore participants' own understandings of governance challenges rather than test predetermined hypotheses. Themes were developed through iterative engagement with the interview material, after which the theoretical perspectives presented earlier were used as interpretive lenses.

Study context: Lake Vättern

Lake Vättern was selected as the empirical case because it represents a freshwater system experiencing multiple and interacting environmental pressures under conditions of scientific uncertainty and contested governance. As Sweden's second-largest lake and a drinking water source for more than 250,000 people, it is of considerable ecological and societal importance. The lake is subject to a range of

environmental pressures, including climate change, PFAS contamination, historical industrial pollution, planned mining and pollution from multiple industrial activities (Larsson et al., 2025). Its exceptionally long water retention time of approximately 60 years further means that contaminants may persist in the ecosystem for decades, making environmental degradation cumulative, slow-moving and often difficult to detect (Larsson et al., 2025).

Governance of Lake Vättern falls within the framework of the European Union Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, 2000), implemented in Sweden through the Water Management Ordinance (*Vattenförvaltningsförordningen*). A central principle of the Directive is stakeholder participation (Article 14), which in Sweden is operationalised through local water governance organisations such as water councils (*vattenråd*) and water conservation associations (*vattenvårdsförbund*) (Vattenmyndigheterna, 2025). Around Lake Vättern, this role is fulfilled by the Vättern Conservation Association (*Vätternvårdsförbundet*), which brings together municipalities, government agencies, industries, landowners and environmental organisations to support monitoring, collaboration and knowledge exchange (Vätternvårdsförbundet, 2025). Such organisations provide important arenas for collaboration and social learning across different levels of freshwater governance (Prutzer et al., 2021).

Despite these collaborative arrangements, governance of Lake Vättern remains contested. Ongoing debates concerning military exercises (Försvarsmakten, 2025; Aktionsgruppen Rädda Vättern, 2025), planned mining at Norra Kärr (Swedish Government, 2026) and industrial pollution illustrate tensions between environmental protection, economic development and competing public interests. Stakeholders also differ in their assessments of the ecological condition of the lake. Whereas the Vättern Conservation Association considers the lake to be in relatively good condition (Vätternvårdsförbundet, n.d.), environmental organisations such as Aktionsgruppen Rädda Vättern identify multiple serious threats, including military activities, mining, industrial pollution and gas exploration (Aktionsgruppen Rädda Vättern, n.d.). These contrasting interpretations make Lake Vättern a particularly appropriate case for examining how environmental defenders understand knowledge, uncertainty and learning in freshwater governance.

Participants and sampling

This study focuses exclusively on environmental defenders actively engaged in protecting Lake Vättern. Participants were selected through purposive sampling because they possess extensive experience of environmental advocacy and long-term engagement with freshwater governance through non-governmental organisations and local environmental associations. Rather than seeking to compare multiple stakeholder perspectives, the study aimed to develop an in-depth understanding of how environmental defenders conceptualise knowledge, uncertainty and learning in relation to freshwater governance.

Twelve respondents participated in the study, ranging in age from 35 to 70 years, including five men and seven women. All respondents were affiliated with organisations working to protect the ecological health of Lake Vättern, although these organisations differed in their specific priorities and activities. Respondents' characteristics are presented in Table 1.

Table 1. Characteristics of interview respondents.

Respondent	Age	Gender	Organizational affiliation
R1	67	Female	NGO
R2	70	Male	NGO
R3	55	Female	NGO
R4	45	Female	NGO
R5	45	Female	NGO
R6	56	Female	NGO/ Academia
R7	67	Female	NGO
R8	65	Male	NGO
R9	55	Male	NGO
R10	40	Female	Self-employed
R11	65	Male	Cooperative body
R12	35	Male	NGO

Transition lab and participant recruitment

Nine respondents had previously participated in a transition lab concerning Lake Vättern held in November 2024. The transition lab formed part of a broader research project examining rights of nature as an emerging framework for environmental governance in Sweden. It involved structured discussions concerning freshwater governance and rights of nature and was open to individuals who identified themselves as environmental defenders of Lake Vättern. Following the transition lab, participants were invited to participate in individual semi-structured interviews, of whom nine agreed. Three additional respondents were subsequently recruited through snowball sampling and direct contact with individuals active in organisations working to protect Lake Vättern.

Although many respondents had prior knowledge of rights of nature through the transition lab, the interviews explored freshwater governance more broadly.

Data collection

The empirical material consists primarily of semi-structured interviews, complemented by documentary material including organisational websites, reports and public statements. These documents were used to provide contextual information regarding organisational activities and governance processes and to support triangulation of the interview material. Semi-structured interviews were selected because they allow participants to describe their experiences and interpretations in their own words while ensuring that common themes are explored across interviews (Bryman, 2016; Kvale & Brinkmann, 2015). Interviews were conducted online between December 2024 and June 2025 and lasted approximately 50 minutes on average. Before each interview, participants received written information about the study, the interview questions and an informed consent form. Where written consent could not be returned electronically, verbal informed consent was recorded at the beginning of the interview. All interviews were recorded, transcribed and anonymised before analysis.

The study adhered to established ethical principles for qualitative research and was approved by the Swedish Ethical Review Authority (*Etikprövningsmyndigheten*) on 5 September 2024 (case no. 2024-03410-01).

Data analysis

The interview material was analysed using thematic analysis (Braun & Clarke, 2006). Analysis began with repeated reading of the transcripts to achieve familiarity with the material. Initial codes and themes were developed iteratively from participants' accounts through constant comparison across interviews. Once the themes had been established, the theoretical framework was used to interpret the findings, rather than to guide the initial coding process.

Methodological considerations

This study deliberately focuses on environmental defenders and therefore does not seek to represent the perspectives of all actors involved in the governance of Lake Vättern. The objective was not to compare stakeholder groups but to develop an in-depth understanding of how environmental defenders understood and responded to the challenges facing Lake Vättern. Consequently, the findings should be understood as representing the perspectives of this actor group rather than the broader governance system. Future research could build on these findings by examining how understandings differ among public authorities, industry representatives, local residents and other stakeholders involved in freshwater governance.

Results

The analysis identified three interrelated themes describing how environmental defenders understand freshwater governance in relation to knowledge, uncertainty and learning. Although presented

separately, these themes are closely connected. Together they illustrate how respondents linked scientific knowledge, contested interpretations of environmental change and governance responses in their efforts to protect Lake Vättern. The findings suggest that environmental defenders understand freshwater governance not simply as a technical challenge of generating more information, but as a broader question of how knowledge is interpreted, communicated and translated into action under conditions of uncertainty and slow-moving environmental change.

Epistemic uncertainty: knowledge deficits, evidence use and demands for 'knowledge-based' governance

Across the interviews, environmental defenders consistently described freshwater governance as depending on the production, interpretation and use of knowledge. Scientific evidence was widely regarded as essential for protecting Lake Vättern; however, respondents generally did not portray governance challenges primarily as resulting from an absence of knowledge. Instead, they argued that existing knowledge was often insufficiently utilised, unevenly communicated, or inadequately translated into political and administrative decision-making. At the same time, several respondents also identified the need for continued monitoring and independent research to strengthen the evidence base for long-term freshwater governance.

A dominant theme was the expectation that governance should be grounded in facts, scientific research and systematic monitoring. Respondents repeatedly articulated 'knowledge-based' decision-making as both a normative ideal and a practical necessity for protecting the lake. Respondent 5 stated that 'it's very important to start from facts, that it's knowledge-based and that the facts and goals are anchored', while Respondent 1 argued that decision-makers should follow scientific recommendations: 'if science and the research that SLU (Swedish University of Agricultural Sciences, authors' note) and others are doing recommend something, then I think we should follow it'.

However, respondents did not portray the challenge primarily as a lack of information. Instead, epistemic uncertainty was often described as persisting because existing knowledge is insufficiently used, unevenly accessed, or not translated into protective action. Respondent 2 suggested that municipal politicians' engagement with already available material is limited, arguing that 'if more municipal politicians got involved and read, for example, the annual reports of the Lake Vättern Conservation Association, we would gain a great, great deal from it'. In these accounts, the barrier is partly institutional and organisational: knowledge exists but does not reliably shape decision-making. Although several respondents advocated continued monitoring and independent research, they generally emphasised that existing scientific knowledge already provided a sufficient basis for stronger governance action if it were more effectively communicated, interpreted and applied. Calls for additional research were therefore primarily directed at strengthening long-term understanding of cumulative environmental impacts rather than addressing a complete absence of knowledge. Respondent 7 proposed that 'one should create some kind of research station... it needs to be research, not based on opinions or trial and error' and Respondent 6 called for 'a broad, deep, and purely thorough investigation... free from financial interests'. Respondent 11 similarly highlighted that fragmented knowledge and short-term thinking make it difficult to understand cumulative effects, including climate change, suggesting that epistemic uncertainty is exacerbated when monitoring and assessment remain sectoral or project-specific rather than integrative.

Respondents' accounts foreground epistemic uncertainty as a governance problem: uncertainties remain not only because of scientific gaps, but because the production and uptake of knowledge are seen as constrained by institutional priorities, time horizons and the distribution of attention across scales.

Ambiguity: contested interpretations, credibility disputes, slow violence and the problem of 'what is true?'

The respondents also described freshwater governance as characterised by ambiguity, in which multiple and often competing interpretations of Lake Vättern's ecological condition coexist. They repeatedly highlighted that disagreements persisted despite the availability of scientific information, reflecting differences in how environmental risks were interpreted, communicated and prioritised. In their accounts,

ambiguity emerged not only from uncertainty about ecological processes but also from competing claims regarding whose knowledge should be regarded as credible and authoritative.

Alongside calls for more and better knowledge, respondents described ambiguity – situations in which multiple plausible interpretations of Lake Vättern's condition coexist and are difficult to reconcile through more data alone. One expression of ambiguity concerned perceived differences in how authorities and organisations describe the lake's health. Respondent 10 argued that risk perceptions vary with governance level and proximity:

'if you go down to the county administrative boards and municipal level, they see pollutants from old paper mills and PFAS from the airfield and firing range. Higher up, like the Environmental Protection Agency, they don't perceive the lake as being in such a bad condition'.

They added that decision-makers in Stockholm 'are so far removed from reality. They would need to be much closer to it'. This suggests that differences in interpretation are linked to where knowledge is produced and what is rendered visible within different institutional and geographic vantage points.

Ambiguity was also described as a problem of public interpretation and credibility, particularly in relation to risk communication. Several respondents portrayed the lake as affected by threats that are difficult to observe directly and therefore easy either to exaggerate or to downplay. Respondent 2 captured this tension by noting that 'Lake Vättern looks so clear, and people are proud of that... it's tricky because the visible clarity hides what's really happening'. Respondent 4 similarly emphasised that invisible pollutants complicate mobilisation and understanding: 'PFAS is invisible, so it's not as obvious that we need to do something about it... You have to know and understand what it means in the body, and so on'. In this context, actors must rely on mediated forms of expertise rather than sensory cues, which can intensify disagreement about urgency and appropriate responses.

Some respondents also suggested that ambiguity is amplified by strategic or affective framing. Respondent 2 argued that 'there are strong interests that don't want to see or understand, but benefit from exploiting the lake', whereas Respondent 5 noted that 'sometimes there are groups that want to push certain issues that aren't actually about Lake Vättern itself, but that use Vättern and rely heavily on emotions'. These statements do not merely point to misinformation; they reflect a broader interpretive struggle over what constitutes a legitimate problem definition and which claims should guide action.

For several respondents, ambiguity therefore appeared as an everyday governance condition. Respondent 9, speaking from the perspective of a resident, expressed uncertainty about how to assess competing narratives: 'As a regular resident... what is true? It can easily become alarmist... or authorities can ignore various threats'. This illustrates how ambiguity is experienced not only institutionally but also socially, as uncertainty about credibility and interpretation. In this way, ambiguity not only shapes how Lake Vättern's condition is interpreted but also influences how actors learn about environmental problems and what kinds of responses become possible.

Learning dynamics: incremental responses, constraints on deeper learning, contested pathways to action and the rights of nature

The interviews further explored how the environmental defenders perceived governance responses to these challenges. Across the material, respondents generally advocated improvements within existing governance arrangements through stronger implementation, better knowledge exchange, enhanced monitoring and more effective collaboration. At the same time, many also recognised institutional and political constraints that limited opportunities for more fundamental forms of learning and governance change. Their accounts therefore illustrate both support for incremental improvements and frustration with the limited capacity of existing governance systems to respond to cumulative and long-term environmental risks.

When respondents discussed how lake protection could be strengthened, their proposals frequently aligned with incremental reforms – consistent with single-loop learning. They called for better monitoring, stronger use of existing documentation, clearer implementation routines and more systematic investigations. The recurring demand for independent research capacity (e.g. Respondent 7's 'research station')

and for improved political engagement with available reports (Respondent 2) exemplifies performance-oriented adjustments within existing governance frameworks.

At the same time, respondents highlighted limits to incrementalism and gestured towards the need for more integrative and reflective learning. Several emphasised that knowledge must be holistic and cumulative, addressing interacting stressors rather than isolated problems. Respondent 11 argued that 'we need to find a way to increase collaboration among us and not think so short-term', indicating that learning requires coordination across organisations and time horizons. This insistence on cumulative understanding also emerged in critiques of how environmental impacts are assessed and acted upon, particularly when processes are experienced as too slow to match environmental dynamics.

Respondents also invoked 'common sense' as a way to express frustration with rigid decision routines and delayed intervention. Respondent 8 argued that 'authorities have to follow regulations and cannot apply private judgement – if common sense were allowed, people would understand you cannot act this way' and added that 'Revising the law takes two years, by which time the water may already be polluted'. Respondent 10 likewise emphasised the perceived obviousness of harm from pollutant loads: 'you just can't... if it's twenty-three thousand litres per hour of leachate going into Vättern, it's bound to affect the lake negatively'. While framed as 'common sense', these claims effectively call for precautionary judgement under uncertainty, rather than procedural delay.

Learning constraints were also described in relation to institutions responsible for interpretation and enforcement of rules. Some respondents expressed confidence in the adequacy of current legislation if applied. Respondent 5 stated that 'I think the existing systems mostly work quite well. Our environmental legislation is actually pretty good' and preferred updating existing laws to creating new ones: 'we already have the legislation. It's better to keep the current rather than replace it entirely'. Respondent 1 similarly argued that 'just following the existing laws could get us part of the way there'. Respondent 12 described local monitoring arrangements as supportive for engagement and questioning: 'it feels very reassuring to have the Lake Vättern Conservation Association as a channel for these issues... they're based locally'. Likewise, the respondents did not consider it necessary to introduce entirely new legal frameworks, such as the rights of nature. While some acknowledged the potential benefits of granting rights to nature, they also expressed doubts about its feasibility in Sweden. For instance, Respondent 3 remarked that 'I wonder if Sweden could even propose such an idea, that would be wonderful', whereas Respondent 6 said that 'I don't want to dismiss the rights of nature, but I don't think society is ready for it'.

Instead, other respondents stressed that the core challenge lies in interpretation, enforcement and institutional capacity. Respondent 2 argued that the issue is less about formal rules than about 'knowledge, insight, and political will', calling for improved legal interpretation: 'we need legislation to be interpreted better. Courts and governments shouldn't decide against the law... Decisions are made as if regulations don't exist'. Respondent 4 similarly maintained that 'the legislation itself isn't wrong; the problem is how it's interpreted and applied by courts', adding that 'cumulative impacts must consider scientific assessments'. Respondent 6 emphasised enforcement gaps – 'the requirements would be much higher if one followed what is written' – and pointed to constraints in judicial work: 'judges have very little time to familiarise themselves. Their opinion carries weight while technical advisors are secondary'. Respondent 8 connected these challenges to temporal mismatch between science and regulation: 'by the time knowledge is incorporated into regulations, so much time has passed that action is needed before rules are updated', concluding that 'the legal path lags behind'.

Finally, several respondents framed the prospects for change in terms of political incentives and public pressure. Respondent 1 characterised politics as oriented towards feasibility and votes rather than knowledge: 'how many votes can I get... pandering... to get votes from people who don't have knowledge about this', and argued that politicians act reactively. Respondent 4 stated that change 'won't happen by itself' and requires 'lots of environmental defenders', while Respondent 8 argued that 'It has to be ordinary people who protest in order to achieve change'. Respondent 3 summarised this perceived hierarchy of priorities by stating that 'the economy is always considered more important than humans and nature'. These accounts suggest that respondents perceive learning and adaptation to be constrained not only by technical and procedural factors but also by political time horizons and incentive structures.

Discussion

This study set out to examine how environmental defenders engaged in the preservation of Lake Vättern conceptualise freshwater governance in relation to knowledge, uncertainty and learning. The findings confirm that governance of Lake Vättern exemplifies many of the characteristics of ‘wicked’ environmental problems: contested problem framings, multiple and interacting stressors, long temporal horizons and the absence of clear or final solutions (Freeman, 2000; Head & Alford, 2015; Howard et al., 2024). From the perspective of the respondents, these governance challenges arise through the interaction of epistemic uncertainty, competing interpretations of environmental risk, constrained learning processes, institutional arrangements, political priorities and the slow and often invisible character of environmental degradation (Nixon, 2011). The findings suggest that respondents understand these challenges to reflect not a lack of scientific knowledge but rather how knowledge is recognised, interpreted and mobilised within governance processes.

Knowledge-based governance and persistent epistemic uncertainty

Across interviews, respondents consistently articulated a strong normative commitment to knowledge-based governance, echoing broader assumptions in freshwater management that decisions should be grounded in scientific evidence and expert assessments (Dudgeon et al., 2006; Reid et al., 2019; Vörösmarty et al., 2010). This expectation aligns with research highlighting the central role of knowledge in governing complex water systems under conditions of climate change (IPCC, 2019, 2021, 2022) and underscores how epistemic authority determines which knowledge claims are recognised as legitimate and influential in shaping governance responses. However, respondents did not primarily frame uncertainty as a lack of data. Instead, epistemic uncertainty was understood as emerging from fragmented knowledge production, uneven access to existing evidence, and weak translation of scientific insights into policy and legal practice.

Moreover, rather than arguing that stronger governance depends on generating substantially more scientific knowledge, respondents viewed continued monitoring and independent research as important for improving long-term understanding of cumulative environmental change and maintaining the credibility and independence of environmental evidence. In this sense, additional research was understood as complementing rather than delaying governance action. This finding resonates with earlier research showing that uncertainty in water governance often persists despite extensive monitoring and assessment because information is not effectively integrated across sectors, scales and decision arenas (Brugnach et al., 2011; Warmink et al., 2017).

Ambiguity, contested interpretations and slow violence

Beyond epistemic uncertainty, the results strongly highlight ambiguity as a central governance challenge. The respondents described multiple, coexisting interpretations of Lake Vättern’s ecological condition, shaped by institutional position, geographic proximity and long-term engagement with protecting the lake. These findings align with theoretical accounts of ambiguity as a form of uncertainty rooted in divergent meanings and problem framings rather than incomplete information (Brugnach et al., 2008, 2011; Warmink et al., 2017).

Ambiguity was particularly pronounced in relation to invisible or slow-moving threats, such as PFAS contamination and cumulative climate impacts. The lake’s apparent visual clarity complicates risk perception and public understanding, reinforcing what Nixon (2011) conceptualises as slow violence: environmental harm that unfolds gradually, remains difficult to perceive and is therefore politically and socially marginalised. Scholarship supports this observation: slow violence poses a particular challenge for governance systems (O’Lear, 2016; Dehm, 2020), and managing uncertainty in relation to slow violence represents an additional obstacle for freshwater management. Similar dynamics have been identified in other contexts of freshwater governance, where diffuse pollution and long-term degradation struggle to compete with more immediate or visible concerns (Bendz & Boholm, 2019).

Respondents' accounts also suggest that ambiguity is intensified by strategic framing and competing interests, echoing findings from research on contested water governance and transboundary risk (Barnes & Alatout, 2012; Linneroth-Bayer et al., 2001). Disagreements over 'what is true' cannot be resolved through better data alone, because they are embedded in different interpretations of evidence, values and priorities. This reinforces the argument that ambiguity requires governance responses that go beyond technical expertise and incorporate dialogue, deliberation and reflexive learning (Brugnach et al., 2011; Lund, 2015).

Learning dynamics, the rights of nature and the limits of incremental adaptation

The results further indicate that governance responses at Lake Vättern are widely perceived to be dominated by incremental, single-loop learning. Alternative governance models, such as those based on rights of nature (Epstein & Andersen, 2024), were dismissed based on perceived incompatibility with Swedish legislation and norms. Interestingly, the limited support for rights of nature among the respondents suggests that even actors advocating stronger environmental protection frequently prioritise improving existing governance arrangements over introducing fundamentally new institutional models.

Calls for improved monitoring, clearer procedures, better enforcement of existing legislation and stronger use of available reports reflect efforts to adjust performance within established governance structures (Argyris & Schön, 1978; Pahl-Wostl, 2009). Such responses are consistent with prevailing approaches in freshwater management, where uncertainty is often treated as something to be reduced through technical refinement and administrative control (Pahl-Wostl et al., 2011).

At the same time, respondents repeatedly pointed to the limits of incrementalism. Fragmentation across institutions, slow legal and administrative processes, and difficulties in addressing cumulative impacts constrain the capacity for double-loop learning, where underlying assumptions and problem framings are questioned. These constraints mirror findings from broader research on water governance, which shows that institutional complexity and sectoral boundaries often inhibit deeper forms of learning and adaptation (Huitema et al., 2009; Prutzer et al., 2021).

Climate change further intensifies these challenges. As Rockström et al. (2009) argue, social-ecological systems are increasingly characterised by non-linear dynamics and surprise, conditions under which incremental adjustments may be insufficient. Respondents' frustration with regulatory time lags and their invocation of 'common sense' can be interpreted as a call for more precautionary and anticipatory governance, capable of acting under uncertainty rather than waiting for definitive proof. This aligns with calls for multi-level governance arrangements that integrate diverse knowledge forms and enable learning across scales (Boyd & Folke, 2012; Dunn et al., 2015; Lidskog et al., 2010).

Wicked problems, participation and contested authority

Analysed collectively, the findings reinforce the conceptualisation of Lake Vättern as a wicked governance problem (Freeman, 2000; Head & Alford, 2015). The respondents did not converge on a single diagnosis or solution; instead, they articulated overlapping and sometimes conflicting expectations regarding expertise, participation and responsibility. While participatory institutions such as water conservation associations are intended to facilitate collaboration and knowledge exchange under the EU Water Framework Directive (Vattenmyndigheterna, 2025; Vätternvårdsförbundet, 2025), the respondents nevertheless perceived these participatory arrangements as simultaneously enabling and constraining learning, particularly when economic interests are involved.

The persistence of conflict around military activities, planned mining and land-use pressures (Aktionsgruppen Rädda Vättern, 2025; Försvarmakten, 2025; Länsstyrelsen i Jönköpings län, 2025b; Länsstyrelsen Östergötland, 2025; Svenska Naturskyddsföreningen, 2024; Urbergsggruppen, 2025) further illustrates how water governance is embedded in broader socio-political struggles. These dynamics reflect longstanding observations that water management is inherently political and shaped by competing worldviews and interests (Bakker, 2012; Johnston & Fiske, 2014).

Implications for freshwater governance

The findings suggest several practical implications for freshwater governance. First, improving governance requires more than generating additional scientific knowledge. From the perspectives of environmental defenders at Lake Vättern, the primary challenge is ensuring that existing knowledge is recognised, interpreted and translated into political and administrative decision-making.

Second, the findings highlight the importance of collaborative learning across governance levels and stakeholder groups. Because uncertainty often reflects competing interpretations of environmental risks rather than a lack of information, governance arrangements should create opportunities for dialogue between public authorities, scientists and civil society organisations to support shared understanding and more legitimate decision-making.

Third, strengthening freshwater governance requires institutional capacities to learn from ambiguity, cumulative impacts and long-term environmental change. This reinforces calls for governance approaches that integrate diverse forms of expertise and foster collaboration across disciplines and governance scales (Boyd & Folke, 2012; Huitema et al., 2009; Lund, 2015; Nixon, 2011).

Finally, the study highlights the important role environmental defenders can play in freshwater governance. Beyond advocating for environmental protection, the environmental defenders at lake Vättern contribute local ecological knowledge, draw attention to slow-moving and cumulative environmental change and challenge dominant interpretations of environmental risks. More systematic engagement with environmental defenders may therefore strengthen adaptive freshwater governance by broadening participation, improving recognition of emerging environmental threats and supporting more precautionary approaches to freshwater protection.

In this vein, future research could compare the perspectives of environmental defenders with those of public authorities, industry representatives and other stakeholder groups to develop a more comprehensive understanding of how different actors conceptualise knowledge, uncertainty and learning in freshwater governance. Future work should also examine legal innovations such as rights of nature through the lens of triple-loop learning, particularly to assess whether and how such frameworks emerge through processes in which underlying governance assumptions are fundamentally questioned and transformed. This is especially relevant where governance change is triggered by acute environmental crises rather than gradual or invisible forms of harm. For example, severe eutrophication in Spain's Mar Menor culminated in a mass fish die-off in 2021 (United Nations Environment Programme, 2025), catalysing governance debates and institutional reflection. Although stakeholders expressed divergent knowledge claims, they converged in recognising the inadequacy of existing governance arrangements (Cabello & Brugnach, 2023), indicating consensus at the level of triple-loop learning (Warmink et al., 2017). Future research should therefore also explore how transformative governance processes interact with trust in environmental institutions and how shifts in epistemic authority and institutional legitimacy shape pathways for addressing complex freshwater governance challenges.

Conclusion

This study examined how environmental defenders engaged in protecting Lake Vättern understand knowledge, uncertainty and learning in freshwater governance. The findings demonstrate that the environmental defenders understand governance challenges as arising less from insufficient scientific knowledge than from how knowledge is recognised, interpreted and mobilised within governance processes. Rather than identifying a single governance deficit, respondents highlighted the interaction of epistemic uncertainty, competing interpretations of environmental risk, constrained institutional learning and the slow and often invisible nature of environmental degradation.

By foregrounding the perspectives of environmental defenders, this study contributes to freshwater governance scholarship by demonstrating how civil society actors engaged in long-term environmental protection conceptualise governance under conditions of uncertainty. More broadly, the findings suggest that addressing increasingly complex freshwater challenges will require not only robust scientific knowledge but also governance institutions capable of recognising diverse forms of knowledge, supporting learning and responding adaptively to long-term environmental change.

Acknowledgments

This work was supported by FORMAS, the Swedish Government Research Council for Sustainable Development, project number 2022–02102.

Ethics approval

This interview study was approved by the Swedish Ethical Review Authority (Etikprövningsmyndigheten) on 5 September 2024 (case no. 2024-03410-01). The approval was granted for the broader research project 2022–02102, *Vatten åt alla varelser: Naturens rättigheter som ekosystemförvaltningsinnovation*, of which this study forms a part.

Author contributions

CRedit: **Mariam Carlsson Kanyama**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft; **Åsa Nilsson Dahlström**: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Writing – review & editing.

Declaration of generative AI use

During the preparation of this manuscript the authors used ChatGPT to check language and grammar in the original text written by us. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by FORMAS, the Swedish Government Research Council for Sustainable Development, project number 2022–02102, full official project name *Vatten åt alla varelser. Naturens rättigheter som ekosystemförvaltningsinnovation*.

About the authors

Mariam Carlsson Kanyama (LLM) is a PhD candidate at Chalmers University of Technology, Sweden. Her research explores biodiversity protection, environmental human rights defense and ecological restoration through Earth jurisprudence.

Åsa Nilsson Dahlström is a Senior Lecturer in Global Studies at the School of Education and Communication, Jönköping University. She has a PhD in Cultural Anthropology from Uppsala University and has previously worked at Linköping University. Her research has focused on the interplay between indigenous peoples' rights, traditional knowledge and sustainable development, especially in Sweden and Aotearoa New Zealand. Her current research focuses on social aspects of the transition towards a fossil-free society and on Rights of Nature as an innovative approach to environmental conservation of freshwater bodies and the impact of the EU Critical Raw Materials Act on Swedish mining policy and practice. She is active in the Sustainable Societies (SUS) research group at Jönköping University and has published several scientific articles on sustainability issues, indigenous studies and education.

ORCID

Mariam Carlsson Kanyama  <http://orcid.org/0009-0008-2813-1607>
Åsa Nilsson Dahlström  <http://orcid.org/0009-0003-1049-6353>

Data availability statement

Interview transcripts supporting the findings of this study are available from the corresponding author upon reasonable request. The transcripts are in Swedish.

References

- Ahopelto, L., Sojamo, S., Belinskij, A., Soininen, N., & Keskinen, M. (2024). Water governance for water security: Analysing institutional strengths and challenges in Finland. *International Journal of Water Resources Development*, 40(2), 153–173. <https://doi.org/10.1080/07900627.2023.2266733>
- Aktionsgruppen Rädda Vättern. (2025). *Om ARV*. <https://www.aktionraddavattern.se/om-arv/>
- Aktionsgruppen Rädda Vättern. (n.d.). *Rädda Vättern*. <https://www.aktionraddavattern.se/>
- Argyris, C., & Schön, D. A. (1978). *Organizational learning: A theory of action perspective*. Addison-Wesley.
- Bakker, K. (2012). Water security: Research challenges and opportunities. *Science (New York, N.Y.)*, 337(6097), 914–915. <https://doi.org/10.1126/science.1226337>
- Barnes, J., & Alatout, S. (2012). Water worlds: Introduction to the special issue of *Social Studies of Science*. *Social Studies of Science*, 42(4), 483–488. <https://doi.org/10.1177/0306312712448524>
- Bendz, A., & Boholm, Å. (2019). Drinking water risk management: Local government collaboration in West Sweden. *Journal of Risk Research*, 22(6), 674–691. <https://doi.org/10.1080/13669877.2018.1485168>
- Boyd, E., & Folke, C. (Eds.) (2012). *Adapting institutions: Governance, complexity and social-ecological resilience*. Cambridge University Press.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Brugnach, M., Dewulf, A., Henriksen, H. J., & van der Keur, P. (2011). More is not always better: Coping with ambiguity in natural resources management. *Journal of Environmental Management*, 92(1), 78–84. <https://doi.org/10.1016/j.jenvman.2010.08.029>
- Brugnach, M., Dewulf, A., Pahl-Wostl, C., & Taillieu, T. (2008). Toward a relational concept of uncertainty: About knowing too little, knowing too differently, and accepting not to know. *Ecology and Society*, 13(2), 30. <https://doi.org/10.5751/ES-02616-130230>
- Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.
- Cabello, V. (2024). Tales on co-response-ability in times of environmental polarization. *Ecology and Society*, 29(4), 22. <https://doi.org/10.5751/ES-15662-290422>
- Cabello, V., & Brugnach, M. (2023). Whose waters, whose nutrients? Knowledge, uncertainty, and controversy over eutrophication in the Mar Menor. *Ambio*, 52(6), 1112–1124. <https://doi.org/10.1007/s13280-023-01846-z>
- Chambers, J. M., Wyborn, C., Ryan, M. E., Reid, R. S., Riechers, M., Serban, A., Bennett, N. J., Cvitanovic, C., Fernández-Giménez, M. E., Galvin, K. A., Goldstein, B. E., Klenk, N. L., Tengö, M., Brennan, R., Cockburn, J. J., Hill, R., Munera, C., Nel, J. L., Österblom, H., ... Pickering, T. (2021). Six modes of co-production for sustainability. *Nature Sustainability*, 4(11), 983–996. <https://doi.org/10.1038/s41893-021-00755-x>
- Dehm, J. (2020). Climate change, 'slow violence' and the indefinite deferral of responsibility for 'loss and damage'. *Griffith Law Review*, 29(2), 220–252. <https://doi.org/10.1080/10383441.2020.1790101>
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. (2000). Official Journal of the European Communities, L327. 1–73. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060>
- Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z.-I., Knowler, D. J., Lévêque, C., Naiman, R. J., Prieur-Richard, A.-H., Soto, D., Stiassny, M. L. J., & Sullivan, C. A. (2006). Freshwater biodiversity: Importance, threats, status and conservation challenges. *Biological Reviews of the Cambridge Philosophical Society*, 81(2), 163–182. <https://doi.org/10.1017/S1464793105006950>
- Dunn, G., Harris, L., & Bakker, K. (2015). Microbial risk governance: Challenges and opportunities in fresh water management in Canada. *Canadian Water Resources Journal / Revue Canadienne Des Ressources Hydriques*, 40(3), 237–249. <https://doi.org/10.1080/07011784.2015.1040457>
- Epstein, S., & Andersen, A. (2024). Contemplating rights of nature in Sweden: Democratic legitimacy, conflict, and centralization of power. *Nordisk Miljörättslig Tidskrift*, 29–46.
- Epstein, Y., López-Bao, J. V., & Bruskotter, J. (2024). Most EU residents support rights of nature laws. *Nordisk Miljörättslig Tidskrift*, 2024, 123–135.
- Försvarsmakten. (2025). *Om verksamheten vid Vättern*. <https://www.forsvarsmakten.se/sv/var-verksamhet/ett-hallbart-forsvar/ett-hallbart-forsvar-ovning-och-insats/om-verksamheten-vid-vattern/>
- Freeman, D. M. (2000). Wicked water problems: sociology and local water organizations in addressing water resources policy. *JAWRA Journal of the American Water Resources Association*, 36(3), 483–491. <https://doi.org/10.1111/j.1752-1688.2000.tb04280.x>
- Global Witness. (2025). *Roots of resistance: Documenting the global struggles of defenders protecting land and environmental rights*. https://gw.hacdn.io/media/documents/Defenders_Annual_Report_2025_online_EN.pdf
- Hargrove, R. (2002). *Masterful coaching* (Rev. ed.). Jossey-Bass.
- Head, B. W., & Alford, J. (2015). Wicked problems: Implications for public policy and management. *Administration & Society*, 47(6), 711–739. <https://doi.org/10.1177/0095399713481601>
- Hommes, S., Vinke-de Kruijf, J., Otter, H. S., & Bouma, G. (2009). Knowledge and perceptions in participatory policy processes: Lessons from the delta region in the Netherlands. *Water Resources Management*, 23(8), 1641–1663. <https://doi.org/10.1007/s11269-008-9356-x>

- Howard, B. C., Buytaert, W., Krause, S., & Hannah, D. M. (2024). Connecting global water agendas: From wicked problematization to opportunities for action. *Perspectives of Earth and Space Scientists*, 5(1), e2024CN000248. <https://doi.org/10.1029/2024CN000248>
- Huitema, D., Mostert, E., Egas, W., Moellenkamp, S., Pahl-Wostl, C., & Yalcin, R. (2009). Adaptive water governance: Assessing the institutional prescriptions of adaptive (co)management from a governance perspective and defining a research agenda. *Ecology and Society*, 14(1), 26. <https://doi.org/10.5751/ES-02827-140126>
- Intergovernmental Panel on Climate Change. (2019). *Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. <https://www.ipcc.ch/srccl/>
- Intergovernmental Panel on Climate Change. (2021). *Climate change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- International Rights of Nature Tribunal. (2019). *Vättern case*. <https://www.rightsofnaturetribunal.org/cases/vattern-case>
- Johnston, B. R., & Fiske, S. J. (2014). *Water, cultural diversity, and global environmental change: Emerging trends, sustainable futures?* Springer.
- Koppenjan, J. F. M., & Klijn, E. H. (2004). *Managing uncertainty in networks: A network approach to problem solving and decision making*. Routledge.
- Krause, F., & Strang, V. (2016). Thinking relationships through water. *Society & Natural Resources*, 29(6), 633–638. <https://doi.org/10.1080/08941920.2016.1151714>
- Kvale, S., & Brinkmann, S. (2015). *InterViews: Learning the craft of qualitative research interviewing* (3rd ed.). SAGE Publications. <https://www.sagepub.com/shop/buy-a-book/interviews-3-239402>
- Länsstyrelsen i Jönköpings län. (2025b). *Yttrande angående ansökan om bearbetningskoncession för området Norra Kärr K nr 2 i Jönköpings kommun*. Jönköpings län (Diariern 8465-2025). [https://www.lansstyrelsen.se/download/18.87303cb19f387b02522f880/1783672739437/Yttrande%20ang%C3%A5ende%20ans%C3%B6kan%20om%20bearbetningskoncession%20till%20Bergsstaten\(8465-2025-5\).pdf](https://www.lansstyrelsen.se/download/18.87303cb19f387b02522f880/1783672739437/Yttrande%20ang%C3%A5ende%20ans%C3%B6kan%20om%20bearbetningskoncession%20till%20Bergsstaten(8465-2025-5).pdf)
- Länsstyrelsen Östergötland. (2025). *Yttrande angående ansökan om bearbetningskoncession för området Norra Kärr K nr 2 i Jönköpings och Ödeshögs kommuner*. Diarienummer 167062025. <https://www.lansstyrelsen.se/download/18.119a35791975d52ae204a879/1750233417177/543-5881-2025%20Yttrande%20till%20Bergsstaten%20250617.pdf>
- Larsson, O., Josefsson, S., & Norrlin, J. (2025). *Förorenade sediment i Vättern (Contaminated sediments in Lake Vättern)* (SGU-rapport 2025:06). Sveriges geologiska undersökning. <https://resource.sgu.se/dokument/publikation/sgurapport/sgurapport202506rapport/s2506-rapport.pdf>
- Lepenies, R., Hüesker, F., Beck, S., & Brugnach, M. (2018). Discovering the political implications of coproduction in water governance. *Water*, 10(10), 1475. <https://doi.org/10.3390/w10101475>
- Lidskog, R., Soneryd, L., & Ugglå, Y. (2010). *Transboundary risk governance*. Earthscan.
- Linneroth-Bayer, J., Löfstedt, R., & Sjöstedt, G. (2001). *Transboundary risk management*. Earthscan.
- Linton, J., & Budds, J. (2014). The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water. *Geoforum*, 57, 170–180. <https://doi.org/10.1016/j.geoforum.2013.10.008>
- Lund, J. R. (2015). Integrating social and physical sciences in water management. *Water Resources Research*, 51(8), 5905–5918. <https://doi.org/10.1002/2015WR017125>
- Macpherson, E. (2021). The (human) rights of nature: A comparative study of emerging legal rights for rivers and lakes in the United States of America and Mexico. *Duke Environmental Law & Policy Forum*, 31(2), 327–377.
- Martinez-Alier, J., Temper, L., Del Bene, D., & Scheidel, A. (2016). Is there a global environmental justice movement? *The Journal of Peasant Studies*, 43(3), 731–755. <https://doi.org/10.1080/03066150.2016.1141198>
- Moutrie, M. (2021). The rights of nature movement in the United States: Community organizing, local legislation, court challenges, possible lessons and pathways. *Environmental and Earth Law Journal*, 10 (1), 2.
- Naturskyddsföreningen, S. (2024). *Skydda det som inte får försvinna – Stoppa gruvan vid Norra Kärr*. <https://www.naturskyddsforeningen.se/artiklar/skydda-det-som-inte-far-forsvinna-stoppa-gruvan-vid-norra-karr/>
- Nixon, R. (2011). *Slow violence and the environmentalism of the poor*. Harvard University Press.
- O’Lear, S. (2016). Climate science and slow violence: A view from political geography and STS on mobilizing technoscientific ontologies of climate change. *Political Geography*, 52, 4–13. <https://doi.org/10.1016/j.polgeo.2015.01.004>
- Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, 19(3), 354–365. <https://doi.org/10.1016/j.gloenvcha.2009.06.001>
- Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D., & Taillieu, T. (2007). Social learning and water resources management. *Ecology and Society*, 12(2), 5. <https://doi.org/10.5751/ES-02037-120205>
- Pahl-Wostl, C., Jeffrey, P., Isendahl, N., & Brugnach, M. (2011). Maturing the new water management paradigm: Progressing from aspiration to practice. *Water Resources Management*, 25(3), 837–856. <https://doi.org/10.1007/s11269-010-9729-2>
- Prutzer, M., Morf, A., & Nolbrant, P. (2021). Social learning: Methods matter but facilitation and supportive contexts are key – Insights from water governance in Sweden. *Water*, 13(17), 2335. <https://doi.org/10.3390/w13172335>

- Reid, A. J., Carlson, A. K., Creed, I. F., Eliason, E. J., Gell, P. A., Johnson, P. T. J., Kidd, K. A., MacCormack, T. J., Olden, J. D., Ormerod, S. J., Smol, J. P., Taylor, W. W., Tockner, K., Vermaire, J. C., Dudgeon, D., & Cooke, S. J. (2019). Emerging threats and persistent conservation challenges for freshwater biodiversity. *Biological Reviews of the Cambridge Philosophical Society*, 94(3), 849–873. <https://doi.org/10.1111/brv.12480>
- Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., ... Foley, J. A. (2009). A safe operating space for humanity. *Nature*, 461(7263), 472–475. <https://doi.org/10.1038/461472a>
- Swedish Government. (2026, June 27). *Regeringen beslutar att fyndigheten i Norra Kärr får undersökas vidare* [Press release]. Regeringen. <https://www.regeringen.se/pressmeddelanden/2026/06/regeringen-beslutar-att-fyndigheten-i-norra-karr-far-undersokas-vidare/>
- Tănăsescu, M. (2021). The rights of nature as politics. In D. P. Corrigan & M. Oksanen (Eds.), *Rights of nature: A re-examination* (pp. 69–84). Routledge.
- United Nations Environment Programme. (2025, September 9). *How Spain is turning an iconic lagoon from “green soup” into a natural oasis* <https://www.unep.org/news-and-stories/story/how-spain-turning-iconic-lagoon-green-soup-natural-oasis>
- Urbergsggruppen. (2025). *Urbergsggruppen*. <https://www.urbergsggruppen.se/>
- Vattenmyndigheterna. (2025). *Vattenförvaltning i Sverige*. <https://www.vattenmyndigheterna.se/vattenforvaltning/vattenforvaltning-i-sverige.html>
- Vätternvårdsförbundet. (2025). *Vätternvårdsförbundet*. <https://vattnet.org/vattnetvardsforbundet/>
- Vätternvårdsförbundet. (n.d). *Om Vättern*. <https://vattnet.org/om-vattnet/>
- Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., Glidden, S., Bunn, S. E., Sullivan, C. A., Liermann, C. R., & Davies, P. M. (2010). Global threats to human water security and river biodiversity. *Nature*, 467(7315), 555–561. <https://doi.org/10.1038/nature09440>
- Walker, W. E., Harremoës, P., Rotmans, J., van der Sluijs, J. P., van Asselt, M. B. A., Janssen, P., & Krayen von Krauss, M. P. (2003). Defining uncertainty: A conceptual basis for uncertainty management in model-based decision support. *Integrated Assessment*, 4(1), 5–17. <https://doi.org/10.1076/iaij.4.1.5.16466>
- Warmink, J. J., Brugnach, M., Vinke-de Kruijf, J., Schielen, R. M. J., & Augustijn, D. C. M. (2017). Coping with uncertainty in river management: Challenges and ways forward. *Water Resources Management*, 31(14), 4587–4600. <https://doi.org/10.1007/s11269-017-1767-6>
- Yanquiling, R. S., Cuadrado-Quesada, G., & Schmeier, S. (2024). Exploring the rights of nature in freshwater and marine ecosystems. *Earth System Governance*, 22, 100224. <https://doi.org/10.1016/j.esg.2024.100224>
- Zeng, Y., Twang, S., & Carrasco, L. R. (2022). Environmental defenders and the protection of freshwater ecosystems. *Biological Conservation*, 268, 109502. <https://doi.org/10.1016/j.biocon.2022.109502>