Testing the waters: dealing with freshwater systems in organization and management studies

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DOCTORAL THESIS

Title	**Testing the waters: dealing with freshwater systems in organization and management studies**
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ABSTRACT

Freshwater systems - such as rivers, lakes or wetlands - provide a myriad of ecosystem goods and services to human societies. Nonetheless, the management of those systems is complex, inter-organizational and often unsustainable from an ecological perspective. Research in organization and management studies, although potentially fruitful, cannot contribute to solving this issue as long as it does not include conceptually ecological aspects of freshwater systems, or does not take a system perspective. Such conceptual and methodological recommendations are easier said than done. **How can organization and management studies integrate the inter-organizational management of a freshwater system with the ecological conditions of that system?** This PhD thesis endeavors to learn by doing and studies the relationship between the inter-organizational management of freshwater systems and the ecological condition of those systems in various ways, with an interdisciplinary approach. Three essays and three methodological approaches are developed - a systematic review of the existing management literature on freshwater management, a qualitative study of ecological embeddedness, and a quantitative test of the ecological outcomes of different forms of actors' participation.

À mes Madeleine

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General Introduction[1]

[1] The references for the general introduction and conclusion of this PhD thesis are jointly included in section 5.3, at the very end of this document.

Setting aside ethical matters, managing ecosystems sustainably is highly desirable simply because the pursuit of our civilizations depends on them (Diamond, 2005). Indeed, ecosystems are providing us with many goods and services (de Groot et al., 2002). These have economic, social and cultural value. Threatening the sustainability of ecosystems can therefore be considered irrational at best, if not plainly dangerous. The dangers of the ecological impacts of our economic model have been known for at least 50 years now (Meadows and Club of Rome, 1972), yet one can still witness life-threatening climate change (IPCC, 2014), widespread soil depletion (FAO, 2015) or overfishing (FAO, 2018). The list goes on. Worldwide, management practices are threatening our planetary boundaries (Whiteman et al., 2013). Researchers still need to understand better what makes us collectively manage our ecosystems the way we do, and, more importantly, how we can get better at it. This PhD thesis is a humble contribution to this greater research endeavor.

1.1 Sustainable social-ecological systems: a collective management problem

The notion of social-ecological systems (SES) has emerged from the idea that understanding the co-evolution and interaction of social and ecological realities is essential to reach sustainable management decisions (Berkes et al., 1998), and that "the delineation between social and ecological systems is artificial and arbitrary"

(Folke et al., 2005, p.443). Previous research outside the field of management has underlined the importance of reciprocal feedback between social and ecological components of systems (Folke et al., 2005). Furthermore, these systems are said to be "complex, multivariable, nonlinear, cross-scale, and changing" (Ostrom, 2007, p.15181).

SES management is an inter-organizational topic by nature. Even if one organization is in charge of the governance of an SES in a top-down approach, other actors would need to grant this organization legitimacy to respect its decisions. Elinor Ostrom's seminal work (1990) indicated that - under certain conditions - common pool resources in SESs have been managed sustainably by collectives of actors. Since then, collaborative forms of management are repeatedly recommended to reach sustainable ecological outcomes. Nonetheless, collaboration can take many forms and has not been a guarantee of success (e.g. Heikkila, 2017 on water governance). Saying that inter-organizational collaboration is the way to manage sustainably SESs is over-simplistic, and researchers and practitioners need to "stop striving for simple answers to solve complex problems" (Ostrom, 2007, p. 15181).

Further, sustainability itself has been criticized as a confusing concept, with competing definitions (Bansal and Song, 2017; DesJardins, 2016; Lankoski, 2016). There have even been calls to go beyond the concept of sustainability, considered as not up to the ecological challenges facing us (Hoffman and Jennings, 2015). As DesJardins (2016, p.121) puts it, one can wonder: "What is to be sustained?". This

PhD thesis is primarily concerned with the sustainability of ecosystem functions of SESs (de Groot et al., 2002), as functioning ecosystems can be considered a prerequisite of functioning societies.

1.2 How to tackle ecological matters in management research

Organization and management studies are replete with valuable insights on inter-organizational dynamics regarding the management of the natural environment, such as the emergence of organizational fields around ecological issues (Hoffman, 1999), or of a shared understanding among actors (Ansari et al., 2013; Fan and Zietsma, 2017), on discourse (Clark and Jennings, 1997; Phillips et al., 2004), on participation and power dynamics (Selznick, 1949). But all those shy away from studying the interaction of those social dynamics with ecological realities (Boons, 2013; Winn and Pogutz, 2013). Indeed "the business management literature remains focused on understanding the social, organizational, or institutional implications of corporate sustainability, in isolation from quantitative indicators of ecosystem functioning" (Whiteman et al., 2013, p.308). Hence, the management literature is not in a position to inform thoroughly on sustainable SES management.

Management scholars have been urged to grapple with ecological issues (George et al., 2015; Whiteman and Yumashev, 2018), and to adopt a system perspective to sustainability issues, including ecological elements (Gladwin,

Kennelly, & Krause, 1995; Boons, 2013; Whiteman et al., 2013). As it is, in the management literature, "systems thinking has yet to be fully leveraged as a frame for understanding collaboration for sustainability, although collaboration is acknowledged to be important for achieving sustainability goals" (Williams et al., 2017, p.36). Nevertheless, linking inter-organizational management problematics with ecological matters at a system level rapidly implies a high degree of complexity, notably requiring to build on various disciplines. The SES framework - which will be presented more in length in Essay 1 - helps tackle that complexity and is purposefully designed to bridge different theoretical approaches (McGinnis and Ostrom, 2014; Ostrom, 2009).

All three essays of this thesis are developed taking into consideration the SES framework. They are meant to experiment on how we can link current knowledge in organization and management studies with the ecological components of freshwater systems. An interdisciplinary project such as this thesis might suffer from a penalty - being perceived as confusing by the academic audience - or have a lower productivity due to the time required to span various disciplinary approaches (Leahey et al., 2017). Yet, as explained above, the potential rewards in terms of conceptual contribution to SES challenges outweigh the risks. This thesis does not talk to a single research stream in management but builds on various theories and methods. Essay 2 uses grounded theory to contribute to the institutionalist tradition. Essay 3 speaks more to literatures of environmental management and collaborative governance, with a positivist approach. On top of

this, all essays are based on readings from environmental management, system thinking, and natural sciences.

1.3 Freshwater systems: an extreme case to develop an interdisciplinary approach

Focusing on a sole type of SES might seem to management scholars as excessively limiting the scope and potential contribution of this PhD thesis. Nonetheless freshwater can be considered an "extreme case" of other natural resources (Hoffman, 1999). Indeed, this resource is mostly irreplaceable for the services it provides to human physiological needs, farming, fishing and many industrial activities. All actors of a same system have a high degree of dependence to it. Further, those necessities are not easily postponed. Therefore, the spatio-temporal distribution of freshwater in social-ecological systems is critical (Pahl-Wostl, 2006).

The decision to focus on one type of natural resource is based on the ambition to study ecological matters not only as an empirical context, but also conceptually, i.e. to extend existing management theories to embrace ecological dynamics. That seems necessary as “addressing only the social dimension of resource management without an understanding of resource and ecosystem dynamics will not be sufficient to guide society toward sustainable outcomes” (Folke et al., 2005, p. 443). Each type of ecosystem has different functions, offers

different goods and services and therefore potentially has different ways of interacting with management realities. Choosing to study freshwater systems only permits to dig carefully into the interactions between management and ecological dynamics specific to these ecosystems.

Further, freshwater systems - such as rivers, lakes and wetlands - are in themselves so important to human societies that studying their management alone cannot be considered to lead to limited practical implications. Finding answers to water issues warrants in itself vast research endeavors. Beyond merely containing water as resources units, these systems provide through their functions many other ecosystem goods and services: they guarantee the quality of water through natural filtration, and its spatio-temporal distribution, avoiding disruptions such as floods and land erosion. They also provide opportunities of transportation, recreational activities and cultural services (we could think further of the spiritual value of some rivers, such as the Ganges in Hinduism). These systems and their functions are currently frequently poorly managed globally, and increasingly threatened by upcoming climate disruptions and increasing demand pressure (Dodds et al., 2013; Jackson et al., 2001).

Based on what has been presented so far, this PhD thesis aims to answer the following research question: **How can organization and management studies integrate the inter-organizational management of a freshwater system with the ecological conditions of that system?** This thesis therefore investigates as much the relationship between freshwater system management and the ecological

condition of those systems - a topic so vast it exceeds the reach of a PhD thesis, if not a full academic career - as it studies the methods and concepts that will allow organization and management researchers to tackle fully the question of sustainable freshwater system management.

1.4 Structure of the thesis

This thesis is a monograph based on three essays, each addressing one aspect of the broader research question behind this thesis. The research questions for each of the essays are:

1) To what extent does the existing management literature on water contribute to our understanding of sustainable water management?

2) What connections do institutional actors of a social-ecological system have with the ecological components of that system? How does that condition their understanding of ecological matters?

3) For a chosen social-ecological system, how do the participation patterns of different groups of actors within collaborative governance institutions influence the system's ecological state?

The next sections will include a summary of the approaches, methods and findings of these three essays. Their contribution to the overarching research question will be discussed in the conclusion section at the end of this thesis. Essay 1, as a literature review, identified research gaps related to the sustainable management of water from a system perspective that Essay 2 and 3 build on. Those two empirical essays focus more narrowly on a type of inter-organizational management of freshwater system, the collaborative governance of river basins. They rely on a same effort of data collection, led in two French river basin institutions, Loire-Bretagne and Seine-Normandie, from 2017 to 2019. The French system has the particularity to set institutional boundaries equal to the water systems, i.e. to the geographical limits of water sheds, which makes it particularly relevant to study from an SES perspective.

1.4.1 Essay 1

This first essay is a systematic review of the existing management literature on water issues, including 89 articles from 24 journals from 2006 to 2017. Although water-related literature reviews had already been published (Kurland and Zell, 2010; Martinez, 2015), they did not adopt a system perspective and therefore did not bring insights on matters of sustainable freshwater system management.

A first bibliometric analysis unveils that the articles collected in Essay 1 have very different theoretical approaches, with a mix of positivist and

interpretivist perspectives, and only seldom refer to one another. Although there is an increasing interest on water issues in management research, those papers do not constitute a consolidated stream of research and provide limited knowledge accumulation and theoretical development on water management, let along on sustainable freshwater system management.

To make sense of this scattered corpus, we then use the SES framework (Ostrom, 2009; McGinnis and Ostrom, 2014) to map the insights of each paper at the scale of systems. This qualitative content analysis shows that the existing management literature on water issues neglects the ecological components of the SES framework. Therefore, the collected papers most frequently study the social dimensions of water issues while being conceptually and empirically disconnected from the ecological - or material - aspects of water. To bridge that gap, positivist and interpretivist approaches need to be reconciled, keeping in mind the multidisciplinary nature of SES issues.

1.4.2 Essay 2

Based on Essay 1, Essay 2 uses an inductive approach to explore the interaction between the collaborative governance of French river basins and the river basins themselves. It builds on institutional theory as a conceptual background and ambitions to help that theory - which has proven very useful to understand inter-

organizational dynamics - to include more actively ecological components of SES systems, and ecological materiality as a whole.

Therefore, this essay studies how the individuals involved as institutional actors in the management of freshwater systems relate to their ecological context, and whether and how this ecological embeddedness conditions their understanding of ecological matters. The question of a shared understanding of ecological matters among institutional actors is primordial as ”evaluating synergy or other outcomes always depends on adopting some opinion about what is the purpose or goal of the collaboration” (Phillips et al., 2002, p.25). Due to the exploratory nature of that question, this essay follows a grounded theory methodology, relying on 35 semi-structured interviews with members of French river basin institutions. Archival data, via meeting minutes, also helped understand the empirical context of basin committees.

From that research, we find that institutional actors of a shared ecological context have very different understandings of that context, even after long periods of deliberations. Those actors are profoundly influenced not only by their institutional embeddedness, but also by their ecological embeddedness, when approaching ecological matters. From three observed archetypes of actors, we refine the concept of ecological embeddedness. We find that rather than wondering to which extent an actor is ecologically embedded (Whiteman & Cooper, 2000), researchers should study the multiple forms of ecological engagement actors display, considering notions of ecological engagement, ecological schema and

ecological understanding. Acknowledging the diversity of ways in which institutional actors relate to their ecological context allows to capture better the complexity of social-ecological system management.

1.4.3 Essay 3

Essay 1 as well as other papers (Koontz and Thomas, 2006) have outlined how ecological outcomes are missing from the existing literature on the collaborative management of ecological matters such as freshwater systems. This is partially due to methodological challenges, and the absence of data sources combining ecological and social indicators on a satisfactory spatio-temporal level. Therefore, studies of the ecological outcomes of collaborative river basin governance are scarce and their findings incomplete (Biddle, 2017; Biddle and Koontz, 2014; Scott, 2015, 2016). This research gap needs to be filled to inform the debate in the literatures of collaborative governance and environmental management on the ecological effectiveness of participation (Reed, 2008). This essay aims to contribute to that effort to study ecological outcomes.

To that end, the bulk of work for this paper has been to collect and consolidate a dataset that links ecological indicators (such as water quality and river flow) to collaborative governance indicators (i.e. the ratio of members of different interest groups present in meetings) at the level of the two French river basins studied over more than 20 years. This new dataset allows for statistical

analysis on panel data, using Generalized Linear Mixed Models (GLMM), a method more familiar in research in ecology (Bolker et al., 2009).

The results outline the ecological outcomes of the inclusion of different groups of actors, and the multi-dimensional nature of these ecological outcomes. Henceforth, when trying to evaluate the ecological impact of management practices, organization and management researchers need to include various ecological indicators to do justice to the complexity of ecosystem dynamics. In the case of freshwater systems, considering both point-source and diffuse pollution mechanisms is critical.

1.4.4 Presentation and scholarly contribution

The three essays included in this PhD thesis are at various stages of the publication process, as presented in Table 1.1. Although all three essays are co-authored, I am the lead author and have initiated the drafting and data collection for all of them. My supervisor Daniel Arenas has accompanied me on Essays 1 and 2 in terms of conceptual positioning and writing. Joshua Gittins has added his expertise on natural sciences and hydrology to Essay 3, ensuring the validity of our methodological and conceptual approach for the ecological indicators included.

All three essays have been reviewed in peer-reviewed journals, and two of them have been presented in international academic events. Essay 1 is published in *Organization & Environment* (Baudoin and Arenas, 2020). Essay 2 has been

reviewed and rejected in *Administrative Science Quarterly* and is pending for resubmission to another journal to be determined. Essay 3 has received in May 2020 an offer to revise and resubmit for potential publication in the *Journal of Environmental Management*.

Table 1.1 Scholarly contribution of the essays included

Title	Authors	Journal	Status	Conference & seminar presentations
From raindrops to a common stream: Using the Social-Ecological Systems framework for research on sustainable water management	Lucie Baudoin & Daniel Arenas	Organization & Environment	Published	Conference on the Regulation of Infrastructures (Florence School of Regulation)
Everyone has one truth: Forms of ecological embeddedness in a shared social-ecological system	Lucie Baudoin & Daniel Arenas	To be determined	Resubmission planned for Autumn 2020	Ivey PhD sustainability academy, EGOS, ERSCP, Nottingham University
The ecological outcomes of participation across large river basins: A social-ecological study linking institutions to their natural environment	Lucie Baudoin & Joshua Gittins	Journal of Environmental Management	Revise & resubmit received	-

2

From raindrops to a common stream: Using the Social-Ecological Systems framework for research on sustainable water management

2.1 Abstract

Sustainable water management is a growing concern worldwide. Nonetheless, despite the existence of water-related reviews in the business literature, the contribution of organization and management studies to sustainability challenges remains unclear. As systemic approaches are necessary to tackle sustainability challenges, we use Ostrom's Social-Ecological Systems (SES) framework to assess whether and how the current management literature on water contributes to our understanding of sustainable water management. Our review shows that management research is still far from making a significant contribution to this field, due to limited knowledge accumulation and theoretical development, and a lack of integration of environmental factors within social science research generally. The SES framework helps us identify future research opportunities that would feed more effectively into a multidisciplinary effort toward sustainable water management.

2.2 Introduction

Fresh water is necessary for life, and is a non-replaceable resource for most of the purposes it serves. Yet, water challenges are ubiquitous, and scientific findings predict that the situation will get worse over time. The impact of climate change on both quantity and quality of available fresh water is extensively documented (IPCC, 2014).

In 2017, water crises were ranked third in terms of impact in the World Economic Forum's global risks landscape, right after weapons of mass destruction and extreme weather events. Moreover, for the past six years, water issues have been steadily ranked among the top 5 global risks (World Economic Forum, 2017).

Our research project starts from the statement that the greatest challenge in management research is to contribute to sustainable development (Gladwin, Kennelly, & Krause, 1995), and focuses specifically on sustainable water management from the perspective of the natural resource system itself. Heretofore, two water-related reviews (Kurland & Zell, 2010; Martinez, 2015) had been published, but adopting a business perspective. Understanding sustainability requires the adoption of a systemic perspective, embracing environmental, economic, and social dimensions (Boons, 2013; Gladwin et al., 1995; Whiteman, Walker, & Perego, 2013). Hence, those reviews had not drawn precise conclusions on the progress of the literature with regard to sustainable water management, aside from underlining a growing interest in the subject and identifying a host of research gaps (Kurland & Zell, 2010). Those previous literature reviews on water in management have either been focused at the organizational level (Martinez, 2015) or have developed a thematic analysis of water-related business research (Kurland & Zell, 2010). Therefore, the question remains: To what extent does the existing management literature on water contribute to our understanding of sustainable water management? Our questioning follows previous concerns raised by Winn and Pogutz (2013) on organization and management studies:

"Are we providing the interpretative frameworks capable of favouring or supporting the conversation of our fragile ecosystems?" (p.220)

Our research objective is twofold. First, we aim at making sense of the current management literature on water, using quantitative bibliometric analysis and an overview of the theories used in water-related articles. Second, we use qualitative content analysis to assess whether the current research can meet its goal—that is, to develop a better and more coherent understanding of sustainable water management. We answer that question by integrating all water-related articles published since 2006 within Ostrom's Social-Ecological System (SES) framework (2009), which allows us to develop a systemic overview of the research at hand.

Our analysis allows us to offer documented recommendations both on methodology and content for future research on sustainable water management. Further, we demonstrate what Elinor Ostrom's multidisciplinary framework on Social-Ecological Systems (SESs) can bring to organization and management studies dealing with natural resource management (McGinnis & Ostrom, 2014). Indeed, this framework helped us make sense of a highly fragmented literature. This analytical tool has already been widely used in the past in environmental sciences and economics on matters of sustainability, but remains mostly unexplored in management research. Finally, we believe that the separate study of water is necessary due to its unique features. Nonetheless, because of water's vital importance, it can also be seen as an

extreme case for other natural resources (Hoffman, 1999). As such, our research contributes to the literature on natural resources management at large.

2.2.1 Water in the management literature

Water is a Common-Pool Resource (CPR), a resource system from which it is very costly to exclude any potential user, and which is subject to overuse effects (Ostrom, 1990). We can consider water as an extreme case of CPR insofar as it displays a shared dependence to the resource in a more acute way, and across a greater diversity of actors than fisheries, forestry or pastures. Freshwater resources are mostly irreplaceable, and those necessities are not easily postponed. This means that the spatio-temporal distribution of the resource is as critical as the total amount of freshwater available in a system (Pahl-Wostl, 2006). Water issues englobe various aspects, especially concerns of water quantity (with problems going from droughts to floods) and water quality (e.g. pollution or temperature). These two aspects of water resources are not necessarily equally critical to all actors. Nonetheless, the 2018 UN World Water Development report indicates worrying trends on both dimensions, where climate change disruptions and ecosystem degradation add to increased demographic and economic pressure (WWAP, 2018). In a way, predictions show us that water management has to learn to do better with less, as it appears that “sustainable water

security will not be achieved through business-as-usual approaches" (WWAP, 2018, p.2).

A great variety of organizational forms exists regarding water management and the distribution of responsibilities among actors varies depending on regulation. In water distribution and sanitation alone (i.e. setting aside concerns of flood management or ecosystem management), there are national, regional or local organizational structures. Those structures can be fully private, mixed, or fully public, with different degrees of responsibilities. Ostrom's well-known case studies stress that optimal CPR management is neither fully private nor fully public, but instead requires the emergence of polycentric institutions whose success partly depends on management-related concerns, such as reciprocal trust among resource users or administration and monitoring costs. Therefore, sustainable water management poses a challenge for management theories. In a first review of the business literature on water, Kurland and Zell (2010) emphasized that the subject remained understudied and that vast research opportunities existed, particularly with the development of adapted theories, as research still seemed dominated by technical or operational approaches. Kurland and Zell (2010) are not the only authors in management research to note the lack of attention given to water—and in a broader sense to natural resources (George, Schillebeeckx, & Liak, 2015). Jermier and Forbes (2016) also expressed this concern in a striking manner: "We note that, despite warnings from scientists about rampant, unprecedented environmental change and increasingly urgent calls from

across disciplines to engage an environmental sustainability imperative, the natural environment is still not a fully integrated topic in organizational studies" (p.1003). They proposed that this lack of attention may be because water is taken for granted, in a context of "hubris of anthropocentrism" (p. 1008).

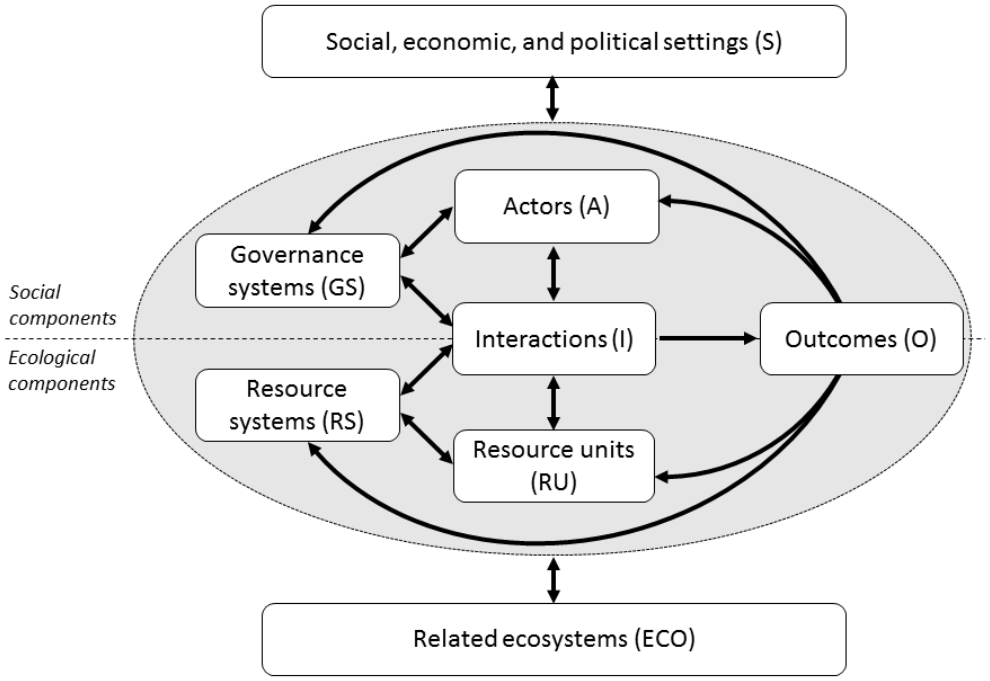
Nonetheless, Kurland and Zell (2010) identified a consistent stream of business research on water from 2006 on. Further, the literature review on Corporate Water Responsibility by Martinez (2015) examines work from 2007 on, when the issue is said to have gained ground among scholars. Yet, his perspective is also on business organizations, rather than the management of the resource itself at the systemic level. We therefore believe the time is ripe to tackle our research question: The management literature on water seems to be rich enough, with over ten years of strengthened focus, for us to expect from it significant contributions to general knowledge on sustainable water management.

2.2.2 The Social-Ecological System framework

The Social-Ecological System (SES) framework was developed by Elinor Ostrom (2007, 2009) in an attempt to provide scholars from all disciplinary backgrounds with a common language to share their work on sustainable resource management. Although this framework is still being refined (McGinnis & Ostrom, 2014), it has

already gathered great attention across disciplines, and especially in environmental studies. It is not the only framework interested in the analysis of SESs, but it has been considered as the most balanced between social and ecological aspects, as well as the most universal (Binder, Hinkel, Bots, & Pahl-Wostl, 2013). Surprisingly, its use remains mostly marginal in management research on natural resources. The usefulness of this framework stems from the idea that interdisciplinary research is vital when it comes to environmental issues. In our literature review, this framework allows us to develop a systemic overview of the research at hand while aggregating articles that do not necessarily have a systemic perspective, and that use very different theoretical approaches. As can be seen in Figure 2.1, this analytical tool conveys a first impression of the complex causality of relationships within a system, where feedback loops are to be expected (Boons, 2013).

Figure 2.1 Components of the Social-Ecological Systems framework [2]



Source: Adapted from Ostrom (2009) and McGinnis & Ostrom (2014)

Water as a natural resource is inscribed in various kinds of SESs. be they rivers, lakes, groundwater plates, or irrigation systems (McGinnis & Ostrom, 2014). The SES framework is especially relevant to integrate the findings and themes mentioned in articles on water management because it is expected to be relatively theory-neutral (Ostrom, 2009). The framework assumes a minimum of agency among members of an SES, an assumption not incompatible, in our view, with the theoretical approaches

[2] The term "user" from Ostrom (2009) was hereafter changed to "actors" in McGinnis & Ostrom (2014), as this terminology was considered more inclusive. Users are a subcategory of Actors. In this paper, we follow the latter version of the framework.

encountered in the articles (McGinnis & Ostrom, 2014). Another advantage of this framework is that it allows us to integrate all levels of analysis (institutional, organizational, and individual). For all these reasons, it seems most appropriate to use it to make sense of the articles collected in our review, since water is the common denominator to all of them.

2.3 Methodology

2.3.1 Journal selection

With this systematic literature review, we aim to ascertain whether and how organizations and management studies contribute to our understanding of sustainable water management. We focus our research on journals central to management studies as the "relevant intellectual territory" (Tranfield, Denyer & Smart, 2003, p.207). To ensure some continuity of results in the bibliometric analysis with the review of Kurland and Zell (2010), we started from the 44 journals they used. We also added seven journals present in the FT50 list and ranked 4* or 4 in ABS 2015 ranking that had not been included in that review.

Finally, we slightly broadened Kurland and Zell's (2010) focus on research in business to a general view of research in organizations and management studies. Although water, as a CPR, is neither a fully public nor a fully private good, it is a highly regulated resource and a public service in most countries. As such, the public management sub-field is expected to concentrate a non-negligible part of the management research on water. We therefore decided to add three journals of public management ranked 4 in ABS 2015, ending up with a total of 54 journals scanned for water-related papers (see final journal list in Table 2.1).

Table 2.1 Journals and papers included

Journal title	**Selection Kurland & Zell**	**ABS 2015**	**FT50**	**Articles found**
Academy of Management Journal	X	4*	X	1
Academy of Management Perspectives	X	3		0
Academy of Management Review	X	4*	X	0
Administrative Science Quarterly	X	4*	X	0
British Journal of Management	X	4		0
Business & Society	X	3		1
Business History Review	X	4		1
Business Strategy & the Environment	X	3		5
California Management Review	X	3		1
Canadian Journal of Administrative Sciences	X	2		1
Corporate Governance	X	3		0
Decision Sciences	X	3		0
Entrepreneurship Theory and Practices		4	X	0
Family Business Review	X	3		0
Harvard Business Review	X	3	X	0

Human Relations	X	4	X	1
Human Resource Management	X	4	X	0
Information System Research		4*	X	0
Interfaces	X	2		6
International Journal of Management Reviews	X	3		0
Journal of Applied Psychology		4	X	0
Journal of Business Ethics	X	3	X	5
Journal of Business Research	X	3		5
Journal of Business Venturing	X	4	X	0
Journal of Consumer Affairs	X	2		0
Journal of Forecasting	X	2		0
Journal of International Business Studies	X	4*	X	0
Journal of Management	X	4*	X	0
Journal of Management Information Systems	X	4	X	0
Journal of Management Studies	X	4	X	1
Journal of Operations Management	X	4*	X	1
Journal of Public Administration Research and Theory		4		10
Journal of World Business	X	4		0
Leadership Quarterly	X	4		1
Long Range Planning	X	3		0
Management Science	X	4*	X	2
MIS Quarterly	X	4*	X	0
Omega	X	3		9
Operations research		4*	X	3
Organization & Environment	X	2		11
Organization Science	X	4*	X	0
Organization Studies		4	X	0
Organizational Behavior and Human Decision Processes	X	4	X	1
Organizational Research Methods	X	4		0
Personnel Psychology	X	4		0
Production and Operations Management		4	X	2
Public Administration		4		9
Public Administration Review		4		9
Research in Organizational Behavior	X	3		0
Research Policy	X	4	X	2

Strategic Entrepreneurship Journal		4	X	1
Strategic Management Journal	X	4*		0
Supply Chain Management	X	3		0
Technovation	X	3		0
Total number of articles included				**89**

2.3.2 Papers selection

We collected articles published from January 2006 through September 2017, using the Social Science Citation Index (SSCI) and searching for the topic "*water*". Web of Science's SSCI is a platform commonly used in literature reviews (e.g., Connolly & Cullen, 2018; Hahn, Reimsbach, & Schiemann, 2015), nonetheless it has its limits as some journals are not covered, or not entirely (e.g., *Business Strategy and the Environment* is covered only from 2009 on). Therefore, we also scanned the journals via other platforms available through our home university library, and Google Scholar. This allowed us to add to the database some of the most recent articles that are accepted in the journals but not yet formally published. Cross-checking across platforms helped us to get more assurance of having a complete view of the water-related articles in management research.

We included each paper for which water played a consequential part in the paper's analysis. To define whether or not an issue was relevant to water management, we referred to the thematic taxonomy developed by Kurland and Zell (2010) in their own literature review. Therefore, we included papers as related to water if they were

concerned about water quantity (i.e., inadequate allocation ranging from water scarcity to floods), water quality (e.g., freshwater pollution), water use, sustainable water management, company management, and industry management. Papers were not included if they had only an anecdotal mention of water, or if water was part of a linguistic expression or of an author's name. Compared to Kurland and Zell (2010), we adopted a slightly stricter scope, excluding articles in which water was only part of the empirical context without any interaction with the paper's discussion or theoretical concern—for example, if a study on intrinsic motivation and creativity asked water treatment plant employees to answer their survey (Grant & Berry, 2011). Papers were also excluded if water was not a clear focus of the study but only mentioned as part of a bigger challenge, such as papers mentioning water along with other issues as an example of the consequences of global warming (e.g.. Howard-Grenville, Buckle, Hoskins, & George, 2014). We considered papers on bottled water only if they related concerns of the water taxonomy mentioned above (e.g., water quantity issues). Similarly, following Kurland and Zell's (2010) methodology, studies on activities close to water, such as water transportation, fishery, or offshore oil extraction were not included unless the question at stake was related to the water taxonomy. Finally, we decided to include only full-fledged academic papers. Editorials, case studies without analysis, and book reviews were excluded.

To understand the contribution to sustainable water management of the articles collected, our analysis is twofold. First, we examine their factual characteristics, their

methodology, and their theoretical framework, to get a sense of what the stream of research consists of. Then we dive into a qualitative assessment of their content using the SES framework to develop a systemic perspective of the state of the research on water management. Both steps allow us to draw strong recommendations for future research on water and natural resources as a whole in organization and management studies.

2.4 Descriptive overview of the research stream

We collected 89 articles in total, distributed among 24 different journals. The bulk of the research was found in journals dedicated to public management (31% of the total), operations (27%), or with a focus on the natural environment (18%). The papers collected are predominantly empirically based, with 55% (49) papers resorting to quantitative methods of analysis, 34% (30) to qualitative methods, and 4% (4) using mixed approaches. The remaining 7% (6) were conceptual papers and literature reviews. Geographically, 66% (59) of studies base their observations in Western developed countries. Australia is the focus of nine papers. The acuteness of water scarcity in that country cannot by itself explain this overrepresentation, as the Middle-East region—one of the driest on the planet—accounts for only two articles. Echoing the call of Ostrom (1990) for a polycentric management of CPRs, 51% (45) of the papers position their analysis on an institutional/inter-organizational level, 31% (28)

are set at the organizational level, and 4% (4) deal with the individual level. Finally, we found it interesting that 10% (9) use multilevel approaches.

Regarding the theories encountered, it is true that many papers have technical or operations backgrounds, as Kurland and Zell (2010) observed, but the situation is more nuanced than that, as can be seen in Table 2.2. There is a great diversity of theoretical approaches applied from management fields or other areas, such as political science, economics, philosophy, and sociology. Papers resorted to theories as diverse as Karl Polanyi's double movement, Morgan's images of organizations, or Laughlin's organizational change. Also, several articles adopted a multidisciplinary approach, such as that of Jaffee and Newman (2013), which uses Harvey's idea of accumulation by dispossession with a mix of sociological, geographical, and anthropological approaches. We note the contrast between hard-fact positivist papers focusing on water issues as physical phenomena (e.g. Almiñana et al., 2010; Porcher, 2016), and more interpretivist approaches studying water as a socially constructed object (Cashman & Lewis, 2007; Lejano & Leong, 2012).

Table 2.2 Theoretical affiliations as mentioned in the papers (non-exhaustive[3])

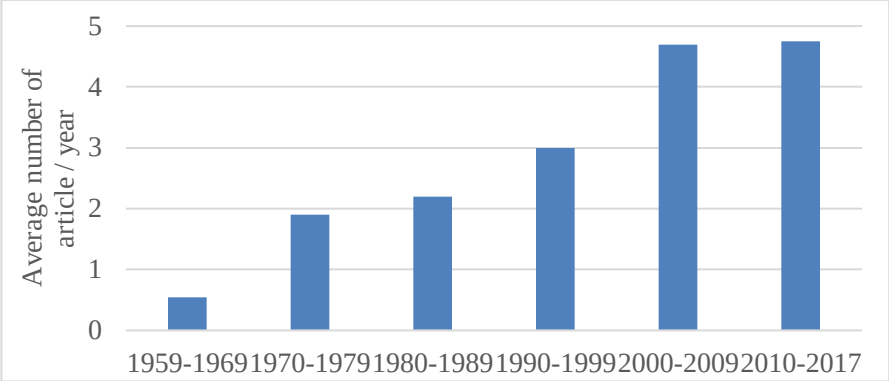
Theoretical affiliations mentioned	Fields
Strategic Response to Climate Change (Gasbarro et al., 2016) Resource-Based View of the Firm (Porcher, 2016)	Corporate Strategy
Laughlin's model of Organizational Change (Egan, 2015) Social Learning and Resilience (Colvin et al., 2014)	Management
Leadership styles, Complexity Leadership (Harley et al., 2014; Taylor et al., 2011)	Leadership
Fast & frugal heuristics (MacGillivray, 2014) Salience Biases (Tiefenbeck et al., 2018)	Psychology
Harvey's accumulation by dispossession (Jaffee & Newman, 2013) Political Rationalities (Behagel & Arts, 2014)	Socio-Political approach
Institutional Logics (Fan & Zietsma, 2017) Institutional Theory (Fuenfschilling & Truffer, 2014; Schaefer, 2007) Oliver's approach of Institutional Theory and Resource Dependence Theory (J. Tingey-Holyoak, 2014; J. L. Tingey-Holyoak & Pisaniello, 2017) Karl Polanyi's Theory of Double Movement (Mariola, 2011) Images of Organizations (Jermier & Forbes, 2016) Environmental Sociology / neo-Weberian theory (Rice, 2013) Organizational Sociology / Suchman's framework of legitimacy (Wood, 2015) Ecology of Games (Berardo & Lubell, 2016; Lubell et al., 2017)	Sociological approach
Dynamic Capability (Dominguez et al., 2009) Subsistence Markets (Viswanathan et al., 2016)	Strategy and Entrepreneurship
Paul Ricœur's Hermeneutics (Lejano & Leong, 2012)	Philosophy
Inventory Theory (Kolesar & Serio, 2011) Triple Bottom Line (Murali et al., 2015; Wu, Lv, Liang, & Hu, 2017) Multi-Attribute Utility Theory (Morais & de Almeida, 2012)	Operations Research
Contingent Valuation (Perez-Pineda & Quintanilla-Armijo, 2013) Dynamic Efficiency (Pointon & Matthews, 2016)	Economics

3 In this table, we only display the theoretical affiliations as reported in the papers collected. Many papers did not mention clearly the theories they based their work upon, and some referred to broader streams of research than others. That is why this table is non-exhaustive.

Transaction Costs Economics (Porcher, 2016) Fiscal Federalism (Hong, 2017)	
Dependency Theory (C. L. Shandra et al., 2011; J. M. Shandra et al., 2008)	International Relations

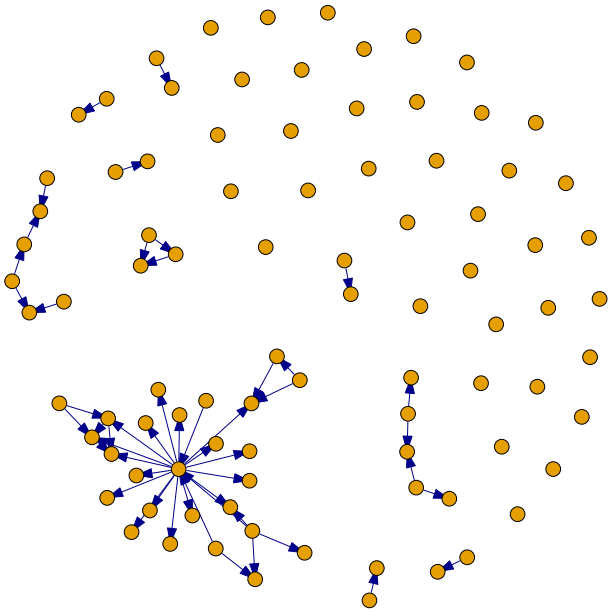
Our findings seem to point to an increased focus on water challenges among management scholars. On the exact scope of journals selected by Kurland and Zell (2010), we witness an average publication rate of about 4.7 water-related articles per year from 2010 on. Screening Kurland and Zell's review, we found a publication rate of 2.5 water-related papers annually on those same journals, over a period of 51 years, with a sharp increase since the 2000s (see Figure 2.2). We believe this comparison is relevant, even though we took some distance from their selection criteria. Indeed, we used a slightly stricter scope, which means that the increase would be equal or steeper if we had kept exactly the same criteria. Nonetheless, the mere analysis of the number of articles over such a long period has some limits and should be treated with caution. The scope of journals relevant to management might have evolved. The total number of articles published per year might have increased. Also, the oldest articles might be harder to track through online research.

Figure 2.2 Evolution of yearly publication rate for water-related issues among journals selected in Kurland & Zell (2010)



In any case, an increase in the total number of articles published does not necessarily mean we are witnessing the rise of a consistent stream of research. Reading through the articles, we did not get the impression that we were in presence of an ongoing discussion among scholars, let alone of a cohesive literature development. To check that impression, we resorted to a basic analysis of the network of citation linkages among the articles selected. We tracked all the references among the articles selected and computed them in a binary matrix. Using R's "igraph" package, we represented the output in a simple directed network graph (see Figure 2.3), with vertexes representing articles and edges the reference, going from the article quoting to the article quoted.

Figure 2.3 Reference network among articles selected



We see that references among articles are very scarce. The impression of a stream of research on water management seems only linked to an increase in articles published, but for the most part those articles do not relate to each other. Of the 50 internal references tracked, 21 are from the two literature reviews included (Kurland & Zell, 2010; Martinez, 2015). They are the two articles creating the agglomeration on the bottom left of Figure 2.3.

Therefore, our first analysis of the articles shows that water challenges can be addressed from a broad range of different theoretical approaches in management research, but it also points to the risk of water management research going in several directions simultaneously without scholars building on each other's work. Currently,

management theories do not align towards an improved understanding of sustainable water management. This echoes Ostrom's statement on the study of SESs:

> This process is complicated, however, because entirely different frameworks, theories, and models are used by different disciplines to analyse their parts of the complex multilevel whole. A common, classificatory framework is needed to facilitate multidisciplinary efforts toward a better understanding of complex SESs. (Ostrom, 2009, p. 420)

We are surprised to note that, although it is considered a foundational work on CPR management, Ostrom's work is quoted in only 17 of the 89 papers collected, and mostly in papers from the field of public management and governance. Ostrom's warning and her SES framework have been largely neglected in organization and management research.

2.5 Analysis through the Social-Ecological Systems framework

The SES framework is structured around eight components, which are themselves composed of a sub-set of second-tier variables. Components interact with each other, but SESs are partly decomposable (Ostrom, 2007). It is normal for researchers to focus

on only a part of those variables. Nonetheless, covering the overall SES framework is necessary to obtain a systemic understanding of phenomena related to natural resources. Indeed, the components of the SES framework could be understood as "the universal elements that any theory relevant to the same kind of phenomena would need to include" (McGinnis & Ostrom, 2014, p. 2). Therefore, although individual studies on water management can focus on one specific subset of variables, any full-fledged theory on sustainable natural resource management that lacks one or several of those elements would be incomplete and have limited explanatory power. To check which aspects of the SES framework were addressed by the literature, we tracked elements in the articles linked to the code of second-tier variables (S1, S2, etc.) from the SES model updated by McGinnis and Ostrom (2014) (see Table 2.3).

For each variable we ended up with a collection of statements that had been formulated by the authors based on theory or empirical evidence. Some codes were covered by none of the articles, indicating an absence of research. This first step allowed us to obtain a qualitative overview of the statements, findings and insights from the management literature on water management, related to each component of the SES framework. We present this summary in the following section. We do not mention exhaustively all articles collected as some issues were repetitive. When articles hold different views on one element (e.g., on the governance network structure), we mention that a debate is present in the literature without taking a position.

Table 2.3 Social-Ecological System framework, updated from McGinnis & Ostrom (2014)

First-tier variables	**Second-tier variables**	
Social, economic, and political settings (S)	*S1 Economic development*	*S5 Markets*
	S2 Demographic trends	*S6 Media organization*
	S3 Political stability	*S7 Technology*
	S4 Other governance systems	
Resource systems (RS)	*RS1 Sector (e.g., water, forests, pasture, fish)*	*RS5 Productivity of system*
	RS2 Clarity of system boundaries	*RS6 Equilibrium properties*
	RS3 Size of resource system	*RS7 Predictability*
	RS4 Human-constructed facilities	*RS8 Storage characteristics*
		RS9 Location
Governance systems (GS)	*GS1 Government organizations*	*GS5 Operational-choice rules*
	GS2 Nongovernment organizations	*GS6 Collective-choice rules*
	GS3 Network structure	*GS7 Constitutional-choice rules*
	GS4 Property-rights systems	*GS8 Monitoring and sanctioning processes*
Resource units (RU)	*RU1 Resource unit mobility*	*RU5 Number of units*
	RU2 Growth or replacement rate	*RU6 Distinctive characteristics*
	RU3 Interaction among units	*RU7 Spatial and temporal distribution*
	RU4 Economic value	
Actors (A)	*A1 Number of relevant actors*	*A6 Norms (trust-reciprocity) /social capital*
	A2 Socioeconomic attributes	
	A3 History or past experiences	*A7 Knowledge of SES/mental models*
	A4 Location	
	A5 Leadership/entrepreneurship	*A8 Importance of resource*
		A9 Technologies available

Interactions (I)	*I1 Harvesting* *I2 Information sharing* *I3 Deliberation processes* *I4 Conflicts* *I5 Investment activities*	*I6 Lobbying activities* *I7 Self-organizing activities* *I8 Networking activities* *I9 Monitoring activities* *I10 Evaluative activities*
Outcomes (O)	*O1 Social performance measures* *O2 Ecological performance measures*	*O3 Externalities to other SESs*
Related ecosystems (ECO)	*ECO1 Climate patterns* *ECO2 Pollution patterns*	*ECO3 Flows into and out of focal SES*

2.5.1 Social, Economic, and Political Settings (S)

Concern for this component of the SES framework is present in a minority of the papers collected. While Shandra et al. (2011) point out the necessity of accurate economic development policies (S1) to ensure broader access to clean water, Jorgenson (2007, 2009) shows that economic growth in less-developed countries becomes a threat to water quality, especially with the development of export markets (S5) and industrial activities. The lack of study of the link between political stability (S3) and water issues might be due to an overrepresentation of Western countries among articles—countries in which this concern is minor. Nonetheless, the political context can have great managerial implications for water management, even in

developed countries, as water utilities are public services. In a study focusing on South Korea, Hong (2017) underlined the risk that short-term electoral pressures lead local services to pursue inadequate water policies, which require a longer-term view to be robust. Meanwhile, a cross-national study on less-developed countries points to a positive correlation between democracy and water quality (Shandra, Shor, & London, 2008).

Demographic increase (S2) and urbanization are mentioned as additional pressures on water systems (Jorgenson, 2007; Skinner, 2017). No study focuses on the impact on water systems of other governance systems (S4)—that is, those not directly involved in water management—or of available media (S6), such as newspapers or television channels. Such governance systems and media outlets are nonetheless likely to play a role in creating a shared understanding of the SES among actors. Finally, although technological advances (S7) could also have a clear impact on water management, with the example of smart water, we found little consideration for this among the papers collected.

2.5.2 Resource Systems (RS)

Regarding the system boundaries (RS2), many papers focus on the river basin as a unit of analysis for water resources (e.g., Harley, Metcalf, & Irwin, 2014; Kolesar & Serio,

2011). In most cases, hydrographic basins are imposed by regulation as the main level of management, as set by the European Water Directive, for example (Hovik & Hanssen, 2015). Likewise, the size of the water resource system (RS3) is mostly treated as a given by the natural and regulatory context. Those water systems are marked with high uncertainty and unpredictability (RS7), which clearly affect decision-making processes, as seen with water allocation optimization models or the planning of controlled flooding in the United States' Grand Canyon (Raffensperger, Milke, & Read, 2009; Rice, 2013; Wang & Huang, 2014). Moreover, water systems have an impact on many different sectors (RS1): local populations, manufacturing industries, power providers, farmers, ecosystems, and leisure activities, among others. Decision-making processes at the level of a water system confront the needs of different sectors, to the extent that those sectors depend on common water resources. Further, they also all have an impact upon those shared resources, as with the case of hydroelectric generation and its relation to recreational activities or irrigation along the Columbia River in the United States (e.g., Harley et al., 2014; Hu et al., 2015).

However, among management scholars just as among practitioners, the natural environment continues to be the "muted stakeholder" (Kurland & Zell, 2011, p.489). The articles collected do not take into consideration the facilities available (RS4), the system's productivity (RS5), its equilibrium properties (RS6), its storage characteristics (RS8), nor its location (RS9).

2.5.3 Resource Units (RU)

On the economic value of resource units (RU4), opinions differ on the application of market logics to water resources as an incentive to preserve the resource. The question of price for water is a sensitive issue. But even when there is awareness of water scarcity, high public subsidies on water prices foster resource waste, as in Kuwait, for example (Aljamal, Speece, & Bagnied, 2016). To ensure sustainable water use, some regulatory initiatives have taken an incentive approach to give a correct economic value to services provided by water (Mariola, 2011; Whittaker et al., 2017).

Water quantity (RU5) and quality (RU6) are determinants for the mobilization of actors and drivers of change. For example, water scarcity crises are mentioned as catalysts for actors' awareness and involvement (Skinner, 2017). Water systems planning takes into account time variability (RU7) because of seasonal changes, whether in the Middle-Eastern country of Jordan or along the Delaware River in the United States (e.g., Elimam & Girgis, 2012; Kolesar & Serio, 2011).

However, the management papers collected do not deal in depth with issues of resource unit mobility (RU1), growth or replacement rate (RU2), or interaction among resource units (RU3), showing again that key aspects of the natural environment are muted.

2.5.4 Governance Systems (GS)

Most papers on governance mention the challenge of dealing effectively with the complexity of water issues. Regarding government organizations (GS1), several public management papers discourage a top-down authoritative approach to water regulation (e.g., Harley et al., 2014; Heikkila, 2017; Sarker, 2013) because coercive, centralized water management policy can lead to conflict among private actors (Harley et al., 2014). There seems to be consensus on the necessity of involving non-government organizations (GS2)—not only NGOs (Jorgenson, 2009; Nikolic & Koontz, 2007; Shandra et al., 2008) but also local economic actors. Integrated institutional frameworks are less likely to face resistance in the implementation of sustainable practices (Tingey-Holyoak, 2014). Yet, there is still some debate on whether water resources are better managed by a local or a central form of governance (Hong, 2017). Overall, regulation, or the prospect of future regulation and sanctions, is still seen as a driver for sustainable water management actions for organizations (Egan, 2015; Koski & May, 2005).

Models of collaborative governance, where non-government organizations such as local communities, industries, and NGOs are actively involved in deliberation, often depend on regulatory frameworks that set which actors are to be included in the CPR institutions, and what their respective responsibilities and rights shall be (Hovik

& Hanssen, 2015). Regulatory frameworks have to be considered fair and appropriate by all actors to ensure compliance. In the example of the Delaware river, tensions were created as decrees were found to be favoring the lower-basin actors over the upper ones (Kolesar & Serio, 2011). When actors have diverging interests, any policy introduced can trigger conflict among groups (Harley et al., 2014).

Water management is marked by not only a multitude of actors, but also a multitude of regulatory entities. In most cases, there is no single public authority controlling every aspect of water issues in a given locale; instead, many different authorities are involved, often with no clear hierarchical structure—a state of affairs that may lead to confusion and raise concerns about legitimacy (Cashman & Lewis, 2007; Lubell, Mewhirter, Berardo, & Scholz, 2017; Sarker, 2013; Wood, 2015).

Water governance typically takes place within a multilevel network (GS3) of governmental and non-governmental entities. Local policy networks are thought to be essential for the implementation of sustainable policies among actors, especially when monitoring costs are high (Lubell & Fulton, 2007). In developing countries, decentralized water programs acknowledge the ability of local communities to self-administer their water resource in a rational manner (Shrestha, 2013). Some concerns are raised on the effectiveness of deliberative democratic governance, because it is seen as likely to reinforce power asymmetries (Behagel & Arts, 2014). It has also been

noted that there is no universal formula for water governance; institutions are expected to evolve with time, as issues evolve (Heikkila, 2017).

On collective-choice rules (GS6), one article raises the question of the optimal voting system for correct aggregation of preferences among the actors of a river basin (Morais & de Almeida, 2012). Meanwhile, questions of constitutional-choice rules (GS7) are not addressed.

Most technical and operation papers aim at providing public authorities with operational-choice rules (GS5). These are presented as decision-making optimization tools to help process the complexity of water issues. Some examples are dikes cost-benefit optimization (Eijgenraam, Brekelmans, den Hertog, & Roos, 2017), water service quality assessment tools (Pinto, Costa, Figueira, & Marques, 2017), and water allocation rules (Wang & Huang, 2014).

Among the management papers covered, few articles raise the question of water ownership and property-rights systems (GS4). Those that do mostly focus on municipal water service (Murali, Lim, & Petruzzi, 2015; Warner & Bel, 2008). Nonetheless, there are some discussions on the treatment of water as a commodity. Whereas some papers treat water as a good which allocation needs to be optimized based on hydrological models, considering the value of water to be its market price (Raffensperger et al., 2009), others defend a less anthropocentric vision of the natural resource (Jaffee & Newman, 2013; Rice, 2013).

Monitoring systems (GS8) are central to proper CPR management to ensure user compliance (Schlager & Heikkila, 2011) and are depicted as a necessary first step for any sustainable water management process (e.g., Egan, 2015; Fan & Zietsma, 2017; Kolesar & Serio, 2011), or for adaptation measures to increasing water scarcity (Gasbarro, Rizzi, & Frey, 2016). In particular, an effective monitoring system has been shown to be essential to improve the quality of municipal water services, whether public or private (Cunha Marques & Berg, 2011; Pinto et al., 2017). At the level of a river basin, information gathering does not have the same importance for all actors, and regulation must ensure that the cost of monitoring is evenly distributed (Schlager & Heikkila, 2011). Accountability is also critical for the legitimacy of water governance bodies when those are not elected (Wood, 2015). Nonetheless, the environmental benefits of the monitoring system are not clear if the application is purely bureaucratic and mechanical, even if this system might bolster external legitimacy (Schaefer, 2007). Regulatory changes require the introduction of new accounting and monitoring mechanisms—for example, the implementation of the European Union water framework directive—but operationalization of the concept of sustainability through monitoring systems remains challenging (Behagel & Arts, 2014; Cashman & Lewis, 2007).

Sanctioning systems (GS8) are not specifically studied in the papers collected, but work has been done on economic incentives schemes. For example, the possibility

of a tax on fertilizer has been proposed as a way to preserve water quality in agricultural zones (Whittaker et al., 2017).

2.5.5 Actors (A)

The actors involved in water systems have extremely diverse socioeconomic profiles (A2), which influence their decision-making processes (Fuenfschilling & Truffer, 2014; Srdjevic, Kolarov, & Srdjevic, 2007; Weible & Moore, 2010). Regarding knowledge of the SES and mental models (A7), there is evidence of different heuristics used in the decision-making process around water management (MacGillivray, 2014). Furthermore, actors have very different levels of understanding of the technical SES information, from full-time water experts to neophytes. These knowledge gaps increase the cost of cooperation (Kurland & Zell, 2011; Lubell et al., 2017).

Water issues might be the first occurrence to bring actors together to interact at all. Therefore, initial social capital can be low among them, with diverging norms and values and consequent lack of trust (A6). Yet, the emergence of new norms can trigger successful collaboration in a community that was not predisposed to do so (Weber, 2009). Further on norms, some papers stress the political and ethical dimension of water management because of water's vital importance and the high degree of actors' interdependence (Spar & Bebenek, 2009; Tingey-Holyoak &

Pisaniello, 2017). On corporate water responsibility, Martinez argues that companies have to combine public policy responses with their own individual motives, and with actor relationships (Martinez, 2015).

Several papers studied the importance of champions or leaders (A5) in pushing for sustainable water management practices (Egan, 2015; Harley et al., 2014; Taylor, Cocklin, Brown, & Wilson-Evered, 2011). For example, leaders can play a role in the emergence of trust among actors (Harley et al., 2014). From a public management point of view, there are also studies on the role of policy entrepreneurs to push for reforms (Colvin et al., 2014; Teodoro, 2010).

In addition to having diverging cognitive (A7) and normative (A6) perceptions of the resource, actors have different levels of awareness of their dependence upon it (A8). This is why water issues are considered wicked problems: Merely defining the problem itself among actors is a problem (Harley et al., 2014; Kurland & Zell, 2011). Questions of salience of water issues drive us back to the importance of information systems for feedback and monitoring. Experiments show that water use is prone to strong salience bias at the individual level (Tiefenbeck et al., 2018). At the organizational level, before any measure, organizations must accurately perceive water issues and measure their exposures to them (Gasbarro et al., 2016). Beyond perceptions, access to clean water is a hard-fact life-or-death matter. In a humanitarian context, the econometrical calculation of the deprivation cost of water includes a

terminal value, set at 120 hours, corresponding to the point of death of the individual due to lack of water (Holguín-Veras et al., 2016). Access to clean water is tied to reduced child mortality (e.g., Jorgenson, 2009; Shandra et al., 2011). Pressure on water resources can deeply affect the life of communities and their subsistence market, as Viswanathan et al. (2016) have recently shown in their research in Tanzania.

With regard to history or past experiences (A3), some papers depict the historical evolution of water systems in longitudinal studies, without focusing on path dependency. Location (A4) within a water system explains diverging interests, as it has been seen to some extent with upper and lower river users in opposition to each other (Schlager & Heikkila, 2011). Finally, no article mentions potentially different access to technologies (A9) among actors within a water system.

2.5.6 Action Situations: Interactions (I)

Far from being static, Ostrom's SES framework takes into account interactions among all components of the framework, such as Actors, Governance Systems, Resource Systems and Units. Interactions studied in the articles are accounted for in this separate section. The first prerequisite for coordination among actors is information sharing (I2) (Hovik & Hanssen, 2015), as it is necessary for deliberation processes (I3). Such deliberation optimally requires multi-criteria decision-making processes (i.e.

components of the Governance System) that include diverse interest groups (Dominguez, Worch, Markard, Truffer, & Gujer, 2009; Morais & de Almeida, 2012; Srdjevic et al., 2007). Yet, because of time pressure, complexity and different mental models of the SES among actors (A7), there are issues of transparency, information availability and interpretability. Conflicts around treated wastewater reuse as fresh water show that displaying pure scientific facts falls short of settling the debate between policymakers and civil society (Lejano & Leong, 2012).

Conflicts (I4) are nurtured by actors' (A) differences in analytical biases and normative beliefs (Weible & Moore, 2010). They are also influenced by the evolution of Social, Economic, and Political context (S), or of related ecosystems (ECO): The diminution of available water resources (RU) due to climate change is expected to reinforce competition among different actors for the same resource. Several articles study the competition among actors with conflicting interests, such as different US states (Kolesar & Serio, 2011), or a bottled water company and local communities (Jaffee & Newman, 2013). Governance Systems (GS) such as river basin organizations are expected to play a key role in mitigating or resolving conflicts, as they are acting as forums of discussion (Schlager & Heikkila, 2011). Since actors remain embedded in the logic of their home organizations, river boards have been studied as a type of boundary organization (Fan & Zietsma, 2017). Examples of self-organizing activities (I7) are a minority among the papers collected (e.g., Shrestha, 2013), nonetheless the

role of the state in accompanying the process of self-organization has been studied in research on Japan (Sarker, 2013).

Adding to what has been said previously about governance networks (GS3), the implementation of networking activities (I8) is complex and costly (Lubell et al., 2017), with concerns for power asymmetries and lack of trust (A6) (Harley et al., 2014). With regard to the cost of networking activities, no paper focuses on the cost of monitoring (I9) or evaluative activities (I10). On lobbying activities (I6), the role of external actors to put pressure on organizations for sustainable water management is mentioned a few times, but no in-depth study on the topic was found.

Aside from technical and economic papers on the optimization of investment decisions, no management or organizational paper in our sample studies the investment activities (I5) of actors in water systems, and how these investments affect inter-organizational relationships. Similarly, although harvesting (I1) activities are identified as the source of tensions among actors, little has been said in the literature on the differences of harvesting patterns, nor on potential synergies. Both observations could be linked to the limited attention paid to Resource Systems (RS) and Resource Units (RU).

2.5.7 Action Situations: Outcomes (O)

Management scholars have been more eager to study interactions than their outcomes. The papers collected provide valuable insights on what explains one type of behavior or interaction, but few focused specifically on the short- or long-term social and environmental outcomes of those interactions (O1, O2). Scott (2016) points out "the lack of evidence concerning the environmental outcomes of collaborative governance" (p. 769). According to him, the lack of research on environmental outcomes could be due to methodological challenges and a lack of data. Similarly, very limited attention is paid to externalities to other SESs (O3), such as considerations for the water–energy nexus (Gasbarro et al., 2016).

Facing the difficulty of measuring regulatory outcomes, some have used perceived effectiveness from stakeholders (Lubell et al., 2017) or environmental policies implementation to evaluate the performance of governance systems (Lubell & Fulton, 2007; Nikolic & Koontz, 2007; Tingey-Holyoak, 2014). Although those are important variables, they do not provide evidence for the actual socio-ecological relevance of those governance systems, given the unpredictability of water systems. Other papers used one-dimensional variables to assess the outcomes of human activities on water systems, such as water quality (Jorgenson, 2007, 2009; Scott, 2016; Shandra et al., 2008) or groundwater quantity (Llopis-Albert, Palacios-Marques, & Soto-Acosta, 2015). For example, Hong (2017) shows that a central form of governance might lead to increased water network efficiency while decreasing social satisfaction. Further, ecological preservation of water bodies can interfere with urban

water supply security (Kolesar & Serio, 2011). Despite their merits, these are still incomplete measures of the multidimensional reality of water SESs.

Few articles focus on the measurement of multidimensional outcomes. Some technical and operations papers consider several performance indices together from a positivist perspective—using, for example, the triple bottom line approach in the context of municipal water services (Murali et al., 2015; Pinto et al., 2017). These are only first steps to get a more accurate measurement method. For example, Murali et al. (2015) use only affordability of water as a proxy for societal impact, thus ignoring the socially constructed aspect of water issues.

2.5.8 Related Ecosystems (ECO)

Like other components from the natural environment (RS, RU), this component of the SES framework is almost completely absent from the literature. Although some papers mention the impact of climate change (ECO1) on water systems, with decreasing water quantity and quality (Gasbarro et al., 2016), little has been said on pollution patterns (ECO2) and flows into and out of local SES (ECO3). At the water utility level, water transfers are said to be driven both by water scarcity and prices with economies of scale (Porcher, 2016).

2.6 Discussion

2.6.1 Structuring management research on water

The scope of our review comprises many different theories and approaches in the business, management and organizational literatures which have been used in research on the issue of sustainable water management. Our focus on an empirical phenomenon does not mean we hold theories as unimportant. As Parmigiani and Howard-Greenville (2011) framed it, such agnostic phenomenon-based literature reviews can offer "insights that transcend specialized language and assumptions" (p.415). Management is an applied science that aims to solve practical problems and contribute to the improvement of society, and sustainable water management is a societal challenge of utmost importance. Nonetheless, our reference network analysis shows that references across the papers selected are close to nonexistent: Water-related articles in management are more raindrops than a stream of research, and do not accumulate knowledge on sustainable water management. We agree that research on sustainable water management should draw from research from other fields and different theoretical debates, but to study an empirical setting as complex and specific as water management one also needs to build on previous research on the phenomenon. Further, this points to the limited development of theoretical contributions specific to

sustainable water management within the management and organizational studies literature. Structuring the contributions on water management under the SES framework, we wish to compensate for the familiar tendency to focus on a particular theoretical silo and to promote more balance between theoretical and phenomenon-based considerations in future studies.

But the SES framework can do more than help us analyzing the existing literature. Indeed, to address that societal challenge, management scholars need to refine existing theories which so far have failed to fully integrate environmental realities (Winn & Pogutz, 2013). Ostrom's SES framework, while originating from social sciences, is considered balanced between social and ecological aspects (Binder et al., 2013) and it can help scholars position organizations and their role regarding CPR issues appropriately, within the SES they are embedded in, as Actors and part of a Governance System.

Put differently, taking the SES framework as a starting point of analysis for any management theory creates a dramatic attention shift, from purely social components to social and ecological components, and from the survival and prospering of organizations, to the survival and prospering of the system as a whole. Hence, we believe this framework may have particularly insightful implications for theories which build on how managers' attention is channelled and what logics they use (e.g. Ocasio, 1997; Thornton, Ocasio, & Lounsbury, 2012).

2.6.2 Future research avenues

Our analysis of the literature reveals that many aspects of the SES framework are left uncovered by organization and management studies on water in the last 12 years, leaving extensive room for further research. We find that the literature tends to neglect the components most related to the natural environment (RS, RU, ECO), as if management decisions or organizational interactions were not inscribed in geographical and bio-physical contexts and influenced by them (Gladwin et al., 1995). Although they are part of social sciences, the papers collected are studying environmental issues, yet our analysis shows that management research on water is still missing the "ecological" in Social-Ecological Systems. Those elements should be more integrated in theoretical developments as determinants of sustainable water management. Building on the SES framework, researchers need to investigate to what extent characteristics of the natural environment—such as the size of a water system (RS3), its storage capacity (RS8), or its water's quantity (RU5) and quality (RU6)—have an impact on the actors' decision-making processes (A), the governance systems (GS) and the interactions thereof (I). Further, we believe rich research perspectives emerge when focusing on how the different components of the SES framework fit with each other: how the governance system (GS) can best fit the resource system's physical

realities (RS) as well as the actors' (A) characteristics; or how the social, political, and economic context (S) can impair or foster the sustainability of a water system.

Above all, the analysis of the literature reveals that more effort should be spent on measuring the environmental and social outcomes (O) of actors' interactions (I), not only within the water system but also on other SESs such as energy systems. Our findings on the lack of measurement of actual outcomes echo previous observations made on the Organization & Environment literature as a whole: Scholars are concerned with the impact of organizations on the natural environment, but that impact is mostly assessed in indirect, remote, or socially constructed ways (Bansal & Gao, 2006; Boons, 2013). Researchers need to be able to measure the social-ecological implications of various forms of water management in a reliable way.

So far, in spite of extensive regulatory efforts from the EU Water Framework Directive since 2000, the 2016 European Environmental Indicator Report announces that it is unlikely to reach the objectives set for the good status of surface waters by 2020. In 2015, only 53% of surface water bodies were estimated to have reached that state, with less than half of the rivers considered as such (European Environment Agency, 2016). This shows that extensive effort put on water governance has not yet fully translated into accomplished environmental improvements. We argue that it is urgent to link water management practices to environmental outcomes, as pressure on ecosystems will most likely increase with economic and climatic changes. A better

understanding of sustainable water management is therefore more needed than ever, and organization and management studies have a role to play in it.

Further, as next generations are at the core of the concept of sustainability (Arenas & Rodrigo, 2016), future research should not adopt a short-sighted view on environmental outcomes but rather pay special attention to medium- and long-term consequences. Although we are aware of the methodological challenges this type of research represents, we believe scholars need to pursue more comparative longitudinal studies linking interactions to social and environmental outcomes. The study of socio-ecological outcomes in their multidimensional complexity is even more important as, when dealing with environmental transitions, "there is no single 'cause' or driver, [but rather] 'circular causality '" (Geels, 2011, p. 29).

As management scholars, it is not our field of expertise to develop measurement methods of the environmental state of a river, but it is necessary for us to look for those measures in other literatures and incorporate them into our research. We can also integrate those measures with more developed social measures of satisfaction of the various actors to develop a truly complete, multidimensional assessment of the outcomes of interactions at the level of a watershed. Connecting different elements of the SES framework, future research could consider, for example, how the participation patterns of actors within collaborative governance institutions relates to concrete environmental outcomes of those institutions.

2.6.3 Reconciling positivist and interpretivist approaches on water management

There seems to be a deep discrepancy between the ways to analyze the natural and organizational environments as they are portrayed both in the academic debate and in the empirical cases reported by the papers studied (Etzion, 2007; Kurland & Zell, 2011). This makes it difficult to elaborate approaches that reconcile or combine these environments. That is why management researchers need to strive to integrate the different components of the SES framework into their analysis, rather than leaving them to be treated only by other disciplines such as economists or environmentalists as has been done so far (George et al., 2015). This requires the elaboration of new methodological approaches and reviewing traditional management theories to include natural aspects.

As discussed earlier, we gathered papers with very divergent epistemological perspectives on water issues, with an apparent gap between positivist and interpretivist approaches. As water problems are socially constructed, the question of assessment of sustainable water management cannot be addressed with purely positivist perspectives, and we need to go further than a pure triple bottom line approach. The way the sustainability of water governance is assessed needs to make sense to actors themselves, otherwise it will be of little practical implication. Therefore, scholars need

to study also how different actors perceive what sustainable water management is, how outcomes are currently tracked, and how a holistic assessment of sustainability of river basins could be developed encompassing the different perceptions of actors. Again, the SES framework encompasses all those aspects conceptually, while leaving room for theoretical development and debates.

2.7 Conclusion and limitations

Going through a descriptive and qualitative review of the water-related articles published since 2006, we show the limited contribution of organization and management studies on sustainable water management. As we take the perspective of the natural resource system, we add a much-needed critical analysis to previous business-oriented reviews of the literature. An initial concern is that neither knowledge accumulation nor extensive theoretical development are taking place. Currently, rather than a common stream of research on water management, we find some raindrops. Organizational scholars have started to investigate water challenges through a broad spectrum of theoretical approaches, but without building on each other's work. We claim that an academic discussion specific to sustainable water management should emerge for organizational and management studies.

Sustainability should be the main concern of research endeavors of organization and management studies on environmental issues, and this requires developing an understanding of natural resources at the system level. To address this need, we categorize the existing research within Ostrom's SES framework. By doing so, we develop a first systemic perspective of the state of affairs of the water management literature. Our analysis shows that research opportunities are numerous, particularly underlining the acute need to better understand the social-ecological outcomes of water management institutions. Management scholars still need to develop theoretical frameworks that allow them to include the natural environmental components of SESs into their reasoning.

Although we tried to be as thorough as possible in collecting and analyzing the articles of this systematic literature review, this research is still prone to human error and some elements might have escaped our analysis. Further, the scattered nature of the articles collected did not allow us to pursue a systemic analysis of the theories themselves; thus, we use articles as our unit of analysis. We nonetheless believe that what could be missing would only marginally affect the results of our analysis and our concluding notes. For reasons of parsimony, all articles collected are not necessarily present in the discussion part; their mention was omitted if they were purely technical or if their content was repetitive with that of other articles. The full list of articles is available on request by contacting the first author.

As stated at the beginning of this paper, we decided to limit the scope of our analysis to the main management journals, searching for the keyword "*water*". We are aware that interesting theoretical insights could be found in more specialized journals, in political science or economics journals that were excluded from our scope, and in articles more related to CPRs or natural resources in general. The purpose of our study, however, was to understand the state of affairs in organization and management studies, to be able to provide appropriate recommendations specific to that field. Nonetheless, we believe that future management articles on water should not limit their references to the main management journals but instead include relevant sources from other disciplines and areas of investigation, due to the multidisciplinary nature of SES challenges.

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3

Everyone has one truth: Forms of ecological embeddedness in a shared social-ecological system

3.1 Abstract

Sustainable management of social-ecological systems involves a great diversity of actors, often gathered in boundary organizations in an effort of shared governance. Nonetheless, those actors may have different understandings of the ecological issues at hand, and different conceptions of sustainability. Institutional theory has studied differences in problem understanding from the perspective of the actors' different institutional embeddedness. We argue that the ecological embeddedness of actors also plays a role in their understanding of ecological issues. Yet we know little on the ways in which institutional actors of a social-ecological system relate individually to their ecological context and how it influences their understanding of ecological matters. We explore that matter by pursuing a qualitative study following grounded theory with members from French river basin committees. Our findings show that members live radically different approaches to ecological matters, making them draw opposite conclusions from their shared ecological context. From that, we develop a new conceptualization of ecological embeddedness, compatible with institutionalist research traditions, that offers a tool to do more justice to the complexity of managing ecosystems.

3.2 Introduction

The ecological challenges our world is facing and is about to face in the 21st century can seem daunting. And the role organization and management studies have to play in coping with those crises has already extensively been argued for (Whiteman, Walker, & Perego, 2013; Hoffman & Jennings, 2015). The sustainable management of our ecosystems is never the concern of a sole organization and ignores preexisting administrative boundaries, requiring the involvement of a broad diversity of actors, public or private, in management practices. That leads to complex multi-level and inter-organizational management challenges.

We know from previous institutional theory studies that when organizational fields form around ecological issues, different interest groups pursue institutional work on how those issues should be interpreted (Hoffman, 1999). The institutional diagnosis made of the problem will determine what decisions are considered to be sustainable. Although the terminology has become ever more common, conceptions of sustainability vary still widely both among practitioners and scholars (Lankoski, 2016; Bansal and Song, 2017), raising the valid question: "What is to be sustained and […] why should it be sustained?" (DesJardins, 2016, p.121). Therefore, it seems necessary to focus more deeply on the determinants of an institutional definition of ecological sustainability, as "addressing topics like ‘ecologically sustainable organizations’ requires first understanding how consensus is built around the meaning of

'sustainability'" (Jennings & Zandbergen, 1995, p.1016). To explore this question, in this paper we study meaning differences regarding ecological issues in the organizational field of French river basin committees.

Managing common-pool resources, which are embedded in social-ecological systems, impacts the activities of a wide range of interdependent actors (Ostrom, 1990, 2009). In the case of freshwater in river basins, these actors might be living upstream in mountain areas or downstream by the sea, have different cultural backgrounds and different activities such as farming, fishing, forestry, and industry. All of these actors are dependent on the river basin, and all of them interact with that basin in a way that would impact other actors. Endeavors to manage common-pool resources therefore come with institutional complexity and often lead to the creation of boundary organizations, such as river basin councils, in charge of managing that complexity. In such a context, the difficulties of a shared understanding around a problem start at the individual level. The actors involved in the management of common-pool resources become dually embedded institutionally, both in their home and in the boundary organization, at the cost of a time-consuming emotional process (Fan and Zietsma, 2017). Yet, this notion of dual institutional embeddedness alone might not be grasping the full complexity managers have to deal with in boundary organizations.

In contexts of institutional complexity, numerous papers have underlined the impact of individual agents' institutional embeddedness on their interpretation of a

problem (Zietsma and Lawrence, 2010; McPherson and Sauder, 2013; Ansari, Wijen, and Gray, 2013). Yet in social-ecological systems, institutions as social (or "human") factors do not exist in a vacuum, but rather ecological components and institutions impact each other and are strongly interrelated (Ostrom, 2009). Nonetheless, studies on the ecological embeddedness of institutional actors have remained marginal and limited to extreme cases (Whiteman and Cooper, 2000). Institutionalist studies have done little to incorporate conceptually the role of materiality on the embeddedness of institutional agents, and even less the role of non-human or ecological materiality. Filling this gap could help develop a more complete approach of embedded agency, and especially one more fit to study the burning ecological issues that multiply around the globe, all set in social-ecological systems.

As little research has been done on the topic, we adopt an exploratory approach and raise the following research questions: What connections do institutional actors of a social-ecological system have with the ecological components of that system? How does that condition their understanding of ecological matters? Members of French river basin committees share both an institutional context - where the basin committees emerged as an organizational field to tackle river basin issues (Hoffman, 1999) - and an ecological context, the river basin itself. Their empirical study therefore allows us to dig deeper in the micro-foundations of institutions (Lawrence, Hardy, & Phillips, 2002; Gray, Purdy, & Ansari, 2015) and to study individuals not only as embedded in institutions, but also in a material, ecological context.

Our paper is in line with numerous calls for research to include physical or ecological components analytically in management studies (Starik and Kanashiro, 2013; Whiteman, Walker, and Perego, 2013; Boons, 2013). Our study offers institutionalist research with an actualized conceptualization of ecological embeddedness. We show that this "other" embeddedness matters to understand the opinions institutional agents form regarding ecological matters. In that sense, studying the ecological embeddedness of actors sheds a new light to the issue of embedded agency (Zietsma and Lawrence, 2010). Approaching this concept in terms of form rather than extent allows the researcher to grasp the full complexity of ecological matters in social-ecological systems. In that sense, our paper also contributes to extend the current research on materiality and institutions towards "a considerably richer view of materiality" (Cloutier & Langley, 2013, p.364).

3.3 Bringing ecosystems into institutional studies

3.3.1 Ecological materiality in institutional studies

The inclusion of materiality in institutionalism remains marginal although argued to be necessary (Jones, Boxenbaum, Anthony, 2013; Monteiro & Nicolini, 2015) , as "understanding the role of material objects in relationship to institutions has been

recognized as an important but under-examined issue" (Lawrence, Leca, & Zilber, 2013, p.1028). The potential impact of material experiences and tools to bring about institutional changes has already been underlined (Purtik and Arenas, 2019; Gond and Brès, 2020).

We agree with these calls for research on the importance of materiality. Yet again, even when a concern is expressed for the study of materiality in organization and management studies, it mostly tackles issues related to human-made or -induced materiality. The literature collected shows concern for the impact of technology evolutions or other human artifacts, such as communication devices or offices setup (Barley, 1986; Elsbach and Pratt, 2007; Gawer and Phillips, 2013; Monteiro and Nicolini, 2015) on institutions. These approaches to materiality preclude any non-human materiality to the extent that "physical environments in organizations" are reduced to "buildings, furnishing, equipment and ambient conditions" (Elsbach and Pratt, 2007, p.181), and exclude of their analysis "surroundings that are completely constructed by nature" (Elsbach and Pratt, 2007, p.182). The same observation goes for research on places and institutional work (Lawrence & Dover, 2015). Notwithstanding the value and relevance of those analyses, we contend that their vision of materiality is too narrow to understand the material conditioning of institutions, especially in the case of institutions dealing with ecological matters. In this paper, we are concerned with the materiality that exists regardless of humankind and its institutions, and even preceded them in time, namely, ecological materiality.

As we conceptualize this materiality as the one that temporally precedes human control - although broad aspects of it are now impacted by human control - it is to be noted that it includes our own human bodies, which are part of ecosystems due to their inescapable physiological needs.

We avoid in our conceptual analysis the words "natural" or "environmental", although those are commonly used to evoke ecological matters and will appear in our findings. As it has been seen in previous research (Descola, 2005; Latour, 2008), and as it came evident also from our own research, those words are subject to a broad diversity of interpretation, partly based on differences cultural contexts. Hence, we found the terminology "ecological" more fit for developing conceptual tools that aim to be applicable in a variety of empirical contexts.

Finally, regarding materiality, although we investigate how different institutional agents understand the same ecological reality in different ways, we oppose an approach that takes common-pool resources as purely socially constructed (Ansari, Wijen, and Gray, 2013). Indeed, the existence of a “human history of nature” does not contradict the existence of the "natural non-history of nature" (Latour, 2008, p.52). In that, we are in line with previous research on common-pool resources and social-ecological systems (Ostrom, 1990, 2009). The management of resources in social-ecological systems is a collective issue first and foremost because of the agents’ shared material interdependence regarding a same set of resources. Different forms of

collective actions and different understandings can emerge from the same context, but they are influenced and limited by the ecological context and cannot fully reinvent it. For example, in the case of French river basin committees, shellfish farmers, who work on the seashores, weren't included at first in deliberations. They got included in the process afterwards, when scientific evidence underlined the impact river streams had on their activity. While it is true that the social process of scientific discovery revealed their material link to river basin management, they would not be included if that link did not exist.

3.3.2 The ecological embeddedness of institutional actors

We contend that actors in social-ecological systems are not only institutionally, but also ecologically embedded (Whiteman & Cooper, 2000). Whiteman & Cooper conceptualized ecological embeddedness as "the degree to which a manager is rooted in the land—that is, the extent to which the manager is on the land and learns from the land in an experiential way" (2000, p.1267). We find this approach difficult to apply to many modern organizational settings. Mirroring approaches to institutional embeddedness (Dacin, Ventresca, and Beal, 1999), we propose a broader approach to this concept; that is, we frame ecological embeddedness as all the connections actors have with their ecological context that prescribes or constraints their thoughts and actions. In this sense, ecological embeddedness encompasses cognitive, emotional and

material aspects. Of course, an individual's ecological embeddedness and institutional embeddedness are not fully independent. Being part of an institutional context implies being exposed to certain experiences that influence the individual relationship to the ecological context. This interdependence is not the topic of this paper, although it could be relevant as a future research endeavor. We focus on understanding better if and how ecological embeddedness plays a role on the opinions of institutional actors form regarding ecosystem management.

Whiteman & Cooper (2000) developed the construct of ecological embeddedness from the analysis of a specific single case, the Cree tallymen in Canada. Although this paper is incredibly informative of what ecological embeddedness can be, it sheds little light on potential differences of ecological embeddedness in a multi-actor context, and on what may lead to differences in ecological understanding among institutional agents. In contrast, we design our research to maximize the variety of cases (i.e. individual institutional agents) while staying in a same institutional setting. By doing that, we propose to see how relevant the notion of ecological embeddedness is in a modern context of institutional complexity. The result of this endeavor could help management and organization studies to link institutions back to their "biophysical foundations" (Gladwin, Kennelly, and Krause, 1995, p.875).

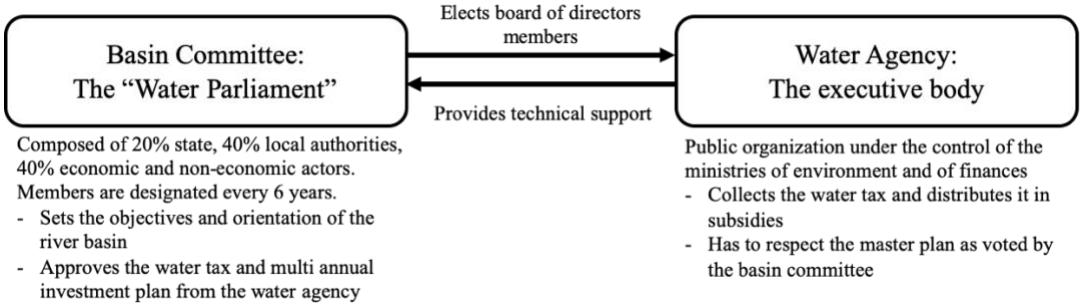
3.4 Methodology

3.4.1 Research setting

Our study is based on French river basin committees (in French, "comités de bassin"), often referred to as "water parliaments". Those organizations were created in the 1960's, in an effort to establish collaborative governance of water resources at the scale of hydrographic basins. The metropolitan French territory is covered by seven basin committees, two of which are covered in our paper, namely Seine-Normandie (later on, SN) and Loire-Bretagne (later on, LB).

The basin committees are instituted by law, which specifies their composition, involving diverse member groups, such as local authorities, industrialists, farmers or NGO activists. Members are not elected but designated according to fixed procedures. The committees are not purely consultative as they formally debate, and vote plans that river basin public agencies are in charge of implementing. They have a say on whether some practices get financial support from those public agencies, such as water retention systems for example. The regulation of those institutions is complex and has evolved since their inception in the 1960's, nonetheless the overall logic remains the same. Figure 3.1 represents in a simplified model the organizational structure of river basin institutions.

Figure 3.1 The organizational structure of basin organizations



This empirical context is promising from a social-ecological system perspective as the boundaries of the basins institutions are designed to fit the ecological boundaries of hydrographic basins, a rare example of human institutions stretching to match ecological realities. This means that the areas covered by river basin committees cut through administrative regions. The composition of river basins aims at representing all "relevant actors" of the river basin. It varies from one basin to another as a "function of the economic and environmental equilibria of the basin" (Cour des Comptes, 2015, p.107). This implies that members have very different social backgrounds and experiences with the river basin. There is nonetheless no requirement for the members to have an economic activity, and it not uncommon to find members who are retired but still represent a group. By the size of those hydrographic basins (for SN and LB, 94,000 m^2 and 155,000 m^2 respectively), they are unique settings where individual members have to engage with actors with whom they would possibly never have met otherwise, from upper to lower basin areas, in big formal plenary

sessions (of 185 and 190 members respectively). Therefore, we can expect members to belong to and have experience from partially different institutional and ecological contexts. Comparing them to one another provides rich data to answer our research question.

3.4.2 Data collection

Data collection took place from 2017 to 2019. We started our data collection process with a round of informal interviews with water agency employees in December 2017, to validate the suitability of our research setting and to gain access. In 2018, we attended two plenary basin committee sessions, one in each river basin studied, as well as a board of directors meeting. Further, 35 semi-structured interviews were conducted with current or former basin committee members and with water agencies managers. The members we interviewed had on average more than 14 years of experience in basin committees. Although water agency managers are not basin committee members per se (e.g. they do not have voting rights), they sit in basin committees and play an active role in the organization of deliberation. They have a valuable experience as third-party observers of the interactions between committee members.

Interviews were gathered with a mix of theoretical and snowballing sampling to catch the diversity of interest groups in the committees, both economically and geographically (cf. table 3.1). Twenty-six interviews were face-to-face, and nine on

the phone. They lasted about an hour and were audio-recorded in all cases but one, on the request of the interviewee. Out of 35 interviews, only three participants were women. This imbalance is representative of the historical gender composition of the two river basins studied, where women have accounted for less than eight percent of all nominated members. Follow-up mails were collected when necessary to confirm analysis and then coded as additional input.

The data collected also includes archive data (i.e. minutes of plenary sessions covering over 40 years of meetings for both river basins), as well as additional official reports gathered based on recommendations from interview participants. Those were not included in the coding process but helped us becoming familiar with the institutional context in which basin committee members evolve.

Table 3.1 Interviews conducted in chronological order

Interview	Activity	Basin	Years of experience as member	Assigned archetype
1	water utility & state	SN & other	3	
2	water utility	SN	44	
3	state & local authority	LB	9	
4	water utility	SN	20	
5	industry	SN	24	
6	water agency & state	LB & other	-	
7	water agency	other	-	
8	water agency	SN	-	Environmental atheist
9	water agency	LB	-	

10	water agency & state	LB	-	Environmental atheist
11	ENGO	LB	32	Colibri
12	expert member	LB	10	Resource environmentalist
13	water agency	LB	-	
14	state	LB	4	
15	local authority	LB	4	
16	industry	LB	13	
17	industry	LB	13	
18	industry	LB	6	Environmental atheist
19	agriculture	LB & SN	18	Resource environmentalist
20	river sport NGO	LB	25	
21	local authority	LB	7	Colibri
22	ENGO	LB	19	Colibri
23	agriculture	LB	2	Resource environmentalist
24	local authority	SN	10	
25	ENGO	SN	10	
26	water consumers NGO	SN	10	Resource environmentalist
27	ENGO	SN	19	Colibri
28	local authority (seaside)	SN	4	Resource environmentalist
29	local authority	SN	17	Resource environmentalist
30	shellfish farming	SN	12	Colibri
31	agriculture	SN	10	Resource environmentalist
32	local authority	LB	26	Resource environmentalist
33	fishermen NGO	SN	2	Colibri
34	fishermen NGO	LB	19	Colibri
35	professional fisherman	LB	19	Colibri

The interview protocol, available in appendix, was developed to invite interviewees to reflect on their personal experience as participants of the basin committees, and to talk about their own perception of the discussions in basin committees. Questions were initially inspired by an institutional perspective (Selznick, 1949) as well as by the collaborative governance literature (Newig, 2007; Reed, 2008). If the topic had not been raised before, a final question dealt with their concern for the

"natural environment". The protocol was adapted depending on the position of participants and their answers, and left room for them to bring up aspects not included formally.

A 25-page report of the findings was finally sent in June 2019 to our interview participants and to experienced water agency employees, including the archetypes which we will present later on in this paper. Five members of very diverse backgrounds and two water agency employees took the time to send us back detailed feedback. This allowed us to make sure that the conceptualization made from the data did not do too much "violence to experience" (Pratt, 2008).

3.4.3 Analysis

We decided to pursue qualitative research on the topic as our aim is to "challenge taken-for-granted theories and expose new theoretical directions" (Bansal, Smith, & Vaara, 2018, p.1189). Our research has a primary focus on the individual level but keeping in mind the institutional context in which individuals are located (Gray, Purdy, and Ansari, 2015). We transcribed interviews verbatim and coded them with NVivo, following grounded theory guidelines (Strauss and Corbin, 1998). After a first phase of open coding, codes were merged into three core second-order themes (i.e. ecological engagement, ecological schema and ecological understanding), and we

focused more specifically on how members differed from one another along those categories. We did not find any significant difference between the two river basins during our analysis, therefore our findings are common to both basins. In tables 3.2, 3.3 and 3.4 (to be found later on in findings), we show how we worked from our data to codes and themes. We refined our analysis in an iterative process of going back and forth between the data and the themes. Memos were written from the beginning of data collection to the elaboration of the draft, also bearing in mind potential personal biases. Interviews were conducted and transcribed in French. The first-order codes were developed at first in English or French, depending on whether we referred to a concept established in the literature, or needed to stick to the meaning given by the participant. Only select quotes were translated in English to be included in the final paper. A translation table with original versions is available on request.

The first focus of our study was on the link between the inclusion of a broad diversity of actors and the evolution of the negotiated collective approach of sustainable river basin management. For that reason, in the interviews, many elements of internal and external power struggles relating to the participation process surfaced. But, as they were answering our questions, participants showed such puzzling differences in conceptualization of river basin topics that we then refocused our paper on that point, preferring depth to scope. Aspects of power and deliberative struggles were intentionally left for further research to focus on the existence of different understandings of ecological issues at the individual level.

3.5 Findings

3.5.1 Setting the stage: The institutional context of members' ecological embeddedness

In this section, we present to the reader the institutional context of basin committees. This is not the core of our findings but a necessary first step to understand our subsequent analysis.

After fifty years of existence, basin committees accumulated institutional traits.

From their long existence, basin committees have developed from being a simple boundary organization to an institution, in which specific cognitive, normative and regulative rules grant or limit the legitimacy of agents (DiMaggio and Powell, 1983). Indeed, interviewees report a "shared culture, […] that isn't necessarily shared once we go outside from basin committee members" (#9, water agency). Accepted rules exist on what are legitimate topics, ways and times to speak up. This set of spoken and unspoken rules aim to guarantee respectful deliberations aiming for consensus and for the "common good". To that end, new members have to learn to become

"constructive". Our field observations show that, even when conflictive topics are discussed, a climate of "courtesy" and even humor is expected to be maintained. Aside from these attitude and behavior towards deliberation, technical expertise, both regarding the regulatory context and the natural dynamics of river basins, is another important source of legitimacy, to the extent that members think that "there is some kind of natural selection so that those who really get involved are people who are able to understand the topics" (#24, local authority).

Not fitting those rules has a cost in terms of legitimacy, as can be seen in the following quote: "Whoever sticks to that speech [of self-interest] - and there have been some - excludes himself. And ... if he does not exclude himself per se, as he is less listened to, his point is ... well, he'll speak because you cannot forbid it, and as he speaks up, all the others will be on their cell phone, or calling their mother" (#12, expert member). Committee members, once passed the first phase of "acculturation", have a dual institutional embeddedness, both in their home organization and in basin committees. We are in a context of high institutional complexity.

Based on that observation, later on in this paper, we will refer to "river basin institutions", as this set of rules, both formal and informal, that emerged from and around basin committees and water agencies in order to govern collaboratively French hydrographic basins.

An evolution of river basin institutions that leaves room for divergence in understandings.

Institutional approaches to river basin management have greatly evolved since the creation of basin institutions in the late 1960's, according to a vast majority of the interviewees, from resource management to more holistic environmental policies, with the introduction of concepts such as "ecosystem". "The place of the environment has grown tremendously within the basin committee" (#3, agriculture). The evolution of discourse is attributed to the influence of new regulation, a broader growing societal concern, and the acute salience of ecological problems. Advances in natural sciences on ecological systems also played a role in this institutional evolution. As a result, some practices went from being the norm to being unacceptable, such as the widespread straightening of rivers and streams, which are now being "restored" to their original meandrous form at great financial costs. Nonetheless, scientific knowledge remains incomplete and hence leaves room for members to have divergent opinions on what is "right or wrong" in environmental decisions, and what the priorities should be.

> So, what is not necessarily clear is what is meant by 'good condition' [of rivers]. Are we sticking to regulations? Or are we going to fantasize a bit further? (#1, Industry)

In spite of the consensus-seeking rules mentioned in the previous section, lasting tensions are reported, which do not seem to erode with time, as can be seen in the following quotes:

> Debates, cutting remarks- especially between agriculture and ENGOs representatives- have been going on for a long time. I can tell you that they were already there in 1997, and probably before that too. (#9, water agency)

> In the end, it's still a lot of time for limited results in terms of mutual understanding. Anyway, it's perhaps the price of democracy as they say. And it's true that, finally, I find that we, often, always, go back to the same topics. (#26, Industry)

Diversity of attitudes among members from a same group.

Previous research has found that group membership greatly influences perceptions of environmental risks (e.g. McCright & Dunlap, 2011). In our context, we understand groups as comprising basin committee members who have a common representative mandate, as well as the non-member peers whose interest they are meant to represent, e.g. industry representatives and industrials from the region. In a sense, these groups are the members' "home" institutional contexts, they also indicate their personal interest. And in line with previous research, we see that members of certain groups oftentimes defend a common position on ecological problems.

But group affiliation does not tell the whole story of how individuals relate to ecological matters. Members might be constrained in their voting decisions by their representation mandate, but they oftentimes hold diverging views from their groups' regarding ecological matters. Moreover, several members, notably from local authorities, said that they sometimes took decisions on their own, without being able to discuss them internally with their colleagues. Interviewees refer to a personal "concern for the environment" or an "environmental sensitivity". An industrialist for example reports that he is happy to come to the basin committee meetings as no one shares his interest in water back in his company (Interview #21).

Further, members of Environmental NGOs (later on, ENGOs) are not the only ones to position themselves as "environmentalists". Members of groups who sometimes oppose ENGOs do so as well. Most notably, members representing conventional farming, who are confronting ENGOs on many topics - such as water retention for irrigation for example - will report in interviews that they "think about the environment all the time" (#11, agriculture). They seem to live an intimate personal commitment to ecological topics, as with this farmer saying that "the environment has always been very strong in [his] head" (#3, agriculture). They, too, report facing tensions and taking risks with their "base", i.e. the conventional farmers they are meant to represent.

3.5.2 Forms of individual ecological embeddedness

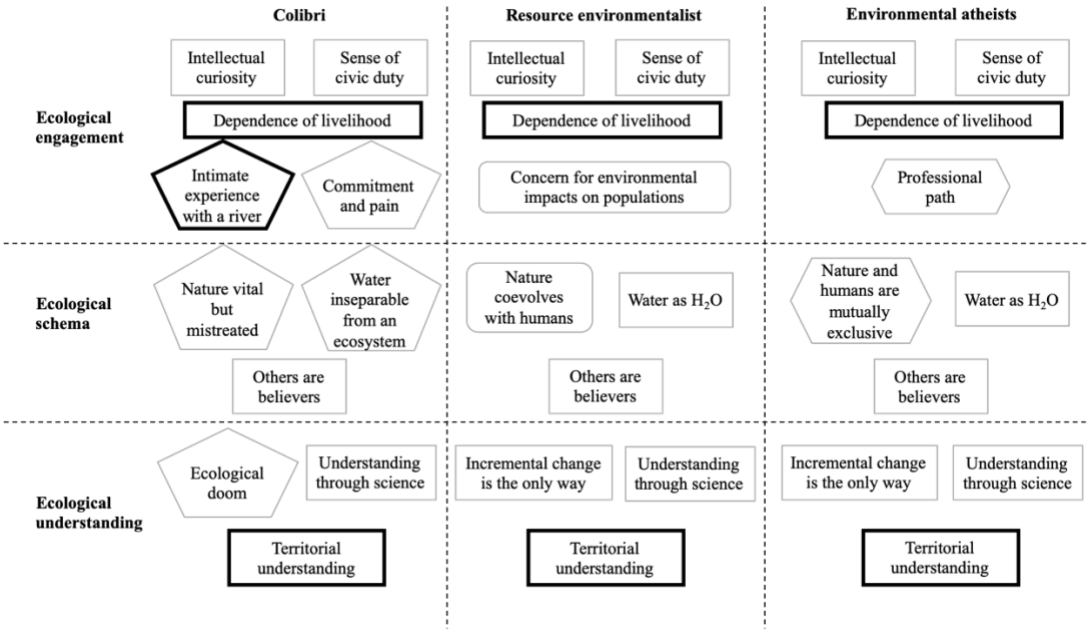
Having presented briefly the institutional context of river basin committees, we investigate what are the different attitudes basin committee members display towards the river basin. Again, we are interested in all kinds of connections members have with their ecological context that condition their thoughts and actions.

Based on our observations, we identified three archetypes of members - which we called "colibri", "atheist" and "resource environmentalist" - distinguishing them by how they differ in their approach to river basin issues. The terminology developed is based on how some of those members present themselves and will become more explicit as we move along with our findings. In the case of the term "colibri" (hummingbird in French), we chose to keep the original word as its meaning is context-specific. It relates to a social movement initiated by Pierre Rabhi, which uses the figure of a hummingbird as a rallying call to prescribe a particular deontological behavior when facing dire ecological issues (Rabhi, 2010).

We will describe those archetypes as we move along the dimensions of ecological embeddedness that emerged from our data, namely, ecological engagement, ecological schema and ecological understanding. The first two concepts help us respond to the first part of our research question, i.e. to identify what kinds of connections institutional actors of a social-ecological system have with the ecological components of that system. The latter, ecological understanding, speaks to the second

part of our research question regarding the conditions for their understanding of ecological matters. The assignment of interviewees to the three archetypes can be found in table 3.1, and an overview of the characteristics of each archetype can be found in figure 3.2.

Figure 3.2 Archetypes and themes of ecological embeddedness



Note: In bold, elements where ecological materiality plays a strong role

The archetypes developed are by essence simplifying, but they help synthesize the differences among actors in a way that group classifications could not, and in that sense, they have an analytical value. Nonetheless, as we presented them back to our

interview participants in the feedback report, they made sense to them. As a participant said, "the three categories suit me and are a good depiction of the committee" (#16, industry). They appeared to us as we saw patterns appearing repeatedly together in interviews. Following Strauss & Corbin's (1998) call for constant comparison between cases and categories, we wondered: they are different, but what is different about them? Nonetheless, some members might have characteristics that span archetypes, and we didn't assign those members with a definite profile. Further, some interviewees are unassigned in case the interview content did not allow to clearly identify them. In table 3.1, the reader will notice that the interviewees we talked to in the earlier stages of our project tend to be less assigned. That makes sense as, in our research process, they mostly helped us grasp the institutional and empirical context, and pointed to the importance of individual profiles, without leaving us time to cover their own individual experiences much in depth. In the later interviews, we invited more actively members to reflect about their perceptions and individual impressions. Water agency employees have been harder to assign as they are not basin committee members per say, and oftentimes purposively affect a role of observant.

Table 3.3 Second-order theme of ecological engagement with quotes

Ecological engagement	
Intrinsic rewards of participation	
Intellectual curiosity	"It's time-consuming, but it's extremely interesting so that's why I go.[…] the way it works, I find it really interesting, I think we make progress, I learn a lot, I mix with ... With people who represent groups that I would never mix with." (#28, local authority)
	"I specialized in that because- well, it's a bit personal. So indeed water is my hobby, and I found other fans within FNE in the network 'Water and aquatic environments'." (#22, ENGO)
Sense of civic duty	"For me, I was going to say, it's a double job. At the same time, I must assume my professional responsibilities towards my clients - especially when you are freelance - And come here just by being paid the travel cost and not compensated for my time. So it's a ... one needs see here a ... civic purpose ... by analyzing the fact that public water policies can not be left to anyone. [...] Since I'm not ... I'm not totally deprived of skills, I said let's get involved." (#12, water expert)
	"If I listen to my wife, she would tell me, 'well, you're completely crazy.' [...] That's what she told me one day. No but it's the interest of the res publica, I think." (#27, local authority)
Concern for future generations	"And it's for tomorrow, for our children and our grandchildren. I myself have a grandchild who is 4-month old. What world are we going to leave him?" (#29, agriculture)
	"It may seem pretentious, but I think we also have a responsibility there regarding future generations. I have a grand-daughter who is about 3 year old. Well I want her discovering something else about water and natural environments than channeled streams, putrid water, putrid streams completely invaded by cyanophycea in summer, green, in which we will not be able to bathe because, indeed, they are unfit for use and consumption." (#34, fishermen NGO)
Commitment and pain *Marker for colibris*	"I say all that but I do it anyway and I ... And I knew what I was getting into. But at some point, you see, what's the return on investment? And this is where I ask myself the question today. [...] I already told my federation, saying, yeah I may be a

	little fed up. I do not know what I'm going to do. And even talking about it just now, I still do not know what I'm going to do. So, I think that I will position myself at the next member convocation but that will be ... it will be really with a heavy heart I would say." (#33, fisherman NGO) "He is going to stop. You'll tell me, he always says he's going to stop, but he's still going on. He cannot do without it, I think. But anyway. But it's true that there are days when he so fed up with all this. He's a bit ... he's really pessimistic right now." (#22, ENGO)
Reported origin of first involvement with river basin management	
Intimate experience with a river *Marker for colibris*	"My professional orientation has nothing to do with it, with the problem of water, but I ended up in water from a very young age, as a child. And in the same way as salmons are imbued with their birth environment, well I remained imbued with the theme of water since my birth almost." (#11, ENGO) "I think water is in my guts. In fact, I fell in it as I was very young. Well I always used to say that I came to water actually a little by chance, but I think that it wasn't chance in fact. One day I played - I went to my grandparents' in the countryside, in the deep countryside, and in a very small stream, I started to lift up the pebbles, to see what was happening in the river and so on. And from there I became a fisherman." (#34, fisherman NGO)
Concern for impacts of environmental problems on human populations *Marker for resource environmentalists*	"The oil crisis made me think about the big shocks that society would experience in the coming years. And I quickly realized that after oil, it would be water. So, I got more closely interested in this problem of water and the consequences that there were ... in terms of pollution but also in terms of scarcity." (#32, local authority) "It's not water, well, it's more than water. It's everything related to environmental challenges, water, air, climate. Today I do a lot regarding climate. That's all ... all these topics around agriculture, the pressure of agriculture, the evolution, about the ground, the work of the soil, the life of the ground." (#31, agriculture)
Professional path *Marker for environmental atheists*	"It was a professional requirement, because they worked with the local authorities, and we were at the service of the local authorities." (#4, water utility)

	"I wanted to discover the corporate world to extend my experience at the time. I was then contacted to join (a water utility company) [...] I liked it a lot and it won my heart for the rest of my professional career until today." (#1, state and water utility)
Dependence of own livelihood on the river basin	
Dependence leading to engagement	"You cannot be an oyster farmer and not talk about water quality." (#31, shellfish farmer)
	"But as a farmer, my work tool, it is the soil. It is water. So, I have no interest in damaging my work tool, neither the soil nor the water. So, what I was trying to explain when I had people - extremists - saying: 'you destroyed everything, the soil is dead, etc.' I cannot hear that. It is not possible. Because it's not true. It is false, the soil, I have an interest in it being as alive as possible. I live from it." (#19, agriculture)
Nuances of dependence	"Frankly, fishermen are generally ... true guardians of nature, I will not say that about hunters. Fishermen, yes, because - because the quality of the environment is important to them. But nonetheless, there is among fishermen the equivalent of what we find a lot among hunters, that is to say people who put fishes in a pond and come to pick it up. And those, the ecosystem they need is a bowl." (#21, local authority)
	"I am lucky not to have an activity comparable to the one that at the moment defends its interests even if ... its cereal or animal production forces to pollute the water resource." (#31, shellfish farmer)

Individual engagement in ecological topics.

We define ecological engagement as any individual self-motived interest in ecological matters and resulting behaviors. By self-motivated interest, we mean interests which are not linked to any potential direct reward from a third party, as for example when employees have interests in topics that can give them a professional advantage. The codes related to that theme can be found in table 3.2. Most members of the basin

committees, albeit their differences of socio-economic background and views on river basin management, show some self-motivated interest regarding the topics at stake, either for a specific place, for "water" or for environmental matters. That is, in the vast majority of cases, participating in basin committees represents a voluntary workload in addition to their professional activity or to their retirement. Participating in basin committees is described as time and energy-consuming and members receive no financial benefit from this, only compensation for their travel costs and a free meal. The engagement with river basin committees is profoundly material as members need to physically go to plenary sessions, with travel times which can take more than four hours one way for some members. Moreover, the topics discussed are technically complex and require work to prepare for meetings, which is tedious to many. We are not saying that members are purely self-motivated. They are not. But external interests alone do not explain their level of engagement with basin committees.

> There is a motivation that must be some kind of pride to belong to such an institution, having the impression to defend water, nature, the environment, etc. Otherwise they wouldn’t go through all that trouble. I admire a lot those people who ... who devote time to that. (#22, water agency and state)

And indeed, aside from specific interests in representing an organization, participants mention intrinsic rewards to their participation in basin committees. As a member puts it, participating in basin committees "is not rewarding financially, but it's

still very rewarding intellectually and one meets new people" (#31, agriculture). Intellectual curiosity is not only linked to a specific interest in water-related topics, but also to a broader interest in discovering other viewpoints in a diverse deliberative process, in other words in "what is going on in the heads, in the motivations of others" (#11, ENGO).

Many members report also a sense of duty, as a citizen, or on a broader moral basis. That sense of duty often originates from a self-assessment of one's own competency that would be wasted if not used. That especially applies to members with scientific backgrounds. Members also share a concern for the well-being of human populations, and more specifically for future generations.

Having said that everyone shares similar self-motivated interests, is it accurate to talk about different archetypes? Digging into how members talk about environmental matters, we can see that they have different ways of engaging with ecological matters. When asked about their motivation to participate in the basin committees, members identified as colibris talk emotionally about water as a constitutive part of their identity, similar to an old fascination as they "always loved water" (#22, ENGO). Colibris often evoke a direct exposure in their youth to a river, along with relatives, such as fishing or simple observation of nature. Members falling under this archetype not only have an interest in water superior to any other ecological topic, but they also have important memories linked to a specific place, a river.

Non-colibri members might also have had contact with rivers in their childhood. But they did not mention such memories when they explained their involvement as basin committee members. Resource environmentalists, for example, typically claimed to have developed an interest in water topics later on, for more utilitarian reasons. This interest is not intrinsic to water per se but relates to the challenges it poses to society. Finally, environmental atheists dealt with water or environmental topics along their career due to their professional role. They did not report an emotional attachment in their initial choice of career path or in their decision to engage in the basin committee, although it might have existed, or they might have developed such an attachment afterwards. These observations lead us to discard considering ecological engagement as a continuum from low to high along which we could rank every member, based on their degree of self-motivated interest to participate in basin committees.

Despite the apparently shared sense of duty mentioned earlier, motivations differ substantially between colibri members and the others, and so do rewards. All members mention some sort of "frustration" at times, regarding the tedious and time-consuming process of participation, but they accept this effort as a necessary part of the process of consensus-seeking. Although colibri members display a strong motivation to participate in basin committees, contrary to others, they get little emotional reward or satisfaction from it. On the contrary, they feel despair and resignation, emotions not mentioned by individuals falling under the other archetypes:

> It may not be much what we do, I do not know. In this respect I would be rather pessimistic, but that does not prevent me from going there. How could I say... This is the story of the 'colibri': There's a forest fire, all the animals are watching the forest burn - you know that story, right? Well, at least I would have done what I could. That's it. So maybe it's - sometimes I say to myself, it's completely ridiculous, I should give up on everything and go fishing as long as there are still fishes. (#22, ENGO)[4]

That observation created a puzzle that emerged early on in our field observations: how can members be at the same time so devoted to a participation process and to an institution, and at the same time so disillusioned regarding their relevance? We will explore this puzzle further on as we go along our findings.

Individual livelihood dependency on the river basin and engagement.

A first possibility that comes to mind to explain differences of engagement is to consider the way in which members individually depend on the river basin for their

[4] The full version story of the Colibri story is the following: "One day, says the legend, there was a huge forest fire. All animals, terrified, aghast, were watching helplessly the disaster. Only the little hummingbird was active, fetching a few waterdrops with its beak to throw them on the fire. After a moment, the armadillo, annoyed by this useless agitation, told him: 'Hummingbird, are you crazy? It's not with these drops of water that you'll put out the fire!' And the hummingbird answered, 'I know, but I'm doing my part.'" (Rabhi, 2010:127)

own livelihood. Matching archetypes with patterns of livelihood dependence, we found that things are more complicated than that. Most colibris are found among ENGOs or fishermen NGOs who do not depend directly on the river basin for their livelihood. Their professional life is disconnected materially from the river basin, e.g. in research institutes, or public administration. And they are in constant opposition to farmers, who are very sensitive to water issues, for example to droughts and floods. All the farmers interviewed matched the profile of resource environmentalists. Nonetheless, professional fishermen and shellfish farmers are just as much exposed to water issues or even more so than farmers, and among them we found colibris too, such as this professional fisherman, who shows a very intimate way of approaching the topic:

> I'm ... a bit of an odd person because, I'm trying to put myself in the place of my fishes. [...] To leave a bit one's own body and put oneself in the place of another living organism that is not human. (#35, professional fisherman)

Conversely, some resource environmentalist we interviewed have a very low level of dependence. Thus, our findings show that seeing material dependency as a single dimension predicting ecological engagement is incorrect. The exact nature of material dependency seems to be potentially a better predictor: what exactly the activity requires from the river basin (e.g. water quality, water quantity, spatio-temporal distribution, specific ecosystem services) and to which degree, and how actors leave water once they have used it.

> I am lucky not to have an activity comparable to that which at the moment defends its interests even if ... its cereal or animal production forces to pollute the water resource. (#30, shellfish farmer)

Finally, it is important to note that members depending on the river basin for their livelihood, may they be colibris or resource environmentalists, struggle when trying to reconcile their values and their financial needs.

> He became a professional fisherman. And so now he, a doctor in biology, defends professional fishing, more than biology. This is paradoxical. A little bit ... sometimes he goes in the same direction as us, but other times not. You see what I mean. That is to say that when the personal interest comes into play, for him that's a vital personal interest, since he lives from it. So, it's not bad faith on his part, but you need to know where you're talking from. (#22, ENGO)

After outlining the differences in terms of emotional and physical ecological engagement among archetypes, in the next section we focus on their cognitive approach to ecological topics, by exploring through which lenses they make sense of them.

Table 3.3 Second-order theme of ecological schemas with quotes

Ecological schema		
Conceptualization of the natural environment		
	Nature and humans are mutually exclusive *Marker for environmental atheists*	"At the time, if you like, there was so much to do, that the natural environment was almost secondary. [...] We knew there was something to be done, but it was really not a concern at all. There was so much to do, I call it primary, it may not be well-said. But most of the effort from everyone was mostly on water supply, water treatment, and sanitation. First wastewater collection, and if possible, wastewater treatment, but wastewater treatment, of course, with a link to drinking water." (#4, water utility) "The natural environment does not exist anymore. We no longer have a natural environment in France." (#10, water agency)
	Nature coevolves with humans *Marker for resource environmentalists*	"It depends on you mean by 'natural environment', because nature has evolved considerably. And from the moment that there was a man, it has changed things. [...] In the Aube area, we have water reservoirs, the Seine and the Aube Lakes, which had been created to protect Paris from floods and to sustain the Seine and the Aube rivers during dry periods. Those are artificial reservoirs, that took roughly 5,000 hectares of land and forest to be made, and today they are turned into nature reserves." (#29, local authority representative but farmer by profession) "When we make a water storage infrastructure, we need to look at the impact of this infrastructure on the environment. Positive and negative. Because when you make an infrastructure there is also an impact ... Well, there is also a positive impact." (#23, agriculture)
	Nature is vital to humans but mistreated *Marker for colibris*	"It’s not only water issues, it’s also the problems of biodiversity, species, and then also of ... having pleasant environments and landscapes. You have bocage countryside, even if it is not dense bocage. Go see in Beauce to see what is looks like. It's rather sad when you are in November and there is fog. No wonder there are farmers who shoot themselves. It's sad. It's ... how to say, naked. It's all empty." (#11, ENGO) "The industrial system in general, but especially the industrialization of agriculture, have destroyed a very old alliance between mankind and the Earth." (#22, ENGO)

Conceptualization of water	
Water inseparable from an ecosystem *Marker for colibris*	"Water, in fact, is mystery. There is what is above water, and then there is what is below the surface of water. And we do not always see on the surface of water even when it's transparent. And beneath the surface of water is the place of mystery." (#11, ENGO) "If you defend water, you defend the ichthofauna, you defend everything that goes with it." (#22, ENGO)
Water as H_2O *Marker for resource environmentalists and environmental atheists*	"I consider that water - may it be fresh or sea water - is an absolutely essential topic, vital for the human species as well as for the fauna and flora. To all, it brings the best benefits or the worst risks. Climate change emphasizes its importance even more today and tomorrow. The balanced, harmonious and sustainable management of both surface and subsurface resources, renewable or fossil, and their multiple economic, social or cultural uses requires all disciplines." (#1, state and water utility)
What constitutes a problem	
Questioning the problematic nature of facts	"I had just shown them a presentation made by IFREMER where you could see the nitrate flows coming out of the Loire like this and around the whole of Brittany to go as far as the North Sea. He said to me 'Oh but in any case, the sea does not need fresh water.'" (#22, ENGO) "I met people from the FNSEA who still tell me [...] 'there will be enough water, but it will be badly distributed through the year'. You imagine how smart it is. 'Water is poorly distributed in the season'. It's true, it's stupid. But the snow is also really badly distributed through the year, it's very stupid. If we could spread the snow better, it would be more, even more intelligent." (sarcastic tone) (#21, local authority)
Perception of belief	
The others are believers	"Today, it is a discourse from believers. They say, 'nature must be protected because we depend on it'. I say that the French natural environment is totally artificial. A little less than in Switzerland. A little less than in Holland. But it is totally- there is nothing natural. Even in Guyana, there is nothing natural about it. And ... so we have the environment we deserve. I worked a lot, to create channels of the North, and to shape landscapes in Provence. I mean the environment for me is a trap." (#8, water agency)

	"Behind this observation, there is the fact of an ideology, the ideology, I would say, of growth, the ideology of production." (#11, ENGO)

3.5.3 Ecological schema

By ecological schema, we consider the distinct conceptualizations members have of common ecological terms used in basin committees. This theme appeared as we realized that, before even differing in opinions regarding the relationship between certain ecological components (e.g. the link between "rain" and "pollution"), members had different conceptualizations of those components in mind (e.g. what is "rain" or "pollution"? Are those standalone constructs?). Depending on who we would talk to, a word would take different meanings. The codes related to this theme are presented in table 3.3.

Conceptualization of the natural environment

The last question of our interview protocol, concerning the space dedicated to the "natural environment" in discussions, led to dividing and revealing reactions. In some cases, it led to blunt reactions, such as a farmer not understanding the question as he found the answer too obvious. As he simply put it, "it's everywhere" (#23, agriculture). But many members found the question important and said that this space was

insufficient. Therefore, we find that many different conceptualizations of nature or the natural environment exist among basin committee members.

In the language of basin institutions, the ecological water renewal system (i.e. evaporation, precipitation, river flow, infiltration) is called the "big cycle" of water. Meanwhile, the "small cycle" of water is the man-made treatment system to obtain potable water (water extraction, drinking water treatment, adduction, wastewater treatment). Environmental atheists, when asked about the place left to the natural environment in the debates, directly refer to debates on the big cycle. In that sense, they conceptualize human intervention and nature as mutually exclusive. To them, ecological elements irredeemably lose their natural aspect as soon as humans starts manipulating them. They see two distinct realms, the realm of things under human control, and the rest. Pushed to its limits, as humans have influenced in some way all the territory, this reasoning sees nature as fully gone, saying that "in the big cycle, there are mostly hopes and things that do not exist" (#8, water agency).

Meanwhile, other members do not see nature as gone. They see this distinction between two worlds as unrealistic, as "there is only one cycle, the big one, the very big one" (#30, shellfish farmer). A resource environmentalist mentioned that one should get rid of the distinction altogether, as "the more global, environmental, ecological concern, regarding resources, I say, the protection of resources is now so integrated into all our subjects that ... having this distinction no longer makes much

sense" (#24, local authority). Resource environmentalists see nature as molded by humans in a negotiated interaction, without it stopping being nature. This vision, especially present among farmers, sees humans not only as destroying but also as potentially contributing to nature by their interventions.

> Nature reacts, so our job is fascinating. (#19, agriculture)

Meanwhile, colibri members present nature as still existent although suffering from humans' assaults. More notably, they see natural, or ecological elements as playing a much broader role than water for drinking and raising crops. When environmental atheists see anything outside of the "small cycle" of water as not directly relevant to human vital needs, colibris perceive that natural elements provide humans much more than physical wellbeing. For example, they also provide mental wellbeing. Natural settings, such as notable landscapes, are presented as vital for psychological health and not a decorative anecdote, as when one member tells how he was struck by the story of a river restoration which allowed inhabitants to "hear the river sing again" (#21, local authority). They experience that mental benefit from the rivers firsthand:

> I do not know if you know the place, in the Orient Forest natural park. So, well, those are exceptional places. Me, one day alone or with my friend, with my buddies, on the water, you feel like you've gone on vacation, you do not know where you are, you come back ... here it is, it's completely ... it relaxes, beyond the fishing. (#33, fisherman NGO)

Conceptualization of water

As discussed earlier, we know that colibri members have a distinct relationship with water issues, linked to an emotional experience of a place, of a river. And when they talk about water, they do not talk only about water resources; they conceptualize water as "inherently the element that structures an ecosystem and inherently not a resource" (#21, local authority). They see themselves as different from the members of other groups, who, in their view, perceive water as "a sort of object, a sort of thing" (#21, local authority). They see water in the context of the ecosystems, with the life that goes with it, or even in an esthetic approach. This vision of water is in coherence with their source of ecological engagement, as they consider their own identity marked by what they understand as water, in a material experience of a place.

In that, they are radically different from both resource environmentalists and environmental atheists, who mostly reported an intellectual interest for water and see no concern in referring to "water resources". Those members conceptualize water in a plain physico-chemical manner, as H_2O particles and the services they serve for ecosystems, as can be see clearly in the following quote:

> Water has a great characteristic, something very special ... Water, how to say, it's never consumed. We never lose water. It's only transformed. […] It's useful to many

things; it’s never lost. One must always know: Water is a zero-sum equation. (#24, local authority)

Those members see the importance of water resources to life forms, both humans and animals. But they see water as distinct from that life, not attached to a place or context. By contrast, the vision of colibris see water only as contextualized in a place, and englobing life that inhabits it.

Anticipating our next point on problem perception, one can see how these differences in vision link to different readings of ecological facts. If a member sees water purely as a resource, then an increase in evaporation is not necessarily a loss: it is a change in the spatio-temporal distribution of that resource. Indeed, a resource environmentalist, to explain that water is not lost with retention and evaporation, invokes Lavoisier and, through him, the famous dictum that "nothing is lost, nothing is created, everything is transformed" (# 19, agriculture). Meanwhile, if one is attached to a specific ecosystem and its characteristics (e.g. landscapes, biodiversity), as the spatio-temporal distribution of water alters them, any change in the water evaporation pattern from that system becomes a loss. This difference of conceptualization can explain the persistence of heated discussions on water retention and irrigation for agriculture going over decades.

What constitutes a problem?

Repeatedly in our interviews, we saw how ecological facts could be easily observable by all but understood as problematic only by some. Different ecological schemas come with different definitions of what is an ecological issue. Those differences in problem perception are not a consequence of a lack of information, but on the contrary are resistant to the exposure to scientific information. Among such facts, we find rain patterns, floods or evolutions of biodiversity such as those resulting from invasive species. The two following quotes are representative of the logic that members use to disregard the problematic nature of ecological facts:

> What makes the Loire ... It's its extreme irregularity. And so, flooding is not a disaster, it's not all that, it's constituent. It is the Loire. That's it. Like the Nile. Egypt is the gift of the Nile; well the Loire Valley is a gift of all that. (#21, local authorities)

> So, what is an invasive species? Well it's a species that we introduced, and which takes the place of native species. I say, isn't it just evolution? It comes from far away and it took… isn't it a bit of racism regarding species coming from far away? (#18, industry)

In the first quote, the member, identified as colibri, does not see how something that is characteristic of the functioning of an ecosystem can be problematic. It is the nature of the river basin to function like that. As his conceptualization of water is always contextualized, he does not see anything problematic in flooding. In the second

quote, an environmental atheist, on the opposite, does not see what is problematic in the evolution of the characteristics of ecosystems. But to him, there is nothing natural about the river basin anymore anyway, because of the modifications already made by humans. And as such, any evolution can be welcomed depending on the benefits it can bring to populations. As his conceptualization of water sets it apart from the ecosystems, this fact is not necessarily a water issue per se.

Different schemas seen as beliefs.

Basin committee members acknowledge that there are other ecological schemas than their own in basin committees and refer to them with strong words, such as "extreme dogmatic visions" (#23, agriculture). To all basin committee members, approaches that differ from theirs on ecological topics are attributed to ideological postures. As a consequence, they regularly resorted in their interviews to pejorative terminology of beliefs or ideologies to mention other members, such as: "technocrat lunatics", "ayatollahs", "fanatics", "green Khmers" (in reference to the infamous Cambodian dictatorship). On the contrary, a member from a different group could still be valued positively if he was perceived as "not sectarian" (#15, local authority).

Interestingly, both colibris and resource environmentalists also sometimes apply a lexicon of belief or ideology to themselves, sometimes portraying their participation to the basins institutions as a "calling". The most flagrant case is a

member reporting an ecological epiphany of sorts, that disrupted her approach to ecological matters.

> And then I immersed myself in everything related to the environment. I discovered that I was a polluter, an unbelievable sinner. I thought, but it's not possible what ... what I'm doing. And suddenly I got passionate. So then for 2-3 months, I couldn't sleep. (#26, water consumers NGO)

We understand these strong expressions as a sign of attachment to one's own schema regarding river basin management. In addition, the negative discourse on others' dogma aims to diminish the value of the contribution of those members to the basin committees, where, as we will explore in the following section, positions are expected to be informed by technical expertise and scientific information.

Table 3.4 Second-order theme of ecological understanding with quotes

Ecological understanding	
Understanding through science	
Calling for more scientific information	"I personally find that we do not rely enough on science. [...] I also think that there are some topics on which there are endless debates with fierce back and forth exchanges between actors. If there was a ... a real scientific analysis, it could - well anyway for me it ... it would make me feel safer." (#18, industry) "I realized that it was necessary to have a qualified external expertise to these visions ... I would say, who are like puzzles. And I fought – but I still have not succeeded, and my successor neither– to have an independent scientific committee within our basin." (#32, local authority)

	Questioning the validity of information	"(There are some) some hardliners who until the last moment vote against the text and who do not adhere at all, who will tell us that they do not agree with the river basin planning because before the planning, there has been an inventory and as they do not agree with the way in which the inventory has been done, they do not agree with the planning." (#9, water agency) "From time to time we give ourselves false ... maybe false scientific justifications by saying yes-yes the data says that - Yes, but finally it was 6 years ago so uh ... Is this really what we should do now, I don't know. It's very ... So we're not really in science there." (#18, industry)
	Uncertainty on long-time frame and climate change	"Well, I mean, all of these are decisions ... where we will see the consequences in 50 years. Is it good or not …" (#19, agriculture) "I have a dam project where we propose an operating solution that would allow ... to leave the way completely free (for fishes) for 3 months in the year. Environmentalists say, 'ah yes but in 20 years ... what tells us that that will still be during 3 months'. Nothing. In 20 years, neither you nor I will be there, there will be anyway perhaps no more fish in the river (laughs). I do not know, well that's it." (#18, industry)
Territorial understanding		
	Territorial information gathering	"For example, if we are not on the lookout in the Aube area, we have seen tracked vehicles in river beds, or example, where there are trout spawning grounds. So there are no more spawning grounds. [...] There is nothing more irritating, as far as I'm concerned, than to pass by a place and see that there is a tracked vehicle there. What the heck is it doing there?" (#33, NGO fishermen) "I was living in the area. I was not doing sports around the Loiret basin as the university people would do. But then there were guys I knew professionally, and they were going jogging [...]. And then while running these people met a local resident who was there. And the resident tells them, you know you must enjoy it, because soon the calm of this place will be gone because there is a highway that will pass over it." (#11, ENGO)
	Territorial influence on understanding	"An operator like me from a semi-urban area, an operator from a very urban area, from Paris, or from a completely rural or maritime area, we have different sensitivities. So, when facing the

	same objective fact, we do not feel the same." (#24, local authority)
Ecological diagnosis	
Upcoming doom *Marker for colibris*	"The human species must ... do more- well do more than currently of course. Whether it is for global warming or the protection of biodiversity. Because shortly there will be only us left on this planet. And (laughs softly), it won't be habitable anymore." (#27, ENGO) "We are massively trashing our countryside after all. We are destroying our soils, we are sending nitrogen in totally abusive amounts…" (#21, local authority) "At the end it's a catastrophe, it's already a catastrophe in a number of places, and if you look at the climate again, it's already a catastrophe. If one looks at the Greenland melting, or the poles, the ... the average alpine glaciers, one looks at that. It's going away with high speed. And we're anticipating that, in the climate change forecasts, in fact the linear extrapolations are certainly not linear, that means it's worse than anything, it's not linear, it's worse than that." (#11, ENGO)
Optimistic outlook *Marker for resource environmentalists and environmental atheists*	"Regarding the environment, I am rather optimistic. I think there is a pro-environmental movement, which is irreversible and necessary. I think that there has been an awakening, and that indeed, we have done too much nonsense on this planet." (#32, local authority) "Overall, the indicators that Europe gives us, show that we have rather damaged water bodies, but, if you look at the territory specifically, at the evolution, because Europe does not want us to. Regarding the evolution, we are very positive." (#12, water expert)

Incremental change is the only way *Marker for resource environmentalists and environmental atheists*	"It's all this difficulty to bring a maximum of actors on board, to find the means, not to be limited to something that is fun, that goes perhaps very far regarding objectives, in terms of ambitions, and that therefore is seen by the bigger crowd like, 'yes it's good but it's not for everyone'. And here I always say to make sure that the step is not too big. We're not here to give ourselves a treat. We're here to ... bring as many people as possible towards more virtuous systems." (#31, agriculture) "I believe in the progression of things, never fast enough when it comes to the well-being of some, there I share that opinion with some members, including extremists. But we shouldn't bury our head in the sand. We cannot move forward any other way." (#12, water expert)

3.5.4 Differences of ecological understanding

Everyone has one truth. (#12, expert member)

Having explored the categories along which members differ in their way to relate to ecological matters, first physically and emotionally (i.e. ecological engagement), and then cognitively (i.e. ecological schema), we dig further into the cognitive aspects of ecological embeddedness, by examining how members acquire and articulate their own set of knowledge regarding ecological matters, based on their different ecological schemas (cf. table 3.4 for related codes).

A nuanced approach to natural sciences.

Throughout the debates in basin committees, all members refer to reason and pragmatism to defend their position. Basin committees are regarded as "schools of

water", in which scientific knowledge and expertise are highly valued, and expected to inform decisions. Nonetheless, when we explore the participants' comments regarding technical expertise and scientific knowledge, we see that members have a more nuanced relation to science. Although it is possible in those institutions to change someone's opinion by presenting him or her with new information, this process seems not so obvious, and is reported as tedious.

> If you are in a commission with 15 people and you are the only one defending an interest, when you are expressing yourself, saying things, you can win if people acknowledge that what you say is intelligent. It happens. It's not every day. Fortunately, it happens, otherwise I would not participate in the commission. (#27, ENGO)

> We notice that it takes a long-long time to discuss until people accept to hear, even to... I wouldn't say to admit, because there are people that never admit anything. You may have argued well, even with solid, scientific arguments, for them it's 'no-no'. It's their opinion that prevails. (#35, professional fisherman)

Participating in committee meetings implies having access to a large amount of scientific information, in the form of reports and presentations. Nonetheless, scientific information is not understood the same by all members. First, this information is quite technical. Participants who do not have a solid scientific background report struggling to process the information given to them, even more so as it is presented in addition to a complex regulatory environment. Aside from the case

of inexperienced members, scientific information is not enough to establish an agreement among members on what is happening in the river basins, and what decisions should be taken from there. Despite being exposed over long time periods -sometimes decades- to the same information, members form divergent opinions of what is going on in their river basin. Opposite views can be seen, for example, regarding the evolution of the ecological condition of rivers, as seen in these two quotes:

> You have things that nobody says and that I spend my time saying. [...] The rivers have never been this clean in France ... just obviously, we had big industrial pollution. Anyway, it was simple: there was no oxygen, there was nothing in the water. You only had organic matter etc. Industrial and domestic. We treated that. So, oxygen came back in the water. (#6, state)

> The year 1964 and even before, well, the state of the environment, in spite that, was infinitely better than now. There isn't even a comparison. [...] So when we say water quality, with biodiversity indicators that tell you what is up. Because in fact, as in any environment, there is life. It's part of the communication of the water agency, there is life in water. Well then there is less and less life or there are very special or different forms of life from what was before. (#11, ENGO)

There are also opposing statements on the feasibility and outcomes of environmental action. The most notable example would be regarding the feasibility of water retention in agriculture to “adapt” to future changing patterns of rainfall due to

climate change. As we saw in the previous subsection, those different readings of reality take their root in different ecological schemas. If one sees nature as disconnected from humans and not directly related to their “primary” necessities, and water as a simple resource, the first statement here above might be accurate: wastewater treatment capacities have made great progress since the 1960’s in France. The same reasoning goes for the second statement, with the notion of water as indistinguishable from an ecosystem. In the end, those ecological statements are the "truth" if one reads them with the corresponding schema, which echoes the statement from a member that "everyone has one truth" (#12, expert member).

Factual disagreements lead to strong emotional reactions and accusations. When faced with contradictory facts, members will try to undermine their validity by aiming at the research paradigm behind, for example by denouncing "a very effective specialized knowledge based on machinery, which ignores the reality of the complexity of the world" (#11, ENGO). The other opinions can also be discarded as irrational or dishonest, as a "belief", or "negationism".

When confronted with facts they don’t agree with, members not only answer by opposing contradictory facts but also by questioning the validity of scientific information. The ecological nature of river basins facilitates this culture of uncertainty, since its management has been marked by a history of unpredictable outcomes and long-term implications. Upcoming climate changes, which everyone expects to bring

additional ecological threats, add another layer of uncertainty and unpredictability, to which scientific information cannot fully answer.

Thus, we see that, due to different factors - and most notably the existence of diverging schemas among basin committee members - the development and communication of vast amounts of scientific information is not enough to reach common definitions of ecological problems.

One last limit to the use of scientific information at face value in basin committees is the perceived divide between "the ones who know, who are the water agency employees, and then the territorial ones, or the representatives of the territories, who do not necessarily have all the technical and financial elements, but who have the knowledge of the territory" (#29, local authority). The territorial members in this quote include all local authorities, economic or non-economic users, i.e. all members who are meant to represent a piece of the territory. They represent the vast majority of basin committee members. That territorial understanding seems to play an important role that links members again to their ecological context, their "realities".

Understanding without science: territorial understanding.

In a modern setting, "walking the land" (e.g. in our case, observing the river directly) plays a role but is not the main way for members to gather information. This does not

mean that the knowledge acquisition of basin committee members is disconnected from their physical presence in one territory. Territorial understanding is actually called for by the basin institutions:

> The advantage of water agencies is that there are representatives from everywhere, so already a real territorial representation, with a specificity of the different zones, with a specificity of local challenges, environmental and others. [...] [The members] have that vision, at the same time knowing a bit the documents, and then at the same time knowing their land, their territory and the environmental issues of their territory. (#31, agriculture)

Territorial affiliation influences in two ways a member's information gathering. First of all, we consider territorial information to be information that would not have been accessed by members if there were not locally socially and ecologically embedded. Members complement their own "land-walking" with a vicarious experience of the river basin through the stories that actors from their social network tell them, in a process of territorial information gathering. This becomes apparent in interviews as members report equally facts they have witnessed themselves, and stories they heard from people living in an area. That each member has more information on a specific territory, or sub-basin area, seems normal due to the sheer size of river basins and diversity of types of ecosystems included in them.

Further than the development of that distinct set of knowledge, the territorial anchorage influences the way members make sense of both the territorial and the

general information given to them. Territorial affiliation can also act as a hindrance on the ability of an actor to make sense of some kind of information, again in part due to the size for river basins, where "there is a certain divide in terms of territory between what happens in a basin committee and then the people in their homes, from the Haute-Loire, Ardèche where the Loire has its source, down to Finistère" (#9, water agency). While actors certainly understand their own dependence to water, it does not mean they instinctively grasp the impact of their own behaviors on actors downstream. Much more than a matter of vested interest, it seems to be a matter of cognitive awareness:

> You see, the sea is something else, but also because we struggle to make the connection between ... freshwater environments and the sea. (#22, ENGO)

> Imagine, the farmer from deep in the Indre-area to whom they say, "you are the cause of marine pollution." (laughs) (#21, local authority)

Inhabitants of river basins do not by themselves gather ecological information covering the whole river basin, nor do they know how to read information from a system perspective. Some form of education or technical knowledge is necessary to make the leap from seeing ecological elements of one's local territory to understand them in the context of the river basin system. A good example is a water agency employee getting upset at people rejoicing to see the Rhône river full in summer. Where they saw a sign of abundance and good ecological health, she saw the melting of glaciers upstream. Similarly, farmers sometimes interpret the flow they see in the

rivers as wasted when they are limited in their own consumption, not understanding how vital this flow of clean water is for downstream activities.

Inhabitants do not relate to the whole river basin as a territory they belong to. But by taking part in basin committee meetings, members get an experience that aims to help them stretch their territorial understanding to match the ecological boundaries of the entire basin. This experience is both institutional (being exposed to information and institutions, talking to actors from other parts of the basin) and material (travelling to the meetings, as well as field trips).

> With field visits, when we went to see a project. Well, we could go there and become aware of a problem that we had not had the occasion to meet before. We are not aware of everything that happens in a large basin because we are all-knowing just by being on the basin committee or the board of directors. We know our own projects, we try to know those of others on paper, but to know them on the ground, to meet people, it's not superfluous. [...] So there is a certain consensus that appears with the influence of time, and field visits that make the realities more tangible. (#1, state and water utility)

Territorial understanding is a striking example that institutional actors are not disconnected from an ecological context, even in a modern setting where one does not spend so much time outdoors. The territorial connection in a river basin, whether upstream or downstream, whether rural or urban, conditions knowledge appropriation.

Ecological prognosis.

Having dug into all the differences of ecological embeddedness among archetypes, both emotionally and cognitively, we now see how having different forms of engagement and schemas link to holding different "truths." These differences culminate when it comes to ecological prognoses, which are key when approaching ecological sustainability and the corresponding regulation. A central divide among members is on the necessary timeliness of solutions to ecological pressures. Contrarily to other members, colibris hold that there is a time constraint, a time limit in the future regarding ecological systems' resistance, and that the current rate of change in regulation and practices is not fast enough to avoid a catastrophe.

> Constant consensus ... really allows things to be pfff ... extraordinarily slow. [...] It's compulsory in a way, but it does not change things. Not fast enough. (#30, shellfish farmer)

This catastrophic outlook is tightly related to their particular emotional attitude towards river basin management matters, to what makes them colibris. They have a sense of hopeless dedication to basin committees as they live with the certainty of a massive ecological collapse in a matter of decades. It is quite telling that, without being ask about this at any time, two of interviewed colibris took the liberty to directly question the ability our first author, younger than them, to have an offspring that

"lasts", saying "mine I think they are of age, they will make it. But yours, I do not know" (27, ENGO).

In contrast, environmental atheists and resource environmentalists believe increased ecological objectives are meant to push things to be even "prettier", with no notion of the necessity to avoid a crisis, but as driven by a political will.

> Participant: We have to getting into ... Well, into grotesque reasonings.
>
> Interviewer: What sort of reasoning?
>
> Participant: May everything be beautiful; may everything look clean. We have to take care of everything at the same time, etc. It's ... well, it's not reasonable. (#5, industry)

Many of these members have an optimistic outlook regarding the evolution of ecological conditions. But more importantly, even when they acknowledge the positive ecological consequences radical regulatory changes would have, they see incremental consensual progress as the only possible way. Quite the opposite, they "believe more in small steps than big ones" (#12, water expert). Where colibri members see an ecological boundary in the future, they see a social boundary in the present. The gap between the ecological prognoses of those archetypes is so broad that transitioning from interviewing a colibri member to another member felt to the interviewer like changing reality.

Non-colibri members present the degree of requirement from colibris as unreasonable, utopian and unnecessary. For colibris, it is the perpetuation of the

current situation that is unrealistic and impossible. All members, once again, claim to have a pragmatic approach, but they do not speak the same language, and talk past each other, hence the lasting disagreements, even in a context like this one where shared basin institutions have emerged.

3.6 Discussion

In this paper, we explored the connections institutional agents involved in French river basin institutions have to their ecological context, and we outlined the main components of ecological embeddedness in a modern institutional setting, i.e. ecological engagement, ecological schema and ecological understanding. Further, we saw how nuances of ecological engagement and schemas can lead to radically different ecological understandings among institutional agents, even if those agents are exposed through long periods of time to the same scientific information in a shared institutional context. In that sense, our study contributes to institutionalist research interested in understanding the relationship of institutions to their surrounding ecosystems, as it outlines the most relevant components of ecological embeddedness, and how it matters to explain the understanding institutional agents have of ecological matters.

3.6.1 Ecological embeddedness and ecological materiality

Our data only had scarce references to firsthand physical experience in the ecosystem. It is indicative of a modern setting, where people spend little time outdoors (Klepeis et al., 2001). But this does not mean that members are independent from ecological contexts. Our analysis shows that in the context of French river basins, ecological materiality plays a role in the development of a member's ecological engagement, schema, and ecological understanding. It does so through the experience a basin member has from ecological elements, lived as an important childhood event, or as a daily territory. In figure 3.2, elements where materiality plays an important role are outlined in bold boxes. Although the place of lived materiality can seem discrete at first, its effects are lasting and can resist years of institutionalization.

If we look at the themes we developed from our data, we can see that none of them are completely devoid of social influence (past education, territorial affiliation, and so on). But none of them are devoid of ecological influence either. Ecological materiality influences institutional actors through their ecological embeddedness, but ecological embeddedness is not entirely material. That finding makes sense, as, in a social-ecological system framework perspective (Ostrom, 2009), ecological embeddedness should be seen as an interaction between social and ecological components. Therefore, strictly speaking, ecological embeddedness as we frame it is

more a window for institutional theory to look towards ecological components, rather than a perfect ecological equivalent to institutional embeddedness.

3.6.2 Forms of ecological embeddedness as a tool to embrace complexity

We see from our findings that ecological embeddedness is a matter of forms rather than of extent, as previously framed by Whiteman & Cooper (2000). Treating an actor as ecologically embedded or not provides limited valuable insights, just as it would to say actors are institutionally embedded or not. One should ask: In which institution or field? With which position? Similarly, concerning ecological embeddedness we should ask: Do they materially depend on this ecosystem? What for? What are their emotional relations to it? What sort of ecosystems do they think we need? Likewise regarding institutional logics, following our result, the notion that there is a single "green" or "environmental" logic (e.g. Dahlmann and Grosvold, 2017), seems over-simplistic and does not do justice to the complexity of ecological issues that managers have to face and the complexity within the institutions which manage these issues.

We have identified three archetypes of ecological embeddedness, although we expect many more to exist, with internally consistent engagements, schemas and understanding, which we summarize in figure 3.2. As it is a first exploratory study,

our study does not map for every potential river basin topic how different forms of ecological embeddedness relate to different opinions, nor was it our intention to do so. Although resource environmentalists and environmental atheists are arguably closer to one another, their relationship to their ecological context is intrinsically different, notably regarding their conceptualization of the natural environment, and will lead to different conceptions of what is a problem. From a collaborative governance or institutional perspective, those differences of ecological embeddedness can lead to lasting disagreements and conflicts that would not fade away with the emergence of a shared logic (Ansari, Wijen, and Gray, 2013).

Our contribution to that regard are the notion of ecological embeddedness as a matter of form and not of extent, and the three themes we outline (i.e. engagement, schema, understanding). The three forms - or archetypes - presented here are mere tools that allow us to approach these notions. They could arguably be limited by the empirical context, not only culturally (i.e. a Western setting), but also ecologically (e.g. temperate Western European climate). Nonetheless, they can be of some relevance in other empirical contexts as a comparison. The particular approach of colibri members for example, in their commitment to an institution that they see as pointless, interestingly echoes in the contemporary world and within contemporary institutions the "radical hope" the Crow tribe resorted to when facing the collapse of their way of living and of "the destruction of [their] telos" (Lear, 2006, p.152). Such a comparison can make us reflect on how modern institutions can react when faced with

their own ecological vulnerability, as "the inability to conceive of its own devastation [is] the blind spot of any culture" (Lear, 2006, p.83).

3.6.3 A way forward to overcome differences of ecological understanding

From an institutionalist tradition, we approached ecological embeddedness as all the interconnections actors have with their ecological context that prescribe or constrain their behavior. In that we develop a broader definition to ecological embeddedness than Whiteman and Cooper's (2000), revealing the diversity of profiles hidden behind that concept. This new approach is more compatible to the contexts of multi-actor institutional complexity we often encounter in our societies.

Under certain conditions, diversity can be positive to collective endeavors when facing ecological issues, such as the diversity of resources made available to the collective (Dutta, 2017). But we are not here facing a problem of resource scarcity, but rather an issue of problem definition, where diversity of worldviews can represent a burden. In participatory processes, Selznick (1949) warns us against the dangerous drift of organizational goals when those include "unanalyzed terms". For example, the management literature oftentimes focuses on companies' efforts as turning to measures that are "greener", or more "sustainable" (e.g. Martinez, 2015). Those papers

focus directly on what makes companies decide to implement those measures, without questioning what makes them more beneficial to "the environment". This approach assumes that what an environment in a good state is or should be is unambiguous, that actions can clearly be classified as being beneficial to the environment.

In our study, we show that this approach risks offering a simplistic story, and that we, as organizational scholars, need to dig into the complexity of ecological issues to tackle them in a relevant way. In a case like the one studied here, basin committee members can be said to be "educated" in a boundary organization to the challenges their river basin faces (Fan and Zietsma, 2017). They are exposed to the same scientific information during several years, sometimes decades, as well as to a representative diversity of interests and opinions of actors with whom they share that river basin. And yet, although they developed a shared understanding of how deliberations should go - through the adherence to the basin committee institution - they have not developed a shared understanding of the river basin itself as a common (Ansari, Wijen, and Gray, 2013). They continue to disagree on what practices represent good environmental management. They don’t just disagree on the accuracy of ecological statements, they disagree on the interpretation one can make from those statements, and they disagree on priorities. They even continue to disagree on what the natural environment is or is not. And those actors have been exposed to the same debates for years, even decades for some of them. To sum up, we see that ecological engagement and schema go beyond knowledge acquisition. Resorting to these concepts could help understand

better the phenomenon of climate denialism among managers, and the divergence of opinion even within one same profession (Lefsrud and Meyer, 2012).

Natural sciences alone cannot inform with an absolute certainty which practice is "good" or "bad" from an ecological perspective, or what is a "problem". This is partly due to the complexity and unpredictability of ecosystems such as river basins, which is amplified due to their interaction with human societies (e.g. Rice, 2013). Indeed, the ecological outcomes of environmental measures such as ecological restoration are oftentimes very hard to assess (e.g. Morandi, Piégay, Lamouroux, & Vaudor, 2014). But further than that, natural sciences cannot answer the questions raised when confronting different ecological beliefs, different visions of what human societies need from a river basin. In our research context, some members are aware of that:

> We do not even defend nature. We defend a vision. We defend an idea. Because, again, it is not nature that has mandated us to go there. So, we do not defend that. We are- we defend something like a political vision. In a way, we are the only ones to defend a public interest. (#21, local authority but identifies as ENGO)

When we are talking about sustainability in the context of river basin management, we can wonder again, "what is to be sustained?" (DesJardins, 2016, p.121) Is it a certain form of drinking water and food supply? Is it landscapes with all their characteristics? Or is it a certain form of biodiversity as inherited by millions of

years of evolution? The list of wishes could go on forever. The answer cannot be "all of the above" as those goals have different material implications. The current model of agriculture, for example, alters biodiversity and threatens the quality of water resource for drinking water supply. Historical buildings, which are part of cultural landscapes, such as old mills, pose a threat to the fauna. Tough choices have to be made and, again, ecological materiality sets conditions: All cannot be kept as it is, not because we do not want to, but because ecosystems work within a constrained realm of possibilities, for example constrained by the laws of physics, regardless of how we conceptualize them.

In the end, discussions boil down to one question: Keeping ecological constraints in mind, what environment do we wish for our society in the future? And to its uncomfortable corollary: What are we willing to give up on? As it is, this last question is never openly phrased in basin committees. It could nonetheless help to think about the necessary trade-offs societies will have to face (Bendell, 2018).

3.7 Limitations and future research

We limit our investigation to the individual understanding of environmental problems. Indeed, previous research has underlined the importance of initial problem identification for the effectiveness of the answers of a community on environmental

projects (Gunderson, Holling, and Light, 1995), as well as when facing social challenges (Arenas, Murphy, and Jáuregui, 2019). Nonetheless, further research is needed to link those different forms of embeddedness to institutional work or change. Also, on the influence of ecological materiality through emotional experiences, how and why physical presence leads to an emotional attachment for some individuals and not others remains undetermined and can be explored in future research. Future research could potentially elaborate and test on potential combinations across dimensions of ecological embeddedness, and between ecological embeddedness and institutional embeddedness with QCA methods.

The members who took the time to participate in our study might also be the ones most committed and "acculturated" to the river basin institutions. Other profiles might exist which do not answer willingly to that kind of research project, or whose form of embeddedness is incompatible with the participation to such institutions. The potential existence of other archetypes, which we endorse as possible, nonetheless does not take away the value of the three archetypes outlined in this paper. On the contrary, it aligns with our call for more research from institutional theory on the role and forms of ecological embeddedness in institutions. Much remains to be done. For example, material dependency and territorial understanding are two important material influences on institutional actors that we have pointed at, but not fully developed due to the limits of our data. Future research should explore this matter further, both qualitatively and quantitatively.

3.8 Conclusion

The organization and management literature is suffering from a paucity of vocabulary when dealing with ecological matters. We have spent great time dissecting different forms of institutional logics (market, community, etc.), yet considering what is "environmental" or "sustainable" as just one big block. Just as colonists setting foot on America and calling all tribes "Indians", management scholars still approach ecological matters as one obscure continent. Our study shows that no study on sustainable ecosystem management should take a practice advanced as "sustainable" at face value, as no institutional actors will have the same approach to that notion, and not only because of differences in institutional embeddedness.

Our study re-conceptualizes ecological embeddedness far from the extreme case of Cree tallymen, closer to realities which can be more familiar to management academics. We offer this renewed concept as a tool for institutionalists to untangle sources of complexity regarding ecological topics. It shows how "modern" Western institutional actors relate to their surrounding ecosystem: humans spending less time outdoors, but ecologically embedded nonetheless, in their own way. More precisely, our findings develop on different ways to relate to an ecological context and resulting ecological understandings.

Finally, having observed how disagreements and misunderstandings on ecological issues can persist in spite of shared organizational goals and scientific information, we propose a new approach to ecological goals at the individual and institutional level, keeping ecological materiality in mind. We should strive not to ask ourselves "what do we wish for?" but rather "knowing the ecological boundaries, what are we willing to give up on?" This approach might prove fruitful to prepare for upcoming climate disturbances.

3.9 References

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3.10 Appendix for chapter 3

Interview protocol

Personal profile

Age, educational background, professional experience

What is your experience with basin organizations? How did you come to take part in them?

Basin organizations as a context. Individual perception of the institutional context.

On the organizational goal of basin authorities:

- At the beginning of your experience, what was the organizational objective of the basin committees for you? Has this perception evolved afterwards?

- Have you perceived any gaps between this rationale and practices? If so, which ones and according to you why?

The role of participation and inclusion:

- What does the inclusion of all different stakeholders in committees mean for you?

- What does effective participation mean for you in the basin committees?

Individual perception of personal involvement and experience.

Personal experience of participation

- What did participating in basin committees represent for you, in terms of commitment, time, etc.?

- Why did you participate? What was motivating your participation?

Information transfer and collective learning

- Have you learned anything / obtained information via basin instances? If so, what and under what conditions?

- Have you given information to someone else via basin instances? If so, what and under what conditions?

Legitimacy of the decisions taken

- What do you think about decisions taken in the basin?

Conflict

- Do you remember seeing conflicts within committees? If yes, how did they unravel, how where they lived and managed?

The place of the natural environment

- In your opinion, what is the place of the natural environment in the river basin deliberations?

Miscellaneous

- Is there a final important aspect of your basin experience that we have not mentioned so far and which you think is worth mentioning in this study?

4

The ecological outcomes of participation across large river basins: A social-ecological study linking institutions to their natural environment

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4.1 Abstract

Collaborative governance of natural resources in social-ecological systems has been repeatedly presented as central to long-term sustainable natural resource management. Nonetheless, the effectiveness of collaborative governance in terms of ecological outcomes has not been proven yet. Therefore, we consider the extent to which this form of governance is effective in the context of river basin management, and under which conditions. More particularly, we investigate whether the participation of different groups of actors matters from an ecological perspective. To that end, this interdisciplinary paper links social and ecological indicators across two large French river basins in a dataset spanning 25 years. We find that participation is not a one-size-fits-all panacea and that ecological outcomes can be influenced differently by the presence of different groups of actors. Further, we show that future research should acknowledge a broad variety of ecological outcomes when assessing the collaborative governance of social-ecological systems, more than having a one-dimensional 'sustainable' vs 'non-sustainable' approach.

4.2 Introduction

Previous reviews of the sustainable water management literature have pointed to a lack of research actively including ecological outcomes conceptually or empirically

(Baudoin and Arenas, 2020). Indeed, research has mostly focused on social outcomes or used regulatory outputs as a proxy for governance effectiveness (Koontz and Thomas, 2006). This research gap is partly due to methodological challenges and a disconnect between datasets dealing with social and ecological issues. The few articles who did tackle that question in the context of river basin governance found nuanced results (Newig and Fritsch, 2009; Biddle and Koontz, 2014; Scott, 2015; Scott, 2016; Biddle, 2017). As a result, the empirical case for the ecological effectiveness of collaborative river basin governance remains weak, whilst this form of governance is still promoted as a strategy to reach ecological objectives.

Participation is central to collaborative governance (Ansell and Gash, 2008), as a requirement for the decision-making process. But participation within a governing institution can take very different patterns; it can be sustained through time, equally distributed among groups of actors, active or passive, and so on. We, therefore, believe that it is crucial to examine the role of participation as more than just a unidimensional variable in the collaborative governance process, and that the following question is worth asking: For a chosen Social-Ecological System (SES), how do the participation patterns of different groups of actors within collaborative governance institutions influence the system's ecological state?

To answer that question, we collated several decades' worth of longitudinal data on participatory processes and the ecological state of rivers within two French

river basins. Understanding if and how different participation patterns translate into ecological outcomes helps further the debate between proponents and opponents of collaborative governance. It sheds light on the processes linking actors' interactions to ecological outcomes within a complex SES such as large river basins (Ostrom, 2009).

More generally, our research endeavours to understand how to gauge the 'success' of sustainable natural resource management by utilizing an ambitious interdisciplinary approach at the system level, with a particular focus on studying ecological outcomes, through ecologically relevant indicators, and not just regulatory outputs. Finally, the statistical modelling approach developed in this paper can open new methodological perspectives to the existing literature on the implementation of the European Union Water Framework Directive (EU-WFD), dominated by descriptive and qualitative approaches (Boeuf and Fritsch, 2016).

4.2.1 River basin management

River basin management is essential as water resources are common-pool resources, meaning they are non-excludable but rivalrous and, therefore, potentially subject to overuse (i.e. over-abstraction) and negative externalities (i.e. pollution), leading to resource depletion (Ostrom 1990). River basins (or watersheds) play a key role in the cycle of water resources, transporting freshwater between landscape sources and sinks,

whilst draining all hydrologically-connected land in the process. However, river basin systems do not only englobe ecological elements, such as water systems and resources, but also social elements, such as groups of actors and institutions. In that sense, river basins are SESs (Ostrom, 2009). Actors of a shared water system oftentimes have little in common except for their interdependence to the same vital resource. Overuse and conflicts are frequent as each actor has a different understanding of what correct water management means. As modern economies expand and populations increase, unprecedented pressures on rivers have been seen, and increasingly, actors are confronted with competing interests for common resources. These conflicts are likely to become more prevalent and hostile with climate change (Bates et al., 2008).

To sustainably manage these river basin systems, a system perspective - i.e. the creation of governance institutions with a holistic approach at the geographical scale of the basins - has been recommended (Voulvoulis et al., 2017). The French river basin institutions, created in the 1960s, have been a form of participatory governance with partial independence from the state, long before the EU-WFD called for such a form of river basin scale governance. Each French river basin has a basin committee (*comité de bassin*) in which members - representing different groups of public or private actors - deliberate over river basin management plans and the allocation of subsidies regarding water resource projects. As the role of these committees is not purely consultative, we might expect to see an impact of the participation patterns of

committee members, through time, on the ecological conditions of the basins they supervise.

4.2.2 Collaborative governance and participation

Collaborative governance is now common practice in water management, with notions of participation and negotiation at its heart (Cashman and Lewis, 2007). Collaborative governance is "a governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented and deliberative and that aims to make or implement public policy or manage public programs or assets" (Ansell and Gash, 2008, p. 544). French river basin institutions are a good example of collaborative governance of a natural resource: the basin committees are instituted by law, which specifies their composition, are supported by each river basin public agency (called *"Agences de l'Eau"*), and do not have a purely consultative role.

More precisely here, we focus our research on participation within collaborative governance institutions. It means that we consider participation as an interaction that takes place or not, in different ways, not as a form of governance. We argue that in complex group dynamics, participation should not be measured by a unidimensional metric, even within one single institutional setting through time. In that, we differ from other multidimensional approaches of participation (Newig et al.,

2018), more set as a mean to compare "institutional possibilities" (Fung, 2006, p.66). When looking at participation, we should consider differences in group level of participation, with concerns of overrepresentation and reproduction of power dynamics. Participation has also to be studied through time. Collaborative governance institutions create structures at an institutional or inter-organizational level, in which participation takes place at a sub-level, may it be considered individual or organizational. Further, we refer in this paper to the participation of actors who can influence decisions, i.e. the committee members, not to overall public participation.

Participation can be justified from two perspectives within SES management. First, it can be justified normatively, as actors could be presented as having a right to have a say on the decisions made on natural resources on which they depend. It can also be justified pragmatically, with participation being expected to lead to improved water management for example (Reed, 2008). In the EU-WFD, the latter pragmatic vision seems to prevail: participation is underlined as "not an end in itself but a tool to achieve the environmental objectives" (European Commission and Directorate-General for the Environment 2003, p.6). In this paper, setting aside the moral justification of participation, we wonder if this pragmatic justification of participation is empirically supported. We believe it is possible to assess the effectiveness of participation in the context of the EU-WFD as this legislation sets a clear yet ambitious objective, attaining the good ecological status of water bodies.

In the collaborative governance literature, many social benefits are attributed to high level of participation: It is considered a sign that participants believe the collaborative institutions to be able to deliver net benefits. It also increases trust and shared norms among participants, which reduces transaction costs (Lubell et al., 2017). As for ecological benefits, participation is theorized, and somewhat expected, to lead to positive ecological outcomes mostly through two mechanisms. Participation should improve decisions made on ecological matters as more comprehensive information is made available by different actors. Past research on participation in environmental management seems to support that claim (Reed, 2008). Further, participation increases the quality of implementation because higher awareness, decision acceptability and trust increase compliance (Newig, 2007).

Nonetheless, researchers have started to show some scepticism towards the effectiveness of participation, pointing to a lack of empirical investigation on the matter: "There have been few attempts to investigate the validity of the many claims that have been made for stakeholder participation (…). The few attempts that have been made have tended to focus on evaluating the process rather than the outcomes" (Reed 2008, p.2421).

4.2.3 An interdisciplinary approach to include ecological outcomes

Our paper tackles the lack of research on ecological outcomes in the context of the collaborative governance of natural resources (Ansell and Gash, 2008; Newig and Fritsch, 2009). This gap has been highlighted also in sub-sections of organization and management studies dedicated to the natural environment: "The vast majority of studies of organizations and the natural environment thus far is to understand the way in which social representations of ecosystems dynamics relate to organizational phenomena" (Boons, 2013, p. 286), which means that the study of ecological parameters as dependent variables remains marginal. Previous research in collaborative governance seems to have studied the outputs of governance more than the outcomes (Koontz and Thomas, 2006). Part of this lack of research can be explained by the difficulties to access relevant data, and the inherent struggles of interdisciplinary research, as it requires to merge approaches from social and natural sciences within one research project.

Few studies have been done on the ecological outcomes of collaborative river basin governance. None of them proved in a strong causal manner the positive ecological outcomes of participation or collaborative governance. Scott (2015) found a positive link between good ecological indicators and the existence of a river basin group with responsibility on biodiversity and water quality, without explaining the processes through which those river basin groups improved ecological conditions.

Biddle & Koontz (2014) found an encouraging positive relationship between sustained participation and the attainment of goals, but those goals are set differently for each group and attainment is self-reported, so evaluation of actual ecological outcomes is limited. Biddle (2017) and Scott (2016) emphasized the importance of financial capacity, but we could wonder if the same investment would lead to ecological improvements regardless of the collaborative efforts. Finally, results differed depending on the ecological indicator selected as dependent variable (Scott 2015). This highlights the importance of acknowledging the complexity and multi-dimensionality underlying ecological outcomes from collaborative governance in SESs (Agrawal and Chhatre, 2011). Overall, it remains unclear what process in collaborative river basin governance led to improved ecological conditions, as none of these studies have a dynamic approach to participation.

4.2.4 Development of a research model

As aforementioned, participation is expected to lead to better ecological conditions through two main channels: the drafting of better decisions and the better implementation of those decisions. We argue that both mechanisms are forgetting power dynamics and the potential existing conflicts amongst the actors involved (Behagel and Arts, 2014). We offer a somewhat more political approach to this matter, looking at the degree to which each group of actors (i.e. river basin committee

members) actually participates in the decision-making process, leading us to the following testable hypothesis:

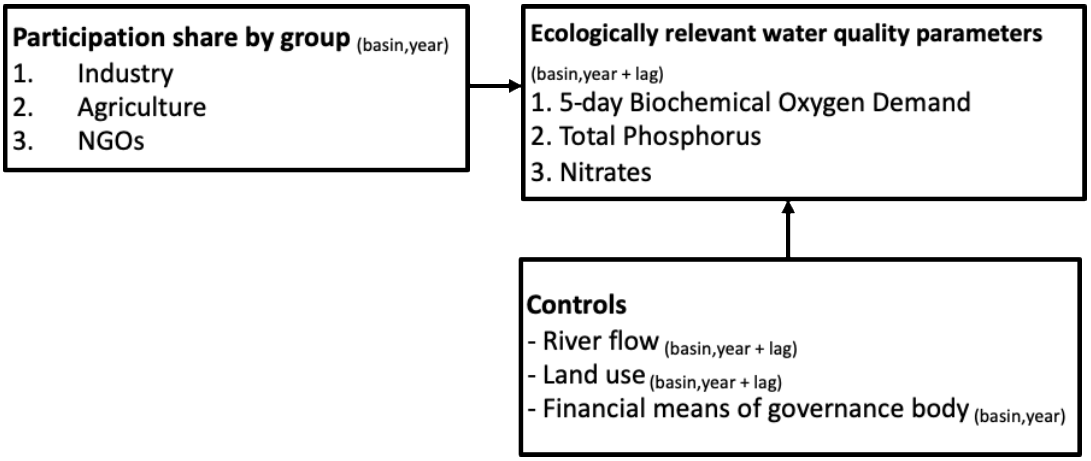
> *H1: The influence of participation on ecological outcomes will be distinct among different groups of actors.*

Further, the notion of quality of a decision on ecological topics needs to be taken with caution when we consider the relative uncertainty and unpredictability of their outcomes in ecosystems (e.g. Rice, 2013), the difficulty to assess those outcomes (e.g. Morandi et al., 2014), and the multi-dimensionality of those outcomes (Agrawal and Chhatre, 2011). This gave us our second hypothesis to test:

> *H2: The impact of participation of different groups of actors on ecological outcomes will be different depending on the ecologically relevant indicator chosen as dependent variable, due to inherently different ecological mechanisms.*

The overall research model we developed can be seen in Figure 4.1 below.

Figure 4.2 Layout of the research model



4.3 Methodology

4.3.1 Data and measurements

We collated a panel dataset going from 1990 to 2018 for two French river basins, namely Loire-Bretagne (LB) and Seine-Normandie (SN). Basic geographic information regarding both river basins can be found in Table 4.1. The size of the dataset is limited by the availability of information from the relevant agencies. Notably, the historical frame is limited to 1990 by the CORINE land cover dataset.

Table 4.4 Geographic profile of studied river basins.

	Population in millions (2018)	Surface (km2)	Land use mix (Corine Land Cover 2018)		
			Artificial	Agricultural	Forest and semi-natural
SN	19.0	94,000	7%	70%	22%
LB	13.3	155,000	5%	74%	20%

Dependent variables: The ecological state of river basins

Water quality parameters, a key precondition for the ecological state of river systems, are monitored on a global scale to ensure an adequate supply of quality water resources. Monitoring for research and compliance is complex and expensive to coordinate, and a multitude of sensing and analytical techniques (*in-situ* and *ex-situ*) have been deployed over the years. When looking at our dataset, several historical developments should be considered: through the years, the number of stations has increased, as well as the number of samples taken, and the number of parameters sampled. Finally, technological advances have improved the limits of detection for a majority of water quality parameters and the frequency of sampling, raising awareness of emerging pollutants and helping lower the standards set for compliance.

All these factors constrained the choice of measures for our dependent variables. As we pursue longitudinal research (i.e. data covering 20+ years), we are limited to measures that have been monitored consistently since the beginning of the timeframe. In the basins studied, there is no systematic historical indicator tracked for the overall ecological state of the basin as measurement procedures have been constantly updated with improving scientific knowledge and evolving regulation. Therefore, three ecologically relevant water quality parameters were chosen as indicators of ecological outcomes: 5-day biochemical oxygen demand (BOD5), total phosphorus (TP) and nitrates (NO_3) (cf. Figure 4.1 and Table 4.2). These parameters drive the ecological health of river systems by influencing the rate at which key biological processes occur (e.g. metabolic processes, reproduction, respiration, to name a few). Further, these parameters have been monitored in French rivers for decades, since the inception of the basin committees. This means that committee members have been aware of these parameters, or at least informed about them, allowing these members to have developed a shared understanding of these aspects of river systems and ecological health. A detailed description of the ecologically relevant parameters included in this study can be seen in Table 4.2.

Table 4.5 Characteristics of the ecologically relevant parameters included

Parameter	Description	Source/driver	Relevant legislation
5-day Biochemical Oxygen Demand (code 1313 in the Naïades database)	Expressed as mg O_2 L^{-1}. Represents the quantity of oxygen required by the microbial community to metabolize the organic compounds present in solution – linked to the quantity of dissolved oxygen available for higher-trophic organisms.	Commonly used as a surrogate for the organic content of treated wastewater (a metric of treatment efficacy). Organics emitted to river systems in wastewater effluent **> A point-source pollution**	- EC Urban Wastewater treatment Directive (91/271/EEC) - 1992 French water law (n°92-3)
Total phosphorus (code 1350 in the Naïades database)	Expressed as mg P L^{-1}. Nutrient considered limiting (primary) in river systems – linked to eutrophication risk (can cause harmful algal blooms).	Naturally occurring element which has been extensively mined from geological deposits. Phosphorus is then converted and used predominantly as fertilizer applied in agriculture. It gets transferred from agricultural land to river systems if applied in excess. Phosphorus is also abundant in human and industrial waste and household products **> Both diffuse and point-source pollution**	- EC Urban Wastewater treatment Directive (91/271/EEC) - 1992 French water law (n°92-3) - EU-WFD (2000/60/EC) - French law n° 2004-338 - French "LEMA" law n°2006-1772 - French Decree n°2007-491 banning phosphates in domestic detergents
Nitrates (code 1340 in the Naïades database)	Expressed as mg N L^{-1}. Highly mobile nutrient, considered limiting in some environments – linked to eutrophication risk (can cause harmful algal blooms) and drinking water contamination (harmful human health effects).	Naturally occurring form of nitrogen fixed from gaseous nitrogen (N_2) by organisms or industrial processes. This conversion allows it to be assimilated by plants. Industrial NO_3 synthesis has proliferated the quantity of NO_3 applied to agricultural land to increase crop and animal product yield – NO_3 can be transported from such land to rivers if applied excessively. NO_3 also abundant in wastewater (human and industrial waste). **> Both diffuse and point-source pollution**	- Groundwater Directive (80/68/EEC), superseded by the revised Groundwater Directive (2006/118/EC) - EC Nitrates Directive (91/676/EEC) - EC Urban Wastewater treatment Directive (91/271/EEC) - 1992 French water law (n°92-3)

			- EU-WFD (2000/60/EC) - French law n° 2004-338 - French "LEMA" law n°2006-1772

Mean annual concentrations were not available for the three parameters at the level of the entire river basins. Therefore, we computed representative trends using recommendations from river basin agency employees. First, individual measurements were collected through the French public database – Naïades. We only collated measurements made from stations included in the network "*Réseau de Contrôle de Surveillance*" (RCS); a network created to give a long-term overview of the river basin using representative stations from the entire database (Laronde and Petit, 2010). For the year 2016, those RCS stations represent 37% of available stations in the SN territory and 17% in the case of the LB territory. Many of those stations existed before 2007, when the RCS network was instituted, as this network aimed to build on existing infrastructure to maintain the historical continuity in monitoring efforts. For each RCS station, we took the annual 90_{th} percentile concentration of each parameter. We then took the mean of these 90_{th} percentile concentrations across the RCS stations at the basin level. Following that procedure, we obtained extremely high Pearson correlation indices (all above 0.92) with the few examples of basin-level historical aggregations we could obtain from the LB river basin agency on BOD5, NO_3 and TP, supporting the validity of our methodology. Analyses run on the entire archive of measures

without selecting stations produced similar historical trends but with higher uncertainty; again, validating our approach. For the year 2000, anomalous BOD5 data at 11 (of total 134) sites in the SN basin were removed from the trend analysis. The stations are not spatially close or even on the same stream. However, 90_{th} percentile concentrations above 20 mg L^{-1} are rarely seen at any of the sites, and the decision to exclude these potentially erroneous data was taken. This did not significantly alter our trends or results but corrected the standard deviation anomaly for that year.

We completed our statistical model and interpretation with some supplementary high-level concentration-discharge (C-Q) analysis of the long-term data to infer the sources (diffuse or point-source) of TP and NO_3 concentrations, as both parameters could be attributed to both forms of pollution (Table 4.2). Typically, C-Q analyses use extremely high-frequency data from short-term rainfall or storm events to determine the source of contaminants within a river basin (Bieroza et al., 2018), either through seeing the dilution (indication of point-sources) or concentration (indication of diffuse sources) of those contaminants over time with increasing discharge. We used monthly means of the 90_{th} percentile C-Q data from 2010 to 2018 for this analysis.

Independent variables: Attendance by groups

We built our independent variables from the minutes of river basin committee meetings. Attendance was tracked in a database where each observation represents one individual at one specific meeting. We excluded state representatives from that dataset for both conceptual and empirical reasons. Their inclusion in the participatory process is radically different. Individually, they have restrained agency in their position compared to other groups, as they are just expected to represent governmental interests, and no territorial specificity. Different rules of participation apply to them. It was also often impossible to track their membership and attendance on an individual basis.

The overall attendance rate is not easily interpretable through time due to a change in representation rules. Indeed, before 2008, members were separated in two groups, the full members, with one voting right per member, and their substitutes, in charge of attending if the first ones could not attend. In 2008, substitutes members disappeared, therefore altering the overall attendance pattern. Meanwhile, we focus our attention on the ratio of presence between three main interest groups: the agricultural interests (i.e. representatives from agriculture, irrigation and industrial agribusiness cooperatives), the industrial interests (i.e. representatives from all forms of industries, water utilities, electricity providers and SMEs) and Non-Governmental Organizations (NGOs) or non-economic interests (i.e. representatives from

environmental NGOs, water consumers, fishermen NGOs and other non-profit organizations). This ratio is unaltered by the change in representation rule that occurred in 2008.

For each group (*A*) and each meeting (*i*), we calculated the following participation indicator (% present$_{A,i}$):

$$\%\ \text{present}_{A,i} = \frac{\text{number of present members}_{A,i}}{\text{number of present members}_{Total,i}}$$

The idea with this variable is not to calculate the assiduity of the group in attending meetings, but the space it occupies comparatively to others. The mean of that percentage is then calculated by group, per year.

Control variables

As mentioned earlier, previous research on river basin partnerships (Biddle 2017; Scott 2016; Leach and Pelkey 2001) underlines the importance of technical and financial capacity of governance bodies. Therefore, we control for the level of financial capital available by river basin agencies (*Agences de l'eau*), measured by historical changes in their income, adjusted for inflation with the OECD consumer price index (CPI).

Previous research also underlines the importance of ecological or physical controls (Scott, 2015; Scott, 2016), such as the average land use in the basin. For each

basin, we calculated the average land use ratio between the main first-level categories of the CORINE land cover dataset - namely, artificial soils, agricultural land, forest and semi-natural areas and wetland - assuming a linear progression between the measurement years available in CORINE land cover (i.e. 1990, 2000, 2006, 2012, 2018). The links between land-use and surface water quality are complex. Historically, there has been strong links between urbanisation (McGrane, 2016) and agricultural intensification (Mateo-Sagasta et al., 2017), more generally referred to as land-use change, and increases in what are considered 'pollutants' (e.g. Mattikalli and Richards 1996). These relationships are typically a result of changes in the hydrological properties of landscapes and quantities of the 'pollutants' introduced into said landscapes.

Climate and weather patterns (i.e. precipitation or dry-spells) influence the master variable of river systems, i.e. flow. This can drive spatial and temporal changes in water quality, whilst simultaneously interacting with complex societal changes to these SESs. We capture this aspect with the historical changes in the average annual flow ("*écoulement annuel moyen*" in French) at a representative station selected to be located at the lowest possible part of the drainage area (watershed outflow) for each river basin while covering the whole time period of the study. This data was accessed on the French "Hydro" database. Representative stations are respectively located in Montjean-sur-Loire in LB (Hydro code M5300010) and Vernon in SN (Hydro code H8100020).

Our controls for ecological outcomes are in line with practices from previous studies on how institutions can impact rivers (Bernauer and Kuhn, 2010). We initially had planned to include more control variables in our model, such as several land use types (from the CORINE Landcover database), the evolution of Gross Domestic Product (GDP) per capita and the population density. Nonetheless, as can be seen in Table 4.3, the correlation among those variables is extremely high, and even more so when we look at each river basin separately, which implied a strong multicollinearity concern for any statistical analysis including these additional control variables.

Table 4.6 Correlation table among potential controls for both river basins

	(2)	**(3)**	**(4)**	**(5)**
(1) % artificial land	-0.987***	0.935***	0.884***	0.962***
(2) % agricultural land	1.000	-0.980***	-0.813***	-0.993***
(3) % forest and semi natural		1.000	0.697***	0.995***
(4) GDP per capita			1.000	0.764***
(5) population density				1.000

Note: Pearson correlation coefficients

Regarding land use, it should be noted that the ratio of land covered with forest and semi-natural areas is strongly correlated to artificial land in both river basins but in opposite directions, i.e. forests evolved along with artificial areas in LB but at the expense of them in SN. Meanwhile, agricultural land is negatively correlated to artificial land in both basins. In the Corine Land Cover nomenclature, artificial land

includes urban fabric, industrial, commercial and transport units, mines, dumps and construction sites, as well as artificial non-agricultural vegetated areas.

From this preliminary data exploration, we therefore chose to retain only the ratio of artificial land to control for the evolution of land use in our statistical model. We will later on consider this variable to be representative of a territory getting more urbanized at the expense of agricultural land, getting more densely populated, and richer. This choice was especially motivated by the size of our sample, which urges to limit the number of coefficients to be estimated. The inclusion of other control variables led to excessive multicollinearity with Variance Inflation Factors (VIFs) reaching above 50 and sometimes in the hundreds. On some models, we tried including the ratio of forest and semi-natural areas, which has a somewhat different characteristic; it did not alter our observations.

4.3.2 Statistical analysis

We run the models separately on the three dependent variables of interest, as has been done before (Scott, 2015). It is relevant in the sense that the three indicators representing ecological outcomes do not tell the same story in terms of anthropogenic impact on the environment (i.e. different sources and processing in the environment), as explained in Table 4.2. The diversity of stories can elucidate the ways in which

institutions impact their environment, for example, with a difference between point and non-point source pollution (Bernauer and Kuhn, 2010).

Based on the empirical context and theoretical insights, we can reasonably expect a delay in the ecological outcomes of institutional factors of more than a year, which means that we had to compute a temporal lag in our data. Based on previous similar studies, we assume this delay to be three to four years (Scott 2016; Scott 2015), and we added an additional lag of five years. We tested all models on all three lags as a robustness check.

In total we analysed nine final model settings, i.e. three different year lags (+3, +4, +5) for our three dependent variables (BOD5, TP, NO_3). Considering the structure of our data (observation by basin per year), a natural model specification is to include both river basin and year effects. Alternative models (econometric panel data analysis comparing various random and fixed effect approaches and Generalized Linear Mixed Models -or GLMM- more common in ecology) were trialled on the three separate dependent variables to reach a decision on the best procedure to follow. We opted for using GLMM as it was more statistically robust for dealing with non-normal ecological data (Bolker et al., 2009) and more flexible to our specific panel configuration, containing a number of complex predictors. Nonetheless, our results were not extensively altered when comparing those results with econometric panel

data approaches. All analyses were run on R (version 3.5.2), using the lme4, plm and stargazer packages (Croissant and Millo 2008; Bates et al., 2015; Hlavac, 2018).

Gamma family GLMM were fitted to our dependent variables, as they are continuous, non-negative (and non-zero) and right-skewed in distribution. The log link-function was chosen based on the resulting sample-size corrected Akaike Information Criterion (AICc) and model validation, when compared to the package's default link-function (inverse). We rescaled the flow and water agency income variables.

4.3.3 Model validation

We explored the residuals to validate our models, as per Zurr and Ieno (2016). The residuals for all of the models were largely distributed normally, which is necessary for a good model fit. However, all nine models did not fit equally well, as was the case for the lag 5 BOD5 and lag 3 NO_3 models. This could not be fully resolved using the gamma family distribution. Plots of residuals vs. fitted response variable appeared to display no clear patterns and a relatively equal distribution below and above zero. Mild clustering was seen below the zero line in the lag 5 models and some of the lag 4 (NO_3), meaning that some slight underestimation of the dependent variable could be possible. All issues with fit were a product of fitting models to highly right-skewed

data (BOD5 and TP) or incorporating the time lag into non-normal data analyses (NO_3). Gamma distributions were the best in dealing with this (i.e. lowest AICc) compared to other distributions trialled (gaussian). Plots of residual distribution are included in annex of this paper (Figures 4.A1 and 4.A2).

Prior to model specification, we followed a data exploration protocol fit for GLMMs and other common linear statistical models (Zuur et al, 2010). Visual exploration of the data did not reveal any problematic outlier.

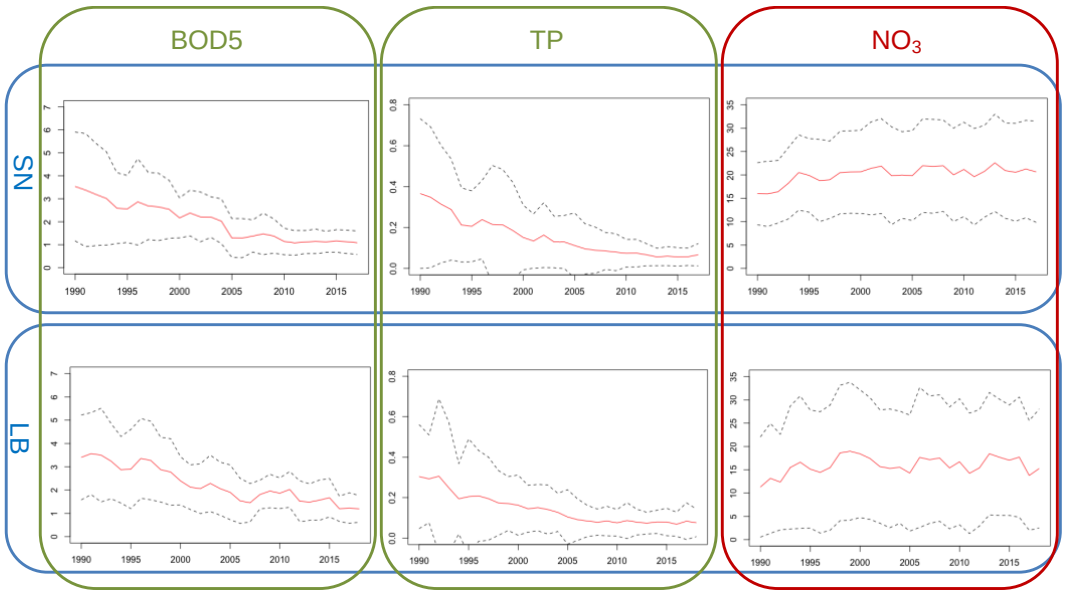
4.4 Results

4.4.1 Descriptive statistics

The trends of historical concentration of the three dependent variables for both river basins are represented in Figure 4.2. As can be seen, reductions in the annual mean concentrations can be seen across both catchments for BOD5 and TP. Conversely, a clear increase over time can be seen for NO_3 concentrations within the SN river basin. Across the LB river basin, a more gradual and variable increase in NO_3 concentrations was seen, followed by stagnation after 2000. The descriptive statistics of our variables, presented in Table 4.4 and Table 4.5 are drawn on the dataset with a 3-year lag. Not

all variables are lagged, only the social ones. As can be seen in Table 4.5, collinearity is a potential concern for these data, which we controlled for by running VIF analysis on our model results.

Figure 4.3 Trends of mean concentrations



Note: concentrations in mg L^{-1} (red line) and upper and lower standard deviations limits (1SD; dashed line) for the three ecologically relevant water quality parameters.

Table 4.7 An example of descriptive statistics of the data used for the models

Statistic	N	Mean	SD	Min	Pctl(25)	Pctl(75)	Max
BOD5 mean	57	2.12	0.79	1.08	1.38	2.77	3.56
NO_3 mean	57	17.98	2.78	11.30	15.53	20.52	22.59
TP mean	57	0.15	0.08	0.06	0.08	0.20	0.37
% artificial soil	57	0.06	0.01	0.04	0.05	0.07	0.07
Mean annual flow	55	633.36	260.59	300.00	422.50	782.00	1,390.00
Annual water agency income (l)	55	83.15	62.35	15.75	43.54	124.40	227.28
% present agriculture (l)	56	0.08	0.03	0.03	0.06	0.10	0.17
% present industry (l)	56	0.23	0.05	0.14	0.19	0.27	0.34
% present NGOs (l)	56	0.14	0.05	0.06	0.10	0.18	0.24

Note: data from the 3-year lag scenario. Variables marked with an (l) are lagged.

Table 4.8 Example of Pearson correlations for the 3-year lag database

	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) BOD5 mean	-0.485***	0.928***	-0.472***	0.015	-0.325**	-0.073	0.351***	-0.863***
(2) NO3 mean		-0.403***	0.805***	-0.169	0.734***	-0.368***	0.461***	0.234*
(3) TP mean			-0.266**	-0.170	-0.254*	-0.221	0.450***	-0.803***
(4) % artificial soil				-0.610***	0.763***	-0.637***	0.525***	0.331**
(5) Mean annual flow					-0.403***	0.536***	-0.420***	-0.140
(6) Annual water agency income (l)						-0.489***	0.556***	0.149
(7) % present agriculture (l)							-0.720***	0.171
(8) % present industry (l)								-0.475***
(9) % present NGOs (l)								

4.4.2 Model results

The model results can be seen in Table 4.6, in addition to some model information. Relating to our first hypothesis, we see that the ratio of presence of the three different interest groups (i.e. committee members) have significantly different impacts on the ecologically relevant indicators studied. Controlling for other influences, we find that a higher percentage of NGO representatives in basin committee meetings is linked to significantly lower concentration levels of BOD5 and TP across all the model lags. The ratio of NGO representatives therefore seems to come with a positive effect in terms of water quality improvement towards legislative targets. Interestingly, linked to our second hypothesis, the effect of NGOs is different for NO_3 as a response variable, with non-significant coefficients for 3 and 4 years of lag, and a significantly positive relationship for the 5-year lag. Conversely, a higher share of industry representatives is related to significantly higher levels of all three response variables (lag-dependent). Finally, stronger participation by agricultural interests has no significant relationship with BOD5 concentrations, but a significant positive link to TP on the 5-year lag. Most importantly, a higher representation of agricultural interests was linked to increases in concentrations of NO_3 across all lags, though only shorter lag times were significant (3 and 4 years).

Table 4.9 Model results

	BOD5 mean			TP mean			NO_3 mean		
	lag 3	lag 4	lag 5	lag 3	lag 4	lag 5	lag 3	lag 4	lag 5
% artificial soil	-33.715***	-13.794***	-45.942***	-79.133***	-71.174***	-73.750***	13.598***	15.205***	-0.101
	p = 0.009	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.988
Mean annual flow	-0.064**	-0.059**	-0.037*	-0.064*	-0.052	-0.049	0.056***	0.057***	0.047***
	p = 0.021	p = 0.044	p = 0.078	p = 0.081	p = 0.122	p = 0.159	p = 0.000	p = 0.000	p = 0.004
Annual water agency income	-0.033	-0.077**	-0.064***	-0.046	-0.083**	-0.079**	0.007	0.020	0.032*
	p = 0.328	p = 0.013	p = 0.008	p = 0.214	p = 0.021	p = 0.035	p = 0.599	p = 0.198	p = 0.056
% present agriculture	0.466	0.468	-1.017	0.005	1.447	1.558*	1.340***	0.844**	0.245
	p = 0.534	p = 0.546	p = 0.143	p = 0.996	p = 0.101	p = 0.084	p = 0.000	p = 0.020	p = 0.494
% present industry	1.673**	2.884***	0.967	0.339	2.545***	1.841**	0.702**	-0.270	-0.381
	p = 0.035	p = 0.000	p = 0.111	p = 0.696	p = 0.002	p = 0.017	p = 0.019	p = 0.385	p = 0.253
% present NGOs	-4.048***	-4.367***	-2.906***	-3.309***	-2.735***	-2.881***	0.330	-0.219	0.724**
	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.003	p = 0.002	p = 0.286	p = 0.527	p = 0.050
Constant	2.713***	1.342***	3.551***	2.928**	1.720	2.040*	1.772***	2.025***	2.832***
	p = 0.001	p = 0.000	p = 0.000	p = 0.015	p = 0.128	p = 0.072	p = 0.000	p = 0.000	p = 0.000
Observations	55	55	55	55	55	55	55	55	55
Log Likelihood	5.694	5.815	4.152	145.158	147.228	146.741	-66.653	-72.548	-74.459
Akaike Inf. Crit.	8.612	8.371	11.696	-270.316	-274.457	-273.481	153.307	165.096	168.919

Note: *p<0.1;**p<0.05;***p<0.01

As hinted at by our exploratory descriptive data approach, the concentration of NO_3 behaves differently over time from the BOD5 and TP. We interpret this as being linked to the social-ecological drivers behind the sources of these parameters within the river basins, i.e. the changes in concentration of NO_3 is caused by different human activities than those of BOD5 and TP. The effect of artificial land use is mostly the opposite for NO_3, compared with BOD5 and TP (Table 4.6). It can be linked to the fact that, as it was already shown in Table 4.3, this land-use is highly correlated to a decrease in agricultural land and a denser, and richer (i.e. higher GDP) population.

Additionally, to support our model results for the second hypothesis, we undertook a high-level C-Q analysis to clarify our interpretation regarding the sources (e.g. point or diffuse sources) contributing to concentration levels of the two dependent variables that could be influenced by both point and diffuse sources, namely, TP and NO_3 (cf. Table 4.2). This analysis (cf. Figure 4.A3 and Table 4.A1 in annex) linked lower TP concentrations with higher mean monthly flow, suggesting point-source pollution, and the converse trend for NO_3, suggesting diffuse sources. The model results in Table 4.6 for the entire database timescale are consistent with this shorter-term C-Q analysis (i.e. TP and BOD5 had negative relationship with mean annual flow, NO_3 had a positive relationship), demonstrating that basin-wide and annual-timescale C-Q analyses can be informative (Rose et al., 2018).

Finally, on the income available for the water agencies to invest in reforms of the river basins, higher income has a clear, significant link to lower concentrations of BOD5 and TP for lags 4 and 5. We draw from this result that the time necessary for the income to have an impact is closer to 4 or 5 years than 3. But in the case of NO_3, water agency income barely has any effect, until the 5-year lag, when on the contrary it has a significant positive relation with NO_3 concentrations.

4.5 Discussion

This study is the first, to our knowledge, using long-term ecological data to statistically outline the ecological outcomes linked to different levels of participation of specific groups in collaborative governance processes. As seen in the results, different groups of actors seem to have very different effects, and this varies depending on which response variable is considered.

Our model control results (notably on artificial land and flow; Table 4.6) and additional C-Q analysis on a monthly frequency indicate that NO_3 concentrations, in contrast to TP and BOD5, are linked to diffuse water pollution from agriculture (DWPA), most likely in the form of run-off containing nitrogen rich fertilisers or animal waste products. Excess fertiliser and animal waste applications to agricultural land have long been recognised as a driver of NO_3 export from land to ground and surface waters (Singh and Sekhon, 1979; Boyer et al., 2002; Howden et al., 2011). This proposed mechanism of NO_3 pollution across the river basin can further be explained by our predictors. Higher levels of NO_3 concentrations had a significant positive link with higher ratios of agricultural representatives in river basin committee meetings. This could suggest that agricultural members in French river basins advocate effectively for more intensive agricultural practices, for example, with less restrictions on applying mineral fertilizers or organic (animal-waste derived) materials.

In terms of BOD5 and TP, our modelled controls and C-Q analysis hint that point sources (e.g. wastewater effluent discharge) were likely driving river basin concentrations of these parameters. Compared to diffuse pollution, point-sources have traditionally been seen as simpler to manage, in population-dense urbanised areas, despite being expensive. Our results do demonstrate an improvement over time in these two parameters (Figure 4.2) but also a significant link with artificial soil (Table 4.6). Point-source pollution management is a less uncertain engineered approach in terms of meeting water quality targets. Therefore, the political will to invest in this approach may be stronger, which might result in water quality improvements. Our model links these reductions in BOD5 and TP to a higher ratio of presence of NGO representatives in basin committee meetings. But this result could either be interpreted as an effective pressure by NGO representatives to address the problems of BOD5 and TP in population-dense areas, or an overall evolution in the political willingness to give more space to environmental interests in the decision-making process. In both cases, we also note the ineffectiveness of NGO participation when it comes to reducing NO_3 pollution, again, potentially highlighting the challenge collaborative governance institutions face with managing DWPA.

Lower concentrations of BOD5 and TP were linked with higher agency income, whilst this was not the case for NO_3. This supports the idea that costly, yet effective point-source mitigation may be responsible for the BOD5 and TP trends over time. Investment to reduce NO_3 concentrations has either not been sufficiently targeted

at diffuse sources, or investment in diffuse sources is generally less efficient at reducing NO_3 concentrations at the basin scale. Discussions around the financial cost of reducing DWPA are ongoing in countries with substantial areas of river basin farmland. A recent study focused on agriculture in England (UK) suggested that a £52 per hectare investment was required, at the national scale, to reduce NO_3 loads to rivers by 2.5% (Collins et al., 2018). Compared to investments in point-source management strategies, such as improvements to wastewater treatment works, this cost per reduction of NO_3 could be considered minimal. However, given the uncertainty of DWPA mitigation, an example being the standard deviations associated with NO_3 concentrations compared to BOD5 and TP (Figure 4.2), a case for combined mitigation approach could be made (i.e. diffuse and point-source).

In our empirical context, we assume the improvements made on the ecologically relevant indicators linked to point-source pollution (BOD5 and TP) to be linked to improved wastewater treatments. The participation of actors in river basin committees is not the only factor that can explain those progresses on point-source pollutions. Indeed, national and supra-national legislative attempts to address all three of the ecologically relevant parameters (Table 4.2) play a clear role in the trends seen in Figure 4.2. The Wastewater Directive of 1992 seemed to have a large impact, if we attribute BOD5 and TP concentrations mostly to wastewater as a point-source. Whilst there would be NO_3 in wastewaters, which may well have been reduced since the introduction of the Wastewater Directive, diffuse additions of NO_3 across the river

basins might be cancelling out any point-source gains. These diffuse sources may be so great as to mask the effect of even older legislation designed to reduce NO_3 pollution (i.e. Goundwater Directive – 1980; Nitrates Directive – 1991). Further, national legislation such as the French Decree (2007) banning phosphate-containing detergents would have played a role in reducing TP concentrations post-implementation, potentially explaining the divergence in BOD5 and TP trends post-2007 (Figure 4.2).

Globally, managing DWPA is a difficult task (practically and legally), especially across large or transnational river basins (Novotny, 1999; Wang, 2006; Duncan, 2017), in spite of the implementation of collaborative governance processes. Although France has pioneered high levels of actor participation within river basin management in Europe, NO_3 and pesticides are now the first cause of closure of drinking water abstraction from a river basin due to poor water quality in this country (DGS, 2012). This might signal that, after decades of deliberations, French collaborative governance efforts, at the basin scale, have not turned into a fully successful case of commons management through collective action (Ostrom, 1990).

A collective acceptance of objectives and rules among involved actors is a necessary step, Ostrom (1990) outlined, for a successful management of common pool resources when the behaviour of individuals cannot be controlled for at a reasonable cost, as it is the case with diffuse pollution. Our data also supports this failure to

collectively manage diffuse sources, potentially due to the influence of individual committee member groups. This hints at a mode of participation and of collaborative governance that is more an arena of power struggles (Selznick, 1949; Behagel and Arts, 2014) than a room where a shared understanding of the common good is created (Ansari et al., 2013; Fan and Zietsma, 2017). Without the emergence of that shared understanding, the involvement of actors does not clearly link neither to better decisions nor to a higher implementability of measures.

4.6 Conclusion

In terms of data collection and analysis of archive data, this paper represents an unprecedented effort to bring together valuable and unexploited sources of information on the history of collaborative river basin governance, merging methodologies from social and natural sciences in the process. Although our data does not allow us to give a final answer to the question "what are the ecological outcomes of participation?", it brings two main contributions to the literature trying to tackle that question.

First of all, we underline how key the choice of ecological outcomes considered is when assessing the evolution of an ecosystem, whether it be directly or via an ecologically relevant indicator. In the future, studies should make great effort in differentiating between different aspects of the ecological context, which, in turn

reflect different aspects of the social context. Especially in the context of river basins, greater attention should be paid to diffuse pollution, which requires more collective action than point-source pollution. Indeed, both financial means and regulatory changes seem less effective in tackling diffuse pollution.

Second, we show statistically that who gets to participate matters. Future studies on the ecological outcomes of participation should, therefore, not limit themselves to the structure of participatory processes, or to an overall level of commitment from local actors but should also always include the relative weight given to different groups of interest in the participatory process, as a key explanatory variable. Our results confirm that alternative conceptual models have to be developed to defend a pragmatic role of participation on attaining ecological objectives in collaborative governance endeavours.

4.7 Limitations and future research

Despite including numerous monitoring sites across each basin, only two river basins were included in our analyses; both with a relatively small final sample size for the models and located in the same country. This is due to the difficulties in accessing data mentioned earlier. Therefore, we hope to see similar studies try to replicate our results in other empirical contexts of collaborative governance, may it be related to river

basins or not. Further, the use of water quality parameters as proxies to determine ecological outcomes could be improved upon by integrating large, long-term, indicator species datasets.

For this study, obtaining historical trends of the evolution of ecologically relevant indicators has been a complex and long process. This fact is in itself telling, showing that collaborative governance actors currently take decisions with little or fragmented feedback of the impact of past management actions on ecosystems. With time, many new indicators or methodologies have been added to river monitoring, which is representative of evolving interests and knowledge regarding ecological conditions but impedes historical overviews. This observation could also be a topic of research in another study.

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4.9 Appendix for chapter 4

Figure 4.A1 Residual distribution in gamma log models

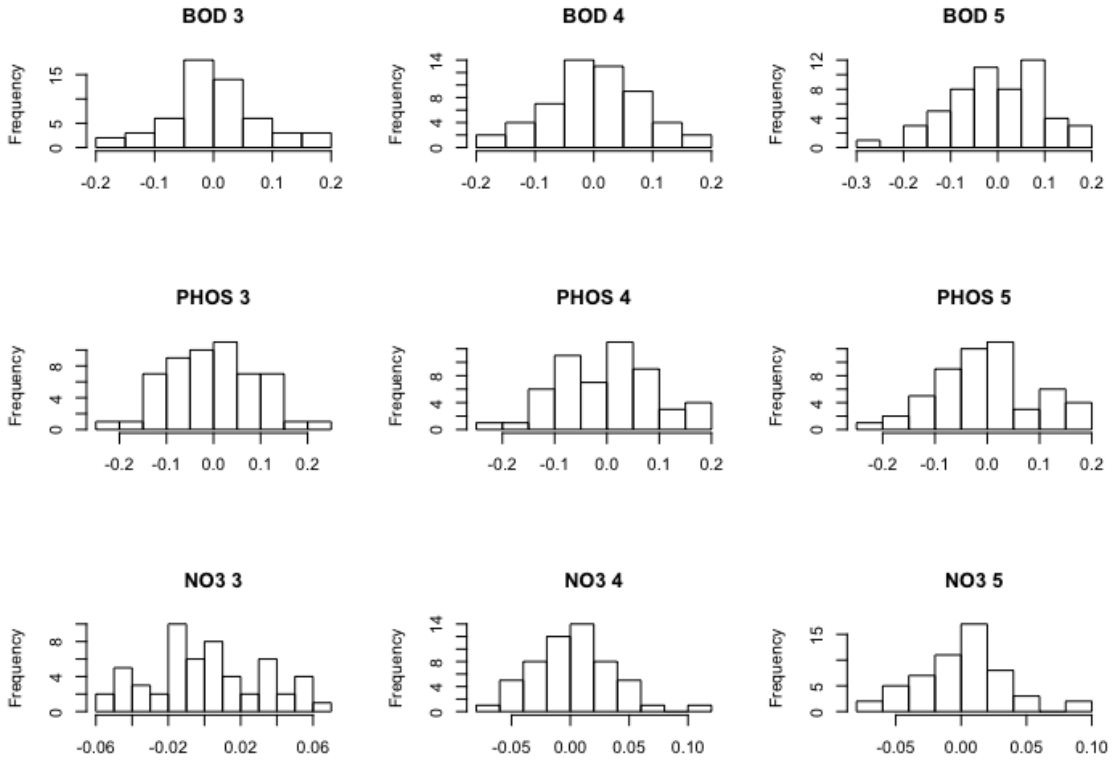


Figure 4.A2 Residuals vs. fitted values in gamma log models

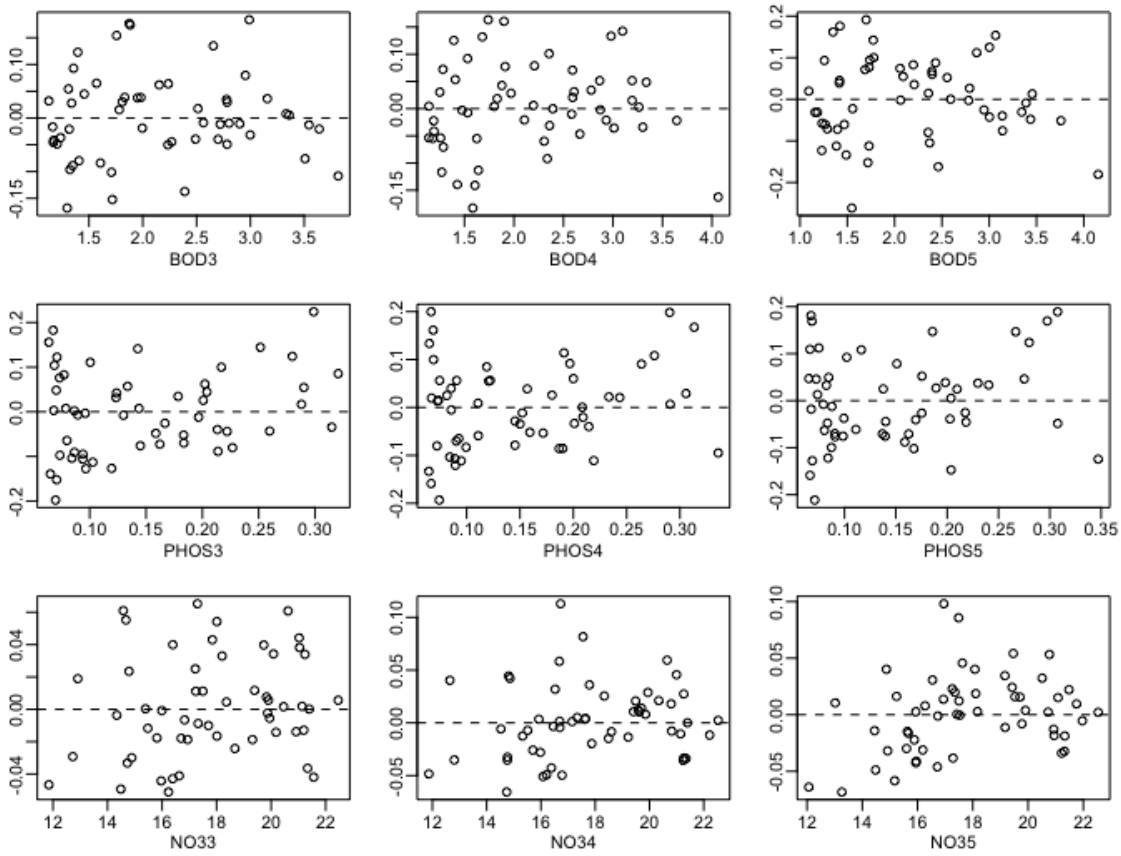
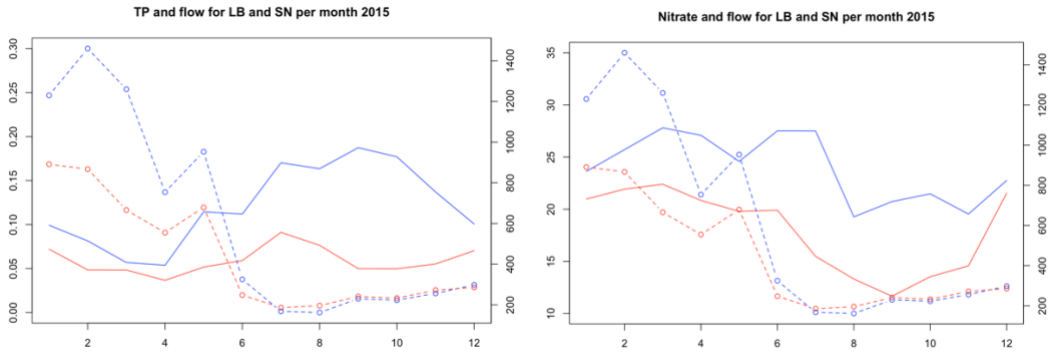


Figure 4.A3 Monthly trends of flow and concentrations of TP and NO_3 in 2015



Note: Monthly trends of flow and concentrations of TP (left panel) and NO_3 (right panel) in 2015. Data for LB in blue, for SN in red. The full line represents the concentration (in mg L^{-1}), the dashed line represents the flow (in m^3 s^{-1}).

Table 4.A1 Pearson correlation between NO_3 and TP concentration and flow

	Flow	**NO_3 concentration**	**TP concentration**
Flow	1.000	0.471***	-0.460***
NO_3 concentration		1.000	-0.431***
TP concentration			1.000

Note: Based on monthly data for LB and SN covering years 2010 to 2018.

5

General Conclusion

This thesis ambitions to study **how organization and management studies can integrate the inter-organizational management of a freshwater system with the ecological conditions of that system**. It explores theoretical and methodological ways that can help the existing accumulated knowledge on inter-organizational management to explain more effectively how to ensure the sustainability of freshwater ecosystem functions. To do so, three studies have been conducted in an interdisciplinary spirit - a systematic literature review, a qualitative grounded theory study and a quantitative panel data analysis. This thesis aims above all to test new waters to provide organization and management scholars with conceptual and methodological tools to include ecological components better. Henceforth, we will not differentiate in this conclusion section between theoretical and practitioners' implications. Although this thesis deals with freshwater systems only, its findings - notably the recommendations for interdisciplinarity - could be extrapolated to the study of SES issues at large.

5.1 Contribution to the overarching research question

The contribution of each essay to the overarching research question is summarized in Table 5.1. Essay 1 poses a diagnostic on the existing literature and validates the SES framework as an actionable conceptual tool for organization and management scholars dealing with freshwater system management. Essay 2 offers yet another conceptual

tool to study differences of understanding among actors, via a renewed vision of ecological embeddedness. Meanwhile, Essay 3 represents more of a methodological recommendation, testing how familiar social indicators on inter-organizational dynamics can be linked to ecological indicators.

Essay 1 confirms that the current literature on water management does not accumulate knowledge or integrate ecological components enough to link comprehensively the management of freshwater systems to their ecological conditions, i.e. to understand how water management ensures sustainability. It therefore shows that the diagnostic of a "fractured epistemology" (Gladwin et al., 1995, p.874) still applies in the current literature on water management. By using the SES framework to make sense of the existing literature, this literature review underlines how both interpretivist and positivist approaches can be used - and even are necessary - in a complementary way to tackle the dual nature - social and ecological - of freshwater systems.

Essay 2 demonstrates the importance of ecological embeddedness to understand the differences of understanding among institutional actors. These actors are not only institutionally embedded in their home organization and in the boundary organization in charge of freshwater system management (Fan and Zietsma, 2017), but also ecologically embedded at an individual level. This essay provides management

scholars with a broader conceptualization of ecological embeddedness (Whiteman and Cooper, 2000). This notion of ecological embeddedness in terms of forms - uncovering the existence of archetypes - is applicable to many empirical contexts and does more justice to the complexity of ecological issues than merely considering actors are more or less ecologically embedded. It sheds light on how differences of understanding among actors involved in the inter-organizational management of freshwater systems resist their shared exposure to scientific information over long periods of time.

Essay 3 is an attempt to link statistically dynamics of participation in French river basin committees - in this case, the share of members from different interest groups present in meetings - to the evolution of the ecological condition of the corresponding river basin. In itself, the time and effort required to compute the necessary dataset resonate with previous research on how demanding interdisciplinary research can be (Leahey et al., 2017). If interdisciplinary research is demanding, it is nonetheless rewarding as this essay manages to entangle the influences of different groups of actors on the ecological condition of the river. It shows that collaboration or participation are in themselves not a panacea (Heikkila, 2017), and that scholars need to dig further in the relation between collaborative governance and ecological outcomes. In doing so, organization and management scholars should nonetheless be weary of including a unique ecological indicator. They should on the contrary embrace the complexity of ecological dynamics in the studied systems. The help of co-authors from natural sciences is critical and recommended in such research endeavours.

Table 5.1 Summary of contributions to the overarching research question

How can organization and management studies integrate the inter-organizational management of a freshwater system with the ecological conditions of that system?
• Interpretivist and positivist studies from all theoretical approaches are valid and can be used as complementary, albeit their differences, when they are situated within the SES framework. (Essay 1) • Ecological embeddedness is a useful conceptual tool to study how institutional actors understand ecological issues, acknowledging the complexity of those issues. (Essay 2) • Researchers need to consider different ecological outcomes from the participation of different groups of actors and to include the diversity and multi-dimensionality of ecological outcomes. (Essay 3)

5.2 Limitations and future research

This PhD is but a grain of sand in the vast amount of management research still needed on sustainable freshwater system and by no means pretends to answer exhaustively to the research question. Being an interdisciplinary research effort, it takes the risk to fail

to bring its message to the desired audience (Leahey et al., 2017), which would greatly hinder its contribution. Beyond the defense of this thesis, a great effort of communication of the results achieved in the three essays is still necessary for this PhD thesis to reach its purpose.

Further on limitations, the empirical analyses of Essay 2 and 3 are based only in the mainland French context, on data from two of the six existing river basin institutions. The socio-cultural specificities, as well as the ecological characteristics of that context have to be taken into account when applying findings to other contexts. In Essay 2, what other archetypes of ecological embeddedness could be found in other cultural - e.g. non-Western - contexts, aside from *colibris*, resource environmentalists and environmental atheists? Would ecological embeddedness play a different role in different freshwater systems, for example in river basins more marked with water scarcity? Would openly acknowledging and discussing these differences of embeddedness be enough to solve discrepancies of views among institutional actors? Otherwise how could these long-lasting discrepancies be overcome?

In the case of Essay 3, limitations are more due to the limited data available. It currently includes three ecologically-relevant indicators, the 5-day biochemical oxygen demand, total phosphorus and nitrates. These parameters of water quality are strongly related to the ecological health of rivers in terms of biodiversity, but including biological indicators such as benthic health (Scott, 2015) would give more precision

to the analysis. Aside from point-source and diffuse water pollution, alterations of hydromorphological aspects of freshwater systems (such as dams, channels) should be considered, albeit maybe being technically harder to track. Last of all, a bigger dataset (e.g. a longer time period, more river basins included) would allow the inclusion of more statistical controls.

Finally, many question marks remain regarding how the inter-organizational management of a freshwater system can be linked to the ecological conditions of that system in organization and management studies. As a contribution, this PhD thesis proposes two conceptual tools to management scholars - a pre-existing one, the SES framework, and an updated one, ecological embeddedness - as well as a methodological approach the inclusion of ecological indicators in statistical models. But important concepts of inter-organizational management such as leadership, discourse, trust or power dynamics have been merely mentioned and should in their turn be put in relation with ecological components of the SES framework. For example, one could wonder, do certain archetypes of ecological embeddedness relate to forms of leadership? How do they affect trust? On ecological outcomes, could different contexts of power imbalance lead to different temporal lags in witnessing ecological outcomes? The geographical distribution of ecological outcomes and actors should also be considered, a question the literature on place would likely be competent to explore (Kennedy et al., 2017).

This list of questions is non-exhaustive but gives a sense of the amount of work remaining, to bridge knowledge from organization and management studies to other fields such as hydrology or environmental psychology. The development of more multidisciplinary research teams will be critical to successfully sail away from the familiar waters of management research to the bigger ocean of SES challenges.

5.3 References

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