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Abstract

This paper aims to identify drivers and barriers to the achievement of EU water policy objectives in the agricultural sector by adopting an institutional perspective on water quality management at the landscape level. We apply a conceptual framework combining Integrated Landscape Management (ILM) and Institutional Design Principles (IDP) perspectives to analyze cooperation initiatives involving water suppliers and agricultural stakeholders to protect drinking water catchments from agricultural diffuse pollution. Three cases representing different forms of cooperation in rural landscapes in France were investigated on the basis of primary data collected at the local, water-basin and national levels. The results show that the success of multi-stakeholder collective action depends on both local factors such as characteristics of the water resource and stakeholders (knowledge, resources, trust and social capital) and on factors linked to the EU and national water and agricultural policy frameworks. In addition to the identification of drivers of and constraints on the implementation of EU water policy in agricultural landscapes, the analysis highlights the conceptual added value in combining the IDP and ILM approaches to understand policy implementation processes at the landscape level.

Keywords:

EU Water Framework Directive; diffuse pollution; Institutional Design Principles (IDP); Integrated Landscape Management (ILM); social-ecological systems; landscape perspective

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1. Introduction

The European Union (EU) Water Framework Directive (WFD) adopted in 2000 sets the objective of protecting and restoring water bodies across Europe (EU, 2000). More particularly, the EU WFD encourages member states to ensure the protection of water bodies used for the production of drinking water "in order to reduce the level of purification treatment required" (Article 7). Diffuse, nonpoint source pollution affects 38% of surface water bodies and 35% of groundwater area (EC, 2019). Agriculture represents 33% of total water uses and constitutes the main source of nutrient pollution in water (ECA, 2014).

Two main policies have been implemented to address diffuse water pollution in the EU: the Nitrates Directive and agri-environmental schemes (AES). The application of the EU Nitrates Directive, adopted in 1991, includes the designation of vulnerable zones, where nitrate concentrations in surface and ground waters are above 50 mg/l or above 40 mg/l with an upward trend. Every farmer in a vulnerable zone has to comply with the measures included in specific action programs (e.g., reduced fertilization application levels and the establishment of buffer strips near watercourses) without any compensation payments. Additionally, a national code of good agricultural practices should be voluntarily applied outside of vulnerable zones (EC, 2002). Since 2005, the payment of common agricultural policy (CAP) subsidies has been subject to farmers' compliance with all environmental regulations, including the Nitrates Directive. AES have constituted a compulsory component of rural development plans in EU member states since 1992. Under these schemes, farmers voluntarily commit for at least five years to adopting practices with positive effects on the environment. In exchange, farmers receive financial compensation for the associated costs and income losses. Following the "polluter pays" principle, agri-environmental commitments must go beyond Nitrates Directive mandatory standards, i.e., beyond the obligations specified by action programs for vulnerable zones and the provisions of the code of good agricultural practices outside of vulnerable zones (EU, 2013). AES are cofinanced by the EU and EU member states. Despite the implementation of these regulatory and incentive-based policies, diffuse pollution from agriculture remains a major threat to water quality (EEA, 2019).

Decentralized cooperation involving water suppliers and agricultural stakeholders for limiting diffuse pollution in drinking water catchments has been developing in the French and European contexts over the last 20 years (De Groot and Hermans, 2009; Grolleau and McCann, 2012; Amblard, 2019). These cooperative arrangements rely on self-regulation among key actors (water suppliers, farmers and other stakeholders) and target specific areas such as water catchments or water protection zones (Brouwer et al., 2003). In France, cooperation initiatives have mostly developed in "priority" drinking water catchments that have been identified in river basin management plans as particularly threatened by diffuse pollution. To meet the WFD-Article 7 objectives, the “Grenelle” policy, launched in 2009 and extended in 2013, identified 1000 priority drinking water catchments to be protected first and foremost (Loi n° 2009–967, 2009; MEDDE, 2013). The policy prescribes the definition and implementation of action plans based on cooperation between water suppliers and agricultural stakeholders (farm organizations and farmers). The implementation of action plans targeting diffuse pollution at the water catchment level relies on the voluntary participation of farmers. Policy tools such as EU AES or environmental land leases are used to incentivize farmers’ participation, along with the provision of free training and technical advice. In 2019, only 58% of the Grenelle priority catchments were covered by an action plan (OFB, 2020). While a few successful cases of drinking water catchment protection have been documented, the “Grenelle” policy thus far has not led to a significant improvement in water quality in the French context (Bénézit et al., 2014; AE Adour-Garonne, 2017; OFB, 2020).

These mixed outcomes raise the question of the factors influencing collective action for drinking water catchment protection. Previous studies addressing EU water policy implementation have highlighted the role of national characteristics of EU member states (e.g., Liefferink et al., 2011; Bourblanc et al., 2013) and of regional and local particularities (e.g., Kastens and Newig, 2007; Franzen et al., 2015) in the implementation process. Nevertheless, little is known about how these factors interact to lead to policy success or failure (Newig and Koontz, 2014; Boeuf and Fritsch, 2016).

This paper aims to identify drivers and barriers to the achievement of EU water policy objectives in the agricultural sector by adopting an institutional perspective on water quality management at the landscape level. We develop a conceptual framework combining the Institutional Design Principles (IDP) (Ostrom, 1990, Cox et al., 2010) and principles from the Integrated Landscape Management (ILM) approach (Sayer et al., 2013; Mann et al., 2018). The IDP serve as a basis for characterizing the governance of water quality management approaches, while the ILM principles help assess their integrative potential.

With the objective of identifying the factors fostering or hindering collective action for drinking water catchment protection, the present analysis relies on the comparative analysis of three cases of cooperation in France, including two cases where cooperation was successful in limiting or preventing diffuse water pollution and one case where collective action has not led thus far to an improvement in water quality.

The paper is structured as follows. In Section 2, we introduce our conceptual framework combining the Institutional Design Principles (IDP) and Integrated Landscape Management (ILM) approaches. The methodology used for the comparative case analysis is detailed in Section 3. Section 4 presents the results of the analysis. In Section 5, we discuss the presence or absence of principles across cases and develop conclusions for the implementation of EU water policy at the landscape level.

2. Conceptual framework

To identify the drivers and constraints bearing on the achievement of EU water policy objectives, we adopt an institutional perspective on water quality management at the landscape level. We understand landscapes as social-ecological systems, i.e., the importance of all biophysical, anthropogenic and cognitive dimensions is recognized to understand the interactions and influences between different landscape components (Matthews and Selman, 2006; Angelstam et al., 2013). Landscapes constitute a workable space in which the actions of individuals intersect with other resource uses and users, often linked to wider-ranging institutions, markets and networks (Frost et al. 2006; van Oosten et al., 2018). Thus, analyzing EU water policy implementation at the landscape level allows us to disentangle the role of local factors, such as biophysical conditions and the characteristics of local stakeholders, from factors linked to the policy context at higher (regional, national and EU) levels (Sayer et al., 2013; Lefebvre et al., 2015).

We use two conceptual frameworks in a complementary manner: the Institutional Design Principles (IDP) and the Integrated Landscape Management (ILM) approach. While the IDP provide a conceptual frame to identify the conditions under which collective action for water quality management at the landscape level is likely to be successful (2.1), the ILM approach serves to integrate the multi-sector and multi-level dimensions of water management in the analysis (2.2). We highlight the complementarities of the two approaches before presenting the combined conceptual framework (2.3).

2.1. Institutional Design Principles (IDP)

Based on the comparative analysis of diverse cases of natural resource management (pasture, forestlands and irrigation systems) in different contexts, Ostrom (1990) identified eight characteristics shared by governance systems leading to the long-term sustainability of resources and rule compliance by resource users (Table 1).

Table 1: Institutional Design Principles (adapted from Cox et al., 2010, Ostrom, 2010, and Poteete et al., 2010)

1A.	Clearly defined boundaries – users
1B.	Clearly defined boundaries – resource system
2A.	Congruence between rules and local conditions
2B.	Proportional equivalence of benefits and costs
3.	Collective-choice arrangements
4A.	Monitoring users
4B.	Monitoring the resource
5	Graduated sanctions
6	Conflict-resolution mechanisms
7	Minimal recognition of rights to organize
8	Nested enterprises

A first characteristic of successful governance systems for collective action is the clarity of boundaries of the natural resource and of the group of users. Well-defined boundaries are considered a prerequisite for the development of sound rules for the management of resources. Furthermore, clear boundaries are assumed to ensure that benefits drawn from the management of the resource accrue to users bearing the costs of management (Ostrom, 1990). Cox et al. (2010) suggested further distinguishing between the clarity of boundaries of the users' community (IDP 1A) and the clarity of boundaries of the resource system (IDP 1B) as two subcategories of this design principle. The long-term sustainability of collective action is also seen as depending on the match between the rules governing the use of the resource and local resource conditions (IDP 2A). Different governance systems are expected to manage the spatial and temporal heterogeneity of resource conditions (Ostrom, 1990). Furthermore, several studies have highlighted that the congruence between rules and local cultural and social conditions matters (Ostrom, 2009; Cox et al., 2010). Also stressed is the proportional equivalence between the benefits allocated to users and their costs (IDP 2B), which favors compliance with rules considered equitable (Poteete et al., 2010). Successful governance systems appear to be characterized by the involvement of users in rule design (Ostrom, 1990) at the collective-choice level (IDP 3). Such participation favors the adaptation of rules to the local ecological and social context, assuming that resource users have better access to knowledge and information regarding their situation and resource dynamics (Cox et al., 2010). The effectiveness of rules depends on the level of compliance from users and hence monitoring systems. Ostrom (1990) observed that in environments characterized by an absence of external authority enforcement, enduring self-governing systems include monitoring and sanctioning activities of resource use by the participants themselves. Ostrom (2010) further distinguished between monitoring resource users (IDP 4A) and monitoring the environmental conditions of the resource (IDP 4B) as subcategories favoring the adaptation of rules to the local context. In this context, the accountability of monitors to users seems crucial. Sanctions may prevent the occurrence of severe rule breaking by users. Taking into account the importance of violations as well as the circumstances of their occurrence in a graduated way ensures that excessive sanctioning does not lead by itself to noncompliance with rules (IDP 5) (Ostrom, 1990). Furthermore, successful governance systems for common-pool resource management are characterized by low-cost access to conflict resolution mechanisms (IDP 6) (Ostrom, 1990). Another condition identified for the success of self-organization by users of common-pool resources is the recognition, by external authorities, of their right to define their own rules (IDP 7). Finally, nested governance systems were found to be more suited to the management of larger resource systems (IDP 8) (Ostrom, 1990). The nesting of governance systems at different scales (for example, from the catchment to the river basin level) facilitates the integration of cross-scale interdependencies while reducing the cost of organizing at a large scale (Ostrom, 1990; Cox et al., 2010).

2.2. Integrated Landscape Management (ILM)

Integrated landscape management (ILM) has been introduced as an innovative form of multi-actor, multi-sector and multi-scale collaboration for landscape management (García-Martín et al., 2016). The concept builds on four defining characteristics: (i) ILM promotes multifunctional land uses and land-use objectives (Mastrangelo et al., 2014); (ii) it works at the landscape scale and includes deliberative planning and management; (iii) it incorporates cooperation among policy sectors and actors (Stenseke, 2016); and (iv) it supports collaborative management and mutual learning (Milder et al., 2014).

Compared to conventional landscape planning approaches, ILM aims to be more holistic, flexible and coherent with a range of land uses and users (Sayer et al., 2013; Freeman et al., 2015). The approach usually involves a range of stakeholders and decision-makers from the agricultural production, water protection, and nature conservation sectors and explicitly deals with land rights, restrictions, conflicts and responsibilities (Estrada-Carmona et al., 2014). With the help of participation, collaboration, and learning arrangements, conflict resolution and the achievement of beneficial outcomes are targeted. The appeal of integrated management at the landscape scale has resulted in the development of various approaches in recent decades, such as integrated water resource management (IWRM) and integrated natural resource management (INRM) (see Sayer et al., 2013; Milder et al., 2014; Reed et al., 2016).

Although integrated management approaches differ in their application scope, studies in landscape research have identified a number of common characteristics that favor land-use conflict resolution from a sustainable development perspective (Sayer et al., 2013; Freeman et al., 2015; Mann et al., 2018). These characteristics are displayed in Table 2.

Table 2: Integrated Landscape Management principles (adapted from Mann et al., 2018)

1.	Common landscape concern/problem understanding
2.	Incorporating multiple land-use objectives
3.	Involving multiple stakeholders
4.	Integrating multiple scales
5.	Transparency of the development of the solution and the identification of trade-offs
6.	Clarity of rights and responsibilities assigned to the process
7.	Occurrence of adaptive management and learning
8.	Participatory monitoring and capacity-building activities

One prerequisite for the development of an integrated landscape management approach is a shared understanding of a land-use problem and the need for its solution (ILM 1) (Sayer et al., 2013; Mann et al., 2018). Given that stakeholders may have conflicting values and management objectives, Sayer et al. (2013) suggest that the identification of a common concern can serve as a first basis for initiating a negotiation process toward the achievement of longer-term land-use goals. Another characteristic is the recognition of the multifunctionality of landscapes and the need to explicitly address the trade-offs between multiple land uses and land-use objectives (ILM 2) (Sayer et al., 2013; Mastrangelo et al., 2014; Stenseke, 2016). In this regard, land-use conflict resolution will be favored by the involvement of the various stakeholders concerned (ILM 3) (Milder et al., 2014; Mann et al., 2018). The design and implementation of participation processes raise the issue of the unbalanced social power of different stakeholder groups (Freeman et al., 2005). Additionally, the level of transaction costs associated with the involvement of all stakeholders in decision-making may constitute a constraint (Sayer et al., 2013). A fourth characteristic refers to the recognition of various administrative scales in regard to the fulfillment of policy and management objectives. Land management interventions shall take into account higher and lower policy levels, as they influence and constrain management outcomes (ILM 4) (Sayer et al., 2013). Furthermore, the resolution of land-use conflicts will benefit from a transparent decision-making process (ILM 5), including the assignment of clear rights and responsibilities to participants (ILM 6) (Sayer et al., 2013). Landscape management includes adaptive management and learning as a means to ensure that landscape dynamics are taken into account to improve management outcomes (ILM 7) (Sayer et al., 2013; Freeman et al., 2015; Garcia-Martin et al., 2016; Mann et al., 2018). Finally, monitoring and capacity-building activities are assumed to facilitate participation and to allow for mutual learning among stakeholders (ILM 8) (Sayer et al., 2013; Mann et al., 2018).

2.3. A combined conceptual framework for analyzing water management systems

The IDP provide a conceptual frame to identify the characteristics of governance systems leading to successful collective action for water quality management at the landscape level. However, the principles were initially developed in the specific case of homogeneous groups of users holding similar values/interests with regard to resource use (Ostrom, 1990). Collective action for pollution control involves heterogeneous stakeholders holding different values and interests with regard to the protection of the quality of the water resource. In contrast, ILM approaches recognize the multi-sectoral nature of landscapes as well as the multiple and conflicting values and interests regarding land use/natural resource management. While the ILM framework highlights the importance of multi-stakeholder cooperation, it does not provide conditions regarding the success of such collective action.

To analyze water management systems with regard to their capacities to allow for collective action and to bridge stakeholder, sectoral and policy objectives, we developed a list of 14 principles. The principles are based on key elements of IDP (Ostrom, 1990; Cox et al., 2010) and ILM (Sayer et al., 2013; Milder et al., 2014; Freeman et al., 2015; Mann et al., 2018). Table 3 summarizes these principles, including their related concepts. A number of principles are common to the IDP and ILM approaches: the principle of multiple scales/nested enterprises (5), the transparency and inclusiveness of decision-making processes (6), and the importance of monitoring (10 and 11). Other principles are specific to one of the original frameworks.

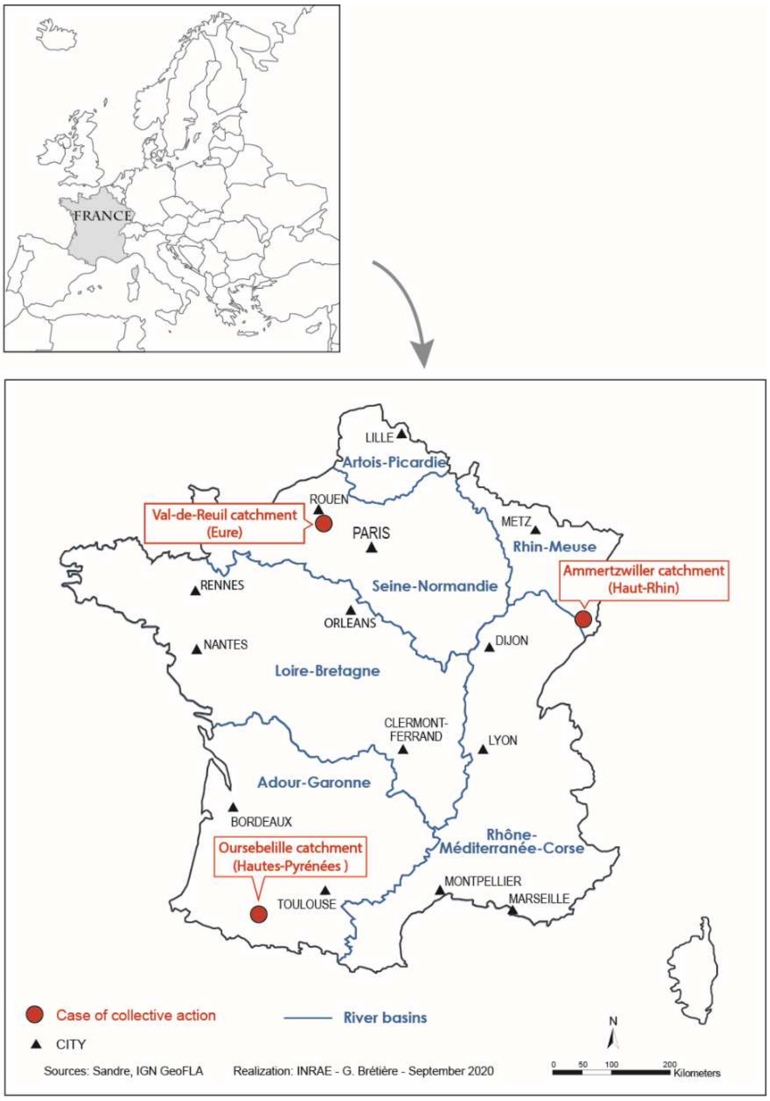
Table 3: Analytical framework combining IDP and ILM characteristics

1.	Common landscape concern/problem understanding (ILM)
2.	Clearly defined boundaries (resource/users) (IDP)
3.	Incorporating multiple land-use objectives (ILM)
4.	Involving multiple stakeholders (private-public; sectors) (ILM)
5.	Integrating multiple scales/nested enterprises (IDP, ILM)
6.	Collective-choice arrangements/transparency of the development of the solution and identification of trade-offs (IDP, ILM)
7.	Clarity of rights and responsibilities assigned to the process (ILM)
8.	Congruence between rules and local conditions (IDP)
9.	Proportional equivalence of benefits and costs (IDP)
10.	Occurrence of adaptive management and learning/monitoring the resource (IDP, ILM)
11.	Participatory monitoring and capacity-building activities/monitoring users (IDP, ILM)
12.	Graduated sanctions (IDP)
13.	Conflict-resolution mechanisms (IDP)
14.	Recognition of rights to organize (IDP)

This conceptual framework was empirically tested against case study evidence on cooperation initiatives in France to identify drivers and barriers to the achievement of EU water policy objectives with regard to the agricultural sector.

3. Methodology

The present analysis draws on a comparison between three cases of cooperation involving water suppliers and agricultural stakeholders for drinking water management in rural areas in France (Map 1). These cases are part of a larger set of cases investigated as in-depth case studies in previous research (Amblard, 2019; Amblard and Reynal, 2015).



Map 1: Map of the selected cases of cooperation for drinking water quality management

All cases involve drinking water catchments where intensive agriculture dominates land use (Table 4). In Ammertzwiller, corn represents 59% of the agricultural area, while grassland only accounts for 6% (CA du Haut-Rhin, 2008). In Oursbellile, irrigated crop farming represents 88% of the agricultural area in the catchment (CA des Hautes-Pyrénées, 2012). In Val-de-Reuil, intensive cereal cropping was initially the main farming system in the area, with seven farmers renting land from a regional public land development agency (Safer, 2008).

In two cases (Ammertzwiller and Oursbellile), the level of water contamination was high (Table 4). Due to high nitrate and pesticide pollution levels, the Ammertzwiller catchment was classified in 2009 as a "priority" catchment under the Rhin-Meuse River Basin Management Plan (RBMP). The Oursbellile catchment, located in a larger zone designated as a Nitrates Directive vulnerable area since 2002, was identified as a Grenelle "priority" catchment in 2009, as nitrate rates regularly exceeded regulatory standard levels between 2003 and 2008 (SIAEP Tarbes-Nord, 2013). In contrast, in Val-de-Reuil, the quality of the resource used for drinking water protection is good (CASE, 2014). However, the metropolitan authority in charge of drinking water production and supply decided to initiate a collaborative process with agricultural stakeholders to limit risks of diffuse pollution from agriculture.

Table 4: Main characteristics of water resources and agriculture in the selected catchments

	Ammertzviller	Oursbellile	Val de Reuil
Water resource			
Drinking water management	Intermunicipal water utility (SIAEP Ammertzwiller)	Intermunicipal water utility (SIAEP Tarbes-Nord)	Seine-Eure metropolitan area authority
Type of pollution	Nitrates/ pesticides	Nitrates	-
Level of contamination	High	High	Good water quality
Agriculture			
Catchment area	363 ha	396 ha	127 ha
Agricultural area	64.5%	82%	86.6%
Number of farms	30	19	7
Farming systems	Field crops	Field crops	Field crops
Share of grassland (% agricultural area)	6%	3%	9%

The cases also differ in terms of the governance of cooperation for water pollution control (Table 5). In Ammertzwiller, the implementation of agricultural actions was framed by EU agri-environmental schemes (AES) (reduction of input use) and contracts between the intermunicipal authority and farmers (implementation of a low-input energy crop (miscanthus)). In Oursbellile, the implementation of the agricultural action plan relied on EU AES (reduction in input use). In Val-de-Reuil, the metropolitan authority bought agricultural land in the catchment and established environmental land leases with farmers to support their conversion to organic farming.

Collective action processes led to different outcomes in the three cases (Table 5). In Ammertzwiller and Val-de-Reuil, cooperation between local stakeholders led to an effective restoration/maintenance of the quality of water resources. In Ammertzwiller, water quality improved significantly between 2009 and 2014 (Ditner, 2014). Collective action led to the effective development of organic farming in the Val-de-Reuil catchment with the conversion of part of the cereal area and the development of organic vegetable production. In Oursbellile, collective action was less successful in terms of farmers' participation and restoration of water quality. Pollution rates decreased but remained close to regulatory standard levels (SIAEP Tarbes-Nord, 2014).

Table 5: Main characteristics of the collective action processes and outcomes in each case

	Ammertzviller	Oursbellile	Val de Reuil
Regulatory framework	Rhin-Meuse River Basin Management Plan	Grenelle	-
Start date	2008	2009	2008
Governance			
Main stakeholders involved	Public water supplier, Agricultural chamber, Farmers	Public/private water suppliers, Agricultural chamber, Regional development agency	Metropolitan water service department, Organic farming associations, Farmers
Operational rules (contracts)	EU AES Supply contracts	EU AES	Environmental land leases
Measures	Reduction in input use Low-input energy crop (miscanthus)	Reduction in input use	Organic farming
Outcomes			
Farm participation	16/30	7/19	4/7
Area covered	34%	18%	87%
Water quality trend	Improvement	No improvement	Maintenance of good quality

In-depth case studies were originally developed based on primary data collected in 2013 and 2014 at the water-basin and national levels (12 interviews with stakeholders of the water and agriculture policy fields) and at the local level (17 semi-structured interviews with local stakeholders involved in cooperation, including water suppliers, farm organizations, farmers and local state agencies) (Appendix A). In addition, secondary data sources were used, such as national and regional research and policy reports, action plans, evaluation reports, meeting minutes, and newsletters. Each case study includes a description of the collective action process and outcomes and the identification of factors favoring or constraining collective action (Amblard and Reynal, 2015).

These in-depth case studies served as the basis for applying the conceptual framework combining the IDP and ILM principles. More particularly, the factors identified as potentially influencing collective action were used for the systematic operationalization of the principles across the three cases (Appendix B).

4. Results

In the following, we present the comparative analysis of the three cases of cooperation based on the analytical framework that combines the ILM and IDP principles. First, we present the commonalities shared by the collective action processes among the three cases. Second, we highlight differences between the cases.

4.1. Similarities among cases

In the three cases analyzed, multiple land-use objectives were integrated into the collaborative process, and public and private actors from different sectors at different scales were involved in collective action (Section 4.1.1). Furthermore, the presence of monitoring systems of the water resource and of farming practices was found to favor farmers' involvement in all cases (Section 4.1.2).

4.1.1. Stakeholder inclusion and integration of heterogeneous interests and objectives

4.1.1.1. Incorporating multiple land-use objectives

In all three cases, multiple land-use objectives were integrated into the collaborative process, although to different extents. In Oursbellile, collective action aimed at improving the quality of the water resource while maintaining agricultural incomes. In Ammertzwiller, the objectives of water quality improvement and maintenance of agricultural incomes were complemented by an objective of developing sustainable local energy production. Finally, in Val-de-Reuil, multiple environmental, social and economic objectives were envisioned: maintaining the quality of the water resource, maintaining agriculture while creating local short organic agro-food supply chains, and maintaining and creating employment in the area.

4.1.1.2. Involving multiple stakeholders

In all cases, public and private actors from different policy sectors at different scales were involved in collective action. The actors' involvement allowed for the pooling of resources (funding, knowledge, skills, and networks) needed to implement catchment protection. Furthermore, the participation of stakeholders brought legitimacy to collective action processes. However, the number of stakeholders involved in collective action impacts the costs of negotiating and deciding on measures to implement for diffuse pollution control. In Ammertzwiller and Oursbellile, the small number of stakeholders favored collective action. In contrast, the larger number of stakeholders participating in the governance of the Val-de-Reuil project raised negotiation and decision-making costs. The hiring of an external facilitator was identified as playing a crucial role in lowering such transaction costs.

4.1.1.3. Integrating multiple scales/nested enterprises

Regional and national public agencies provided financial and technical support to all collaborative processes. In Ammertzwiller, the miscanthus project benefited from support provided by the Rhin-Meuse water agency and the Haut-Rhin departmental council. In Val-de-Reuil, more than half of the total cost of the cooperative process was covered by the Seine-Normandie water agency, the Normandie region and the Eure department. The development of cooperation for the protection of the Oursbelille catchment also benefited from financial support by the Adour-Garonne water agency. However, the public water supplier felt that further regulatory and legal support would be necessary to foster collective action.

4.1.2. Monitoring the water resource and farmers' practices

4.1.2.1. Occurrence of adaptive management/monitoring the resource

The regular monitoring of water quality was found to favor the adaptation of actions and the long-term involvement of farmers in collective action. In Ammertzwiller, a meeting with farmers was organized once a year to discuss the evolution of farming practices and water quality trends. The visibility given to the impact of changes in farming practices favored the long-term involvement of farmers. In Oursbellile, the action program included the regular monitoring of farming activities and water quality based on indicators. In Val-de-Reuil, no centralized system of follow-up actions and their impact on water quality was organized. Instead, data regarding the development of organic farming in the catchment and water quality were gathered and provided by diverse organizations at different scales.

4.1.2.2. Participatory monitoring-capacity building activities

The provision of technical advice to farmers was identified to foster the evolution of farming practices. In Ammertzwiller, farmers growing miscanthus benefited from the technical support of one farmer who experimented with and promoted this new low-input energy crop. In Oursbellile, actions included individual technical support to reduce nitrogen and pesticide use. As the complex dynamics and low reactivity of the hydrogeological system did not allow for evaluating the impact of the evolution of farming practices on water pollution by nitrates, the use of soil nitrogen balance assessments provided information regarding the intermediary environmental impact outcomes needed for voluntary farmers to adjust their fertilization practices. In Val-de-Reuil, individual and collective technical advice was provided to cereal and vegetable farmers to support the development of organic farming.

4.1.2.3. Graduated sanctions

In Ammertzwiller and Oursbellile, the implementation of EU AES was associated with the monitoring system managed by a state agency, which includes a system of graduated sanctions. In Val-de-Reuil, no monitoring of changes in farming practices was formally implemented. However, farms converting to organic agriculture have to comply with the requirements of the organic farming label, which are monitored and enforced by an independent certifying organization. Therefore, collective action in all cases benefited from synergies with the existing policy framework.

4.2. Differences between cases

While the cases present similarities in terms of stakeholders' inclusion and monitoring aspects, they differ with regard to stakeholders' understanding of the water quality problem (Section 4.2.1) and the design of operational rules at the collective-choice level (Section 4.2.2).

4.2.1. Problem definition as a prerequisite for collective action

4.2.1.1. Common landscape concern/problem understanding

In Oursbellile and Val-de-Reuil, different perceptions of the water quality issue at stake posed an obstacle to the collective action process. In Oursbellile, the action program targeted diffuse pollution from agriculture as the main source of water contamination by nitrates. However, some farmers viewed a wastewater treatment plant located upstream as responsible for the pollution. These farmers also disagreed with the choice of a preventive approach for improving water quality, as they would bear the costs of this approach in contrast to alternative curative options, such as the use of nitrate filters. In Val-de-Reuil, the good quality of the water resource constituted a constraint on the involvement of some farmers in the protection program, as they disagreed on the need to undertake costly changes in their farming system while no pollution had been observed thus far. In contrast, in Ammertzwiller, the intermunicipal drinking water supplier and farmers shared the perception that actions were needed to control for rising levels of nitrate and pesticide pollution. Both parties were sensitive to the risks of environmental degradation. Other concerns were at stake as well. On the one hand, the drinking water supplier was willing to avoid investing in costly alternative options for limiting pollutant levels, such as water treatments or resource substitution. On the other hand, farmers were concerned that the increase in water pollution levels could lead to the implementation of regulatory measures imposing strong constraints on their farming activity in the catchment area.

4.2.1.2. Clearly defined boundaries (resource/users)

In Val-de-Reuil, the boundaries of the protection zone within the water catchment were defined in 1996 before the start of the collaborative process. A study conducted in 2008 identified farmers with land in the area (Safer, 2008). In contrast, uncertainty prevailed regarding the catchment boundaries in the cases of Ammertzwiller and Oursbellile. In Ammertzwiller, the delineation of the catchment boundaries was not completed at the time of the start of the collaborative process (2008). Only in 2016 was a hydrogeological study undertaken to identify the limits of the catchment and the most vulnerable areas. However, the assessment of the impact of farming practices and the definition of actions have been based on a protection zone large enough to include the potential effective boundaries of the catchment (CA du Haut-Rhin, 2008). In Oursbellile, the lack of knowledge about the complex dynamics of the hydrogeological system led to uncertainty regarding the exact boundaries of the drinking water catchment, which constrained the definition and implementation of relevant actions for limiting diffuse pollution. Moreover, this uncertainty fueled controversy regarding the agricultural versus nonagricultural source of water pollution of the catchment.

4.2.2 The design of operational rules at the collective-choice level

4.2.2.1. Recognition of rights to organize

While local stakeholders have the autonomy to define actions targeting diffuse pollution, they face a number of constraints linked to (i) the tools of the EU rural development policy (EU AES) and (ii) the EU regulatory framework for state aids. The level of autonomy held by local stakeholders further affects the *congruence between rules and local conditions* and the *proportional equivalence between benefits and costs.*

In France, the choice of the EU AES and corresponding financial compensations is framed by decisions made at the national and regional levels in contrast to other contractual tools such as environmental land leases. In Oursbellile, the agri-environmental measures offered for limiting nitrogen use were not considered adapted to the local agricultural context by stakeholders. In a context where the dominant farming system is highly profitable corn farming, the financial compensation offered by EU AES was considered insufficient for covering the costs of the contracted measures. As a result, the participation of farmers in AES was low. Furthermore, the EU regulatory framework for state aids limits the autonomy of public drinking water suppliers to provide financial compensation for farmers to implement measures outside the scope of the EU rural development program. Beyond a given level of public aid, payments to farmers must be reported to and approved by the European Commission. The notification process requires resources and skills that are not available to all drinking water suppliers, especially smaller suppliers. In Ammertzwiller, the planting of miscanthus, partly funded by the public drinking water supplier, was granted experimental status by the Rhin-Meuse Water Agency to avoid the costly EU notification procedure. The autonomy of local stakeholders in designing the miscanthus supply contract allowed consideration of the characteristics of the local farming systems. The financial compensation and guaranteed outlet offered by the water supplier for growing miscanthus covered the costs borne by farmers. In Val-de-Reuil, the design of the environmental land lease contracts by local stakeholders was also found to have a positive effect on cooperation. The duration of the contracts (9 years) and the lower level of land rent were considered by farmers as benefits outweighing the extra costs associated with the change in farming systems.

4.2.2.2. Collective-choice arrangements/transparency

The participation of farmers in the decision-making process was found to have a positive impact on their involvement in the implementation of agri-environmental actions. In Ammertzwiller, farmers were associated both with the initial assessment of the impact of farming practices on water quality and with the definition of actions targeting diffuse pollution through several meetings, which favored the uptake of actions. In Val-de-Reuil, interviews held with farmers renting land in the catchment served as a basis for taking into account the farmers' perception regarding the evolution of farming practices in favor of water quality (Safer, 2018). Farmers unwilling to convert their farming system were given the option to exchange land farmed in the catchment with parcels outside the protection zone. In contrast, in

Oursbellile, the initial delineation of the catchment boundaries was realized by a private consultancy on behalf of the Adour-Garonne Water Agency without consulting farmers with land in the catchment. The lack of information shared with the farmers contributed to the conflict regarding the identification of pollution sources of the water resource.

4.2.2.3. Clarity of rights and responsibilities assigned to the process

In both Ammertzwiller and Oursbellile, a formal basis was given to the collective action process. In Ammertzwiller, the partnership between the drinking water supplier and the agricultural chamber representing farmers was formalized by a multiyear convention. An action program under the responsibility of the agricultural chamber detailed the actions targeting diffuse pollution. Both documents provided a clear perspective on the objectives and actions to the involved stakeholders, including farmers. In Oursbellile, the formal organization of cooperation, based on technical and steering committees, ensured the clarity of rights and responsibilities assigned to the involved stakeholders. In Val-de-Reuil, the absence of a written basis describing the actions and commitments of the different stakeholders favored the divergence of opinions and raised the transaction costs of defining and implementing actions.

4.2.2.4. Conflict resolution mechanisms

In Oursbellile, local stakeholders see the technical and steering committees as platforms on which conflicting perceptions and opinions are discussed and reconciled. In Val-de-Reuil and Ammertzwiller, no such platforms were established. While in Ammertzwiller the high level of trust and social capital among the stakeholders involved in collective action lowered the costs of conflict resolution, in Val-de-Reuil, the recent character of interactions limited the potential role of trust and social capital in preventing conflicts.

Table 6 summarizes to what extent the principles are met in the three cases of collective action for diffuse pollution control.

Table 6: Application of the combined ILM/IDP principles to the three cases of collective action

		Ammertzwiller	Oursbellile	Val-de-Reuil
	Collaborative water quality management outcome	**Success**	**Failure**	**Success**
1.	Common landscape concern/problem understanding	Yes	No	No
2.	Clearly defined boundaries (resource/users)	Partly	No	Yes
3.	Incorporating multiple land-use objectives	Yes	Partly	Yes
4.	Involving multiple stakeholders (private-public; sectors)	Yes	Yes	Yes
5.	Integrating multiple scales/nested enterprises	Yes	Yes	Yes
6.	Collective-choice arrangements/transparency	Yes	No	Yes
7.	Clarity of rights and responsibilities assigned to the process	Yes	Yes	No
8.	Congruence between rules and local conditions	Partly	No	Yes
9.	Proportional equivalence of benefits and costs	Yes	No	Yes
10.	Occurrence of adaptive management and learning/monitoring the resource	Yes	Yes	Partly
11.	Participatory monitoring and capacity-building activities/monitoring users	Yes	Yes	Yes
12.	Graduated sanctions	Yes	Yes	Yes
13.	Conflict-resolution mechanisms	No	Yes	No
14.	Recognition of rights to organize	Partly	No	Yes

5. Discussion and conclusions

We combined the IDP and ILM principles to assess the drivers of and constraints on EU water policy implementation at the landscape level.

The analysis of the success or failure of collective action for water quality management in the three cases according to the combined principles (Table 6) provides several important insights. First, most principles characterize the governance system in successful cases (Ammertzwiller and Val-de-Reuil). In contrast, half of the principles are not or only partially met in the unsuccessful case (Oursbellile). The comparison of the three cases further suggests that some principles could be essential for collective action to be successful. These are the principles not found in the unsuccessful case only (Oursbellile): the *collective-choice arrangement transparency* and *proportional equivalence of benefits and costs* principles. This result highlights the importance of transparent and fair negotiations and decision-making in participatory processes as well as the prominent role of economic incentives for the involvement of farmers in the collective action process. Other principles were not achieved in successful cases (Ammertzwiller, Val-de-Reuil): *common problem understanding, clarity of rights and responsibilities* and *conflict-resolution mechanisms*. In Ammertzwiller, the risk of conflicts was limited by high levels of trust among stakeholders in the absence of a conflict-resolution mechanism. In Val-de-Reuil, conflicts induced by the absence of clear responsibilities and conflict-resolution mechanisms have not compromised the success of collective action.

Second, the analysis shows that the principles interact in their effects on collective action, as noted in previous studies (Huntjens et al., 2012; Schlager, 2016). The Ammertzwiller and Oursbellile cases suggest that the *congruence between rules and local conditions* and the *proportional equivalence of benefits and costs* depend very much on the level of autonomy held by local stakeholders to design incentives for collective action, i.e., the *recognition of rights to organize*. The Oursbellile case illustrates well how a lack of transparency at the collective-choice level (*collective-choice arrangements/transparency*) reinforces effects of the absence of *common problem understanding* and *clarity of resource boundaries* in leading to conflicts.

Finally, the effect of the principles appears to be contingent on other variables (Agrawal, 2001; Cox et al., 2010; Baggio et al., 2016; Villamayor et al., 2016; Robinson et al., 2017): characteristics of the water resource (the predictability of the resource dynamics), of actors (knowledge, resources, trust and social capital) and of the broader policy context (EU/French rural development policy and EU regulatory framework for state aid). As highlighted by other scholars, the IDP and ILM principles do not provide a blueprint for successful governance across all social-ecological contexts (Cox et al., 2010; Arts et al., 2017).

Regarding factors influencing the implementation of EU water policy at the landscape level, the analysis highlights the interactions between variables at the local (micro) level and variables at the national or

EU (macro) levels (Paavola et al., 2009). The success and failure of multi-stakeholder collective action appears to depend on local factors as well as factors linked to the larger institutional context of the EU and French national water and agricultural policy frameworks and their interplay. Local, national and EU-level factors interact vertically but also horizontally in their influence on collaborative processes on the ground, demanding an integrated approach across levels and sectors.

Our analysis also highlights the crucial role of the materiality and representations of ecosystems in EU water policy implementation, as stressed by other studies on environmental governance and policy (Paavola et al., 2009; Robinson et al., 2017; Stupak et al., 2019). Case studies reveal how existing scientific knowledge and prevailing uncertainties influence the range of policy options available for water quality management. Furthermore, the cases of Oursbellile and Val-de-Reuil demonstrate how the heterogeneity of representations of water pollution among farmers and other stakeholders affects collective action processes.

The governance arrangements studied represent so-called hybrid modes of governance (Lemos and Agrawal, 2006; Ménard, 2011; Villamayor et al., 2019). These modes of governance include different forms of stakeholder participation and collaboration together with hierarchical decision-making structures involving formal rules. All of the governance systems analyzed allow for stakeholder participation. However, governance systems also incorporate – by their institutional nature – forms of hegemonic decision-making such as monitoring and sanctions. The analysis underlines that environmental regulations setting quality standards and monitoring/sanctioning systems are needed to address water pollution problems. Within these regulatory frameworks, participation and collaboration then provide the basis for reaching water quality objectives. In addition to arguments of social responsibility in public policy, participatory approaches are also likely to increase compliance and achieve the intended policy objectives (Kemp et al., 2005; Ban et al. 2013). This highlights the need to provide spaces for raising individual perceptions of problems and solutions, which then increases the likelihood of policy uptake (e.g., Stobbelar et al., 2009; Graversgaard et al., 2016).

The combination of ILM and IDP principles proved useful as a framework for understanding collective action for drinking water quality management in agricultural landscapes. However, our analysis is limited by the small number of cases considered. Future research applying the combined framework to a broader range of cases is needed to identify the characteristics of successful governance approaches adapted to diverse social-ecological contexts. More particularly, the analysis of cases in different EU member states could shed light on how national institutional frameworks affect the achievement of EU water policy objectives. Another research avenue would be to compare implementation processes of different EU environmental policies (e.g., EU water and biodiversity policy) at the landscape level to account for the potential influence of the environmental policy field at stake.

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Appendix A: List of interviews conducted as a basis for the in-depth case studies (Amblard, 2019; Amblard and Reynal, 2015).

Table A.1: List of interviews conducted in 2013 at the national and river basin levels

Organization	Interviewee	Field of expertise	Type of interview	Date/Location
Water agencies				
Seine-Normandie	Project coordinator	Agriculture-related water issues	Face-to face	5/17/2013 Nanterre
Adour-Garonne	Project coordinator	Agriculture-related water issues	Phone	7/16/2013
Rhône Méditerranée Corse	Project coordinator Project coordinator	Pesticide management Drinking water management	Face-to-face	7/15/2013 Lyon
Rhin-Meuse	Head of department	Natural and rural areas	Phone	7/18/2013
Loire-Bretagne	Head of department	Agriculture and territorial water governance	Face-to-face	10/15/2013 Orléans
Ministries				
Ministry responsible for the environment	Policy officer	Agriculture and the Water Framework Directive	Face-to-face	6/7/2013 Paris
Ministry responsible for agriculture	Policy officer	Agri-environmental management	Face-to-face	11/8/2013 Paris
Agricultural organizations				
National network of Agricultural Chambers (APCA)	Project coordinator	Water management	Face-to-face	5/27/2013 Paris
National federation of organic agriculture (FNAB)	Project coordinator	Water management	Face-to-face	10/14/2013 Paris
Think tank Saf agr'iDées	Project coordinator	Environment	Phone	10/21/2013
Private water operators				
Suez Environnement	Project coordinator	Environmental engineering	Face-to-face	11/8/2013 Paris
Veolia Eau	Project coordinator	Sustainable development partnerships	Face-to-face	11/12/2013 Paris

Table A.2: Interviews conducted in 2014 at the local level – Ammertzwiller and Oursbellile cases

Type of organization	Organization	Interviewee	Date/location
Ammertzwiller			
Water supplier	Syndicat Intercommunal d'Alimentation en Eau Potable d'Ammertzwiller et environs (SIAEP)	President of the water utility board (also a farmer and mayor of Ammertzwiller)	4/14/2014 Ammertzwiller
Agricultural Chamber	Chambre d'agriculture du Haut-Rhin	Project coordinator – Environment and innovation	4/15/2014 Sainte-Croix-en-Plaine
Local office of the Rhin-Meuse Water Agency	Service territorial « Rhin supérieur et Ill » de l'Agence de l'eau Loire-Bretagne	Project coordinator – Water and agriculture	4/17/2014 Rozérieulles
Farmer			4/16/2014 Ballschwiller
Farmer			4/16/2014 Ballschwiller
Oursbellile			
Water supplier	Syndicat Intercommunal d'Alimentation en Eau Potable Tarbes-Nord (SIAEP Tarbes-Nord)	President of the water utility board	7/2/2014 Andrest
Private water operator	Veolia Eau	Coordinator of drinking water protection	7/4/2014 Laloubere
Agricultural Chamber	Chambre d'agriculture des Hautes-Pyrénées	Facilitator for agricultural action plan	7/1/2014 Vic En Bigorre
Local office of the Adour-Garonne water agency	Délégation de Pau de l'Agence de l'eau Adour-Garonne	Project coordinator	7/3/2014 Pau
Farmer			7/2/2014 Oursbelille
Farmer			7/3/2014 Oursbelille

Table A.3: Interviews conducted in 2014 at the local level – Val-de-Reuil case

Type of organization	Organization	Interviewee	Date/location
Val-de-Reuil			
Water supplier	Communauté d'Agglomération Seine et Eure (CASE)	Head of the water services department	5/23/2014 Louviers
Regional group of organic farmers	Groupement Régional d'Agriculteurs Biologiques de Basse-Normandie	Project coordinator – Water and territory	5/22/2014 Bois Guillaume
Organic supply chain association	Interbio Normandie	Project coordinator – Organic food systems	5/21/2014 Bois Guillaume
Local office of the Seine-Normandie water agency	Direction territoriale "Seine-Aval" de l'Agence de l'eau Loire-Bretagne	Project coordinator – Agriculture and aquatic environment	5/22/2014 Louviers
Farmer			5/21/2014 Val-de-Reuil
Farmer			5/22/2014 Val-de-Reuil

Appendix B: Methodology for the application of the combined IDP/ILM framework to case studies

Table B.1: Operationalization of IDP/ILM principles (I)

	Principle	Factors identified as favoring/constraining collective action for drinking water quality management (Amblard and Reynal, 2015)
1.	Common landscape concern/problem understanding	▪ Importance of the water resource to water suppliers/farmers (economic, environmental, cultural) ▪ Level of water contamination ▪ Regulatory threat
2.	Clearly defined boundaries (resource/users)	Description of collective action process ▪ Predictability of hydrogeological system dynamics ▪ Knowledge of SES
3.	Multiple land-use objectives	Description of collective action process
4.	Multiple stakeholders (private-public; sectors)	▪ Involvement of all concerned stakeholders ▪ Number of stakeholders ▪ Presence of facilitators ▪ Involvement of agricultural "leaders"
5.	Multiple scales/nested enterprises	▪ Support from public agencies at larger scales
6.	Collective-choice arrangements/transparency	Description of collective action process ▪ Involvement of farmers in collaborative decision-making ▪ Information sharing about evaluations and actions
7.	Clarity of rights and responsibilities assigned to the process	▪ Formal basis of collaboration (committees, conventions, etc.) ▪ Definition of the role of the stakeholders involved ▪ Prioritization of actions
8.	Congruence between rules and local conditions	▪ Duration of contracts ▪ Farmers' compensation for changes in agricultural practices
9.	Proportional equivalence of benefits and costs	
10.	Occurrence of adaptive management and learning/monitoring the resource	Description of collective action process ▪ Monitoring system of the resource

Table B.2: Operationalization of IDP/ILM principles (II)

	Principle	**Factors identified as favoring/constraining collective action for drinking water quality management (Amblard and Reynal, 2015)**
11.	Participatory monitoring and capacity-building activities/monitoring users	▪ Technical support/capacity-building activities for farmers ▪ Monitoring system of farming practices
12.	Graduated sanctions	▪ Monitoring system of farming practices
13.	Conflict-resolution mechanisms	▪ Formal basis of collaboration (committees, conventions, etc.) ▪ Social capital/trust
14.	Recognition of rights to organize	▪ Stakeholders' autonomy in rule design ▪ Regulatory framework for state aids