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Understanding collective action for the achievement of EU water policy objectives in agricultural landscapes: Insights from the Institutional Design Principles and Integrated Landscape Management approaches

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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 **Understanding collective action for the achievement of EU water policy objectives in**
2 **agricultural landscapes: Insights from the Institutional Design Principles and Integrated**
3 **Landscape Management approaches**

4
5 **1. Introduction**

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

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

31 Decentralized cooperation involving water suppliers and agricultural stakeholders for limiting diffuse
32 pollution in drinking water catchments has been developing in the French and European contexts over
33 the last 20 years (De Groot and Hermans, 2009; Grolleau and McCann, 2012; Amblard, 2019). These
34 cooperative arrangements rely on self-regulation among key actors (water suppliers, farmers and other
35 stakeholders) and target specific areas such as water catchments or water protection zones (Brouwer et
36 al., 2003). In France, cooperation initiatives have mostly developed in “priority” drinking water

37 catchments that have been identified in river basin management plans as particularly threatened by
38 diffuse pollution. To meet the WFD-Article 7 objectives, the “Grenelle” policy, launched in 2009 and
39 extended in 2013, identified 1000 priority drinking water catchments to be protected first and foremost
40 (Loi n° 2009–967, 2009; MEDDE, 2013). The policy prescribes the definition and implementation of
41 action plans based on cooperation between water suppliers and agricultural stakeholders (farm
42 organizations and farmers). The implementation of action plans targeting diffuse pollution at the water
43 catchment level relies on the voluntary participation of farmers. Policy tools such as EU AES or
44 environmental land leases are used to incentivize farmers’ participation, along with the provision of free
45 training and technical advice. In 2019, only 58% of the Grenelle priority catchments were covered by
46 an action plan (OFB, 2020). While a few successful cases of drinking water catchment protection have
47 been documented, the “Grenelle” policy thus far has not led to a significant improvement in water quality
48 in the French context (Bénézit et al., 2014; AE Adour-Garonne, 2017; OFB, 2020).

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

55 This paper aims to identify drivers and barriers to the achievement of EU water policy objectives in the
56 agricultural sector by adopting an institutional perspective on water quality management at the landscape
57 level. We develop a conceptual framework combining the Institutional Design Principles (IDP) (Ostrom,
58 1990, Cox et al., 2010) and principles from the Integrated Landscape Management (ILM) approach
59 (Sayer et al., 2013; Mann et al., 2018). The IDP serve as a basis for characterizing the governance of
60 water quality management approaches, while the ILM principles help assess their integrative potential.

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

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

71

72 **2. Conceptual framework**

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

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

90 **2.1. Institutional Design Principles (IDP)**

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

95 **Table 1: Institutional Design Principles (adapted from Cox et al., 2010, Ostrom, 2010, and Poteete**
96 **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

97 A first characteristic of successful governance systems for collective action is the clarity of boundaries
98 of the natural resource and of the group of users. Well-defined boundaries are considered a prerequisite
99 for the development of sound rules for the management of resources. Furthermore, clear boundaries are
100 assumed to ensure that benefits drawn from the management of the resource accrue to users bearing the
101 costs of management (Ostrom, 1990). Cox et al. (2010) suggested further distinguishing between the
102 clarity of boundaries of the users' community (IDP 1A) and the clarity of boundaries of the resource
103 system (IDP 1B) as two subcategories of this design principle. The long-term sustainability of collective
104 action is also seen as depending on the match between the rules governing the use of the resource and
105 local resource conditions (IDP 2A). Different governance systems are expected to manage the spatial
106 and temporal heterogeneity of resource conditions (Ostrom, 1990). Furthermore, several studies have
107 highlighted that the congruence between rules and local cultural and social conditions matters (Ostrom,
108 2009; Cox et al., 2010). Also stressed is the proportional equivalence between the benefits allocated to
109 users and their costs (IDP 2B), which favors compliance with rules considered equitable (Poteete et al.,
110 2010). Successful governance systems appear to be characterized by the involvement of users in rule
111 design (Ostrom, 1990) at the collective-choice level (IDP 3). Such participation favors the adaptation of
112 rules to the local ecological and social context, assuming that resource users have better access to
113 knowledge and information regarding their situation and resource dynamics (Cox et al., 2010). The
114 effectiveness of rules depends on the level of compliance from users and hence monitoring systems.
115 Ostrom (1990) observed that in environments characterized by an absence of external authority
116 enforcement, enduring self-governing systems include monitoring and sanctioning activities of resource
117 use by the participants themselves. Ostrom (2010) further distinguished between monitoring resource
118 users (IDP 4A) and monitoring the environmental conditions of the resource (IDP 4B) as subcategories
119 favoring the adaptation of rules to the local context. In this context, the accountability of monitors to
120 users seems crucial. Sanctions may prevent the occurrence of severe rule breaking by users. Taking into
121 account the importance of violations as well as the circumstances of their occurrence in a graduated way
122 ensures that excessive sanctioning does not lead by itself to noncompliance with rules (IDP 5) (Ostrom,
123 1990). Furthermore, successful governance systems for common-pool resource management are
124 characterized by low-cost access to conflict resolution mechanisms (IDP 6) (Ostrom, 1990). Another
125 condition identified for the success of self-organization by users of common-pool resources is the
126 recognition, by external authorities, of their right to define their own rules (IDP 7). Finally, nested
127 governance systems were found to be more suited to the management of larger resource systems (IDP
128 8) (Ostrom, 1990). The nesting of governance systems at different scales (for example, from the
129 catchment to the river basin level) facilitates the integration of cross-scale interdependencies while
130 reducing the cost of organizing at a large scale (Ostrom, 1990; Cox et al., 2010).

131

132

133 2.2. Integrated Landscape Management (ILM)

134 Integrated landscape management (ILM) has been introduced as an innovative form of multi-actor,
135 multi-sector and multi-scale collaboration for landscape management (García-Martín et al., 2016). The
136 concept builds on four defining characteristics: (i) ILM promotes multifunctional land uses and land-
137 use objectives (Mastrangelo et al., 2014); (ii) it works at the landscape scale and includes deliberative
138 planning and management; (iii) it incorporates cooperation among policy sectors and actors (Stenseke,
139 2016); and (iv) it supports collaborative management and mutual learning (Milder et al., 2014).

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

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

153 **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

154
155 One prerequisite for the development of an integrated landscape management approach is a shared
156 understanding of a land-use problem and the need for its solution (ILM 1) (Sayer et al., 2013; Mann et
157 al., 2018). Given that stakeholders may have conflicting values and management objectives, Sayer et al.
158 (2013) suggest that the identification of a common concern can serve as a first basis for initiating a
159 negotiation process toward the achievement of longer-term land-use goals. Another characteristic is the
160 recognition of the multifunctionality of landscapes and the need to explicitly address the trade-offs

161 between multiple land uses and land-use objectives (ILM 2) (Sayer et al., 2013; Mastrangelo et al., 2014;
162 Stenseke, 2016). In this regard, land-use conflict resolution will be favored by the involvement of the
163 various stakeholders concerned (ILM 3) (Milder et al., 2014; Mann et al., 2018). The design and
164 implementation of participation processes raise the issue of the unbalanced social power of different
165 stakeholder groups (Freeman et al., 2005). Additionally, the level of transaction costs associated with
166 the involvement of all stakeholders in decision-making may constitute a constraint (Sayer et al., 2013).
167 A fourth characteristic refers to the recognition of various administrative scales in regard to the
168 fulfillment of policy and management objectives. Land management interventions shall take into
169 account higher and lower policy levels, as they influence and constrain management outcomes (ILM 4)
170 (Sayer et al., 2013). Furthermore, the resolution of land-use conflicts will benefit from a transparent
171 decision-making process (ILM 5), including the assignment of clear rights and responsibilities to
172 participants (ILM 6) (Sayer et al., 2013). Landscape management includes adaptive management and
173 learning as a means to ensure that landscape dynamics are taken into account to improve management
174 outcomes (ILM 7) (Sayer et al., 2013; Freeman et al., 2015; Garcia-Martin et al., 2016; Mann et al.,
175 2018). Finally, monitoring and capacity-building activities are assumed to facilitate participation and to
176 allow for mutual learning among stakeholders (ILM 8) (Sayer et al., 2013; Mann et al., 2018).

177 2.3. A combined conceptual framework for analyzing water management systems

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

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

195

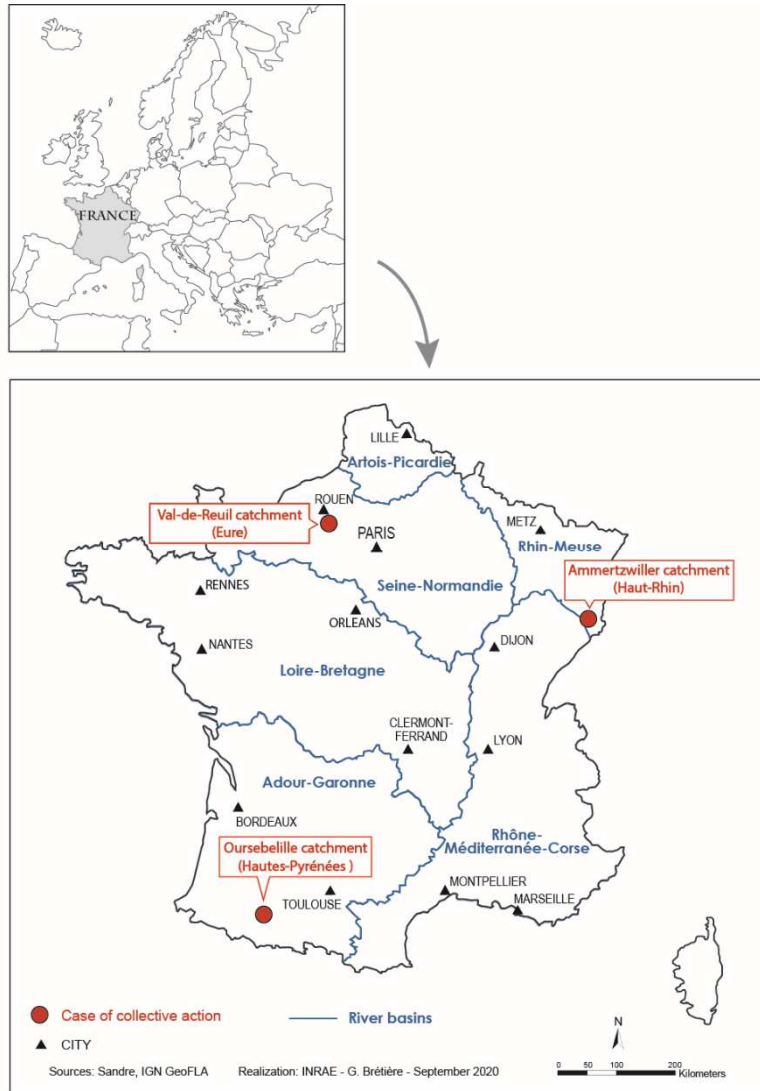
196 **Table 3: Analytical framework combining IDP and ILM characteristics**

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)

197
 198 This conceptual framework was empirically tested against case study evidence on cooperation initiatives
 199 in France to identify drivers and barriers to the achievement of EU water policy objectives with regard
 200 to the agricultural sector.

201 **3. Methodology**

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



206

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

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

214 In two cases (Ammertzwiller and Oursbellille), the level of water contamination was high (Table 4). Due
 215 to high nitrate and pesticide pollution levels, the Ammertzwiller catchment was classified in 2009 as a
 216 “priority” catchment under the Rhin-Meuse River Basin Management Plan (RBMP). The Oursbellille
 217 catchment, located in a larger zone designated as a Nitrates Directive vulnerable area since 2002, was
 218 identified as a Grenelle “priority” catchment in 2009, as nitrate rates regularly exceeded regulatory
 219 standard levels between 2003 and 2008 (SIAEP Tarbes-Nord, 2013). In contrast, in Val-de-Reuil, the
 220 quality of the resource used for drinking water protection is good (CASE, 2014). However, the

221 metropolitan authority in charge of drinking water production and supply decided to initiate a
 222 collaborative process with agricultural stakeholders to limit risks of diffuse pollution from agriculture.

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

	Ammertzwiller	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%

224
 225 The cases also differ in terms of the governance of cooperation for water pollution control (Table 5). In
 226 Ammertzwiller, the implementation of agricultural actions was framed by EU agri-environmental
 227 schemes (AES) (reduction of input use) and contracts between the intermunicipal authority and farmers
 228 (implementation of a low-input energy crop (miscanthus)). In Oursbellile, the implementation of the
 229 agricultural action plan relied on EU AES (reduction in input use). In Val-de-Reuil, the metropolitan
 230 authority bought agricultural land in the catchment and established environmental land leases with
 231 farmers to support their conversion to organic farming.

232 Collective action processes led to different outcomes in the three cases (Table 5). In Ammertzwiller and
 233 Val-de-Reuil, cooperation between local stakeholders led to an effective restoration/maintenance of the
 234 quality of water resources. In Ammertzwiller, water quality improved significantly between 2009 and
 235 2014 (Ditner, 2014). Collective action led to the effective development of organic farming in the Val-
 236 de-Reuil catchment with the conversion of part of the cereal area and the development of organic
 237 vegetable production. In Oursbellile, collective action was less successful in terms of farmers’
 238 participation and restoration of water quality. Pollution rates decreased but remained close to regulatory
 239 standard levels (SIAEP Tarbes-Nord, 2014).

240

241

242 **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

243
 244 In-depth case studies were originally developed based on primary data collected in 2013 and 2014 at the
 245 water-basin and national levels (12 interviews with stakeholders of the water and agriculture policy
 246 fields) and at the local level (17 semi-structured interviews with local stakeholders involved in
 247 cooperation, including water suppliers, farm organizations, farmers and local state agencies) (Appendix
 248 A). In addition, secondary data sources were used, such as national and regional research and policy
 249 reports, action plans, evaluation reports, meeting minutes, and newsletters. Each case study includes a
 250 description of the collective action process and outcomes and the identification of factors favoring or
 251 constraining collective action (Amblard and Reynal, 2015).

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

256

257

258 **4. Results**

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

263 4.1. Similarities among cases

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

268 4.1.1. Stakeholder inclusion and integration of heterogeneous interests and objectives

269 *4.1.1.1. Incorporating multiple land-use objectives*

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

278 *4.1.1.2. Involving multiple stakeholders*

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

288 *4.1.1.3. Integrating multiple scales/nested enterprises*

289 Regional and national public agencies provided financial and technical support to all collaborative
290 processes. In Ammertzwiller, the miscanthus project benefited from support provided by the Rhin-
291 Meuse water agency and the Haut-Rhin departmental council. In Val-de-Reuil, more than half of the
292 total cost of the cooperative process was covered by the Seine-Normandie water agency, the Normandie

293 region and the Eure department. The development of cooperation for the protection of the Oursbellille
294 catchment also benefited from financial support by the Adour-Garonne water agency. However, the
295 public water supplier felt that further regulatory and legal support would be necessary to foster collective
296 action.

297 4.1.2. Monitoring the water resource and farmers' practices

298 *4.1.2.1. Occurrence of adaptive management/monitoring the resource*

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

307 *4.1.2.2. Participatory monitoring-capacity building activities*

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

317 *4.1.2.3. Graduated sanctions*

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

324 4.2. Differences between cases

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

328 4.2.1. Problem definition as a prerequisite for collective action

329 *4.2.1.1. Common landscape concern/problem understanding*

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

346 *4.2.1.2. Clearly defined boundaries (resource/users)*

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

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363 4.2.2 The design of operational rules at the collective-choice level

364 4.2.2.1. *Recognition of rights to organize*

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

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

390 4.2.2.2. *Collective-choice arrangements/transparency*

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

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

403 *4.2.2.3. Clarity of rights and responsibilities assigned to the process*

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

414 *4.2.2.4. Conflict resolution mechanisms*

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

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

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

		Ammertzwiler	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

424

425 **5. Discussion and conclusions**

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

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

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

451 Finally, the effect of the principles appears to be contingent on other variables (Agrawal, 2001; Cox et
452 al., 2010; Baggio et al., 2016; Villamayor et al., 2016; Robinson et al., 2017): characteristics of the water
453 resource (the predictability of the resource dynamics), of actors (knowledge, resources, trust and social
454 capital) and of the broader policy context (EU/French rural development policy and EU regulatory
455 framework for state aid). As highlighted by other scholars, the IDP and ILM principles do not provide
456 a blueprint for successful governance across all social-ecological contexts (Cox et al., 2010; Arts et al.,
457 2017).

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

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

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

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

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

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

691 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	Pesticide management	Face-to-face	7/15/2013
	Project coordinator	Drinking water management		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

693 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 Oursbellille
Farmer			7/3/2014 Oursbellille

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696 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

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

699 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	<ul style="list-style-type: none"> ▪ 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 <ul style="list-style-type: none"> ▪ Predictability of hydrogeological system dynamics ▪ Knowledge of SES
3. Multiple land-use objectives	Description of collective action process
4. Multiple stakeholders (private-public; sectors)	<ul style="list-style-type: none"> ▪ Involvement of all concerned stakeholders ▪ Number of stakeholders ▪ Presence of facilitators ▪ Involvement of agricultural “leaders”
5. Multiple scales/nested enterprises	<ul style="list-style-type: none"> ▪ Support from public agencies at larger scales
6. Collective-choice arrangements/transparency	Description of collective action process <ul style="list-style-type: none"> ▪ Involvement of farmers in collaborative decision-making ▪ Information sharing about evaluations and actions
7. Clarity of rights and responsibilities assigned to the process	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ Duration of contracts
9. Proportional equivalence of benefits and costs	<ul style="list-style-type: none"> ▪ Farmers’ compensation for changes in agricultural practices
10. Occurrence of adaptive management and learning/monitoring the resource	Description of collective action process <ul style="list-style-type: none"> ▪ Monitoring system of the resource

701 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	<ul style="list-style-type: none"> ▪ Technical support/capacity-building activities for farmers ▪ Monitoring system of farming practices
12.	Graduated sanctions	<ul style="list-style-type: none"> ▪ Monitoring system of farming practices
13.	Conflict-resolution mechanisms	<ul style="list-style-type: none"> ▪ Formal basis of collaboration (committees, conventions, etc.) ▪ Social capital/trust
14.	Recognition of rights to organize	<ul style="list-style-type: none"> ▪ Stakeholders' autonomy in rule design ▪ Regulatory framework for state aids

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