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► To cite this version:

Marylise Cottet, Agathe Robert, Hervé Tronchère-Cottet, Thibault Datry. “It’s dry, it has fewer charms!”: Do perceptions and values of intermittent rivers interact with their management?. *Environmental Science & Policy*, 2023, 139, pp.139-148. 10.1016/j.envsci.2022.10.003 . hal-03924360

HAL Id: hal-03924360

<https://hal.science/hal-03924360>

Submitted on 5 Jan 2023

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1 "It's dry, it has fewer charms!": Do perceptions and values of 2 intermittent rivers interact with their management?

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8 Article published in [Environmental Science & Policy](#)

9 <https://doi.org/10.1016/j.envsci.2022.10.003>

10 Submitted revised manuscript version

11 1. Introduction

12 Intermittent rivers are those that cease to flow at some point in time and space. They occur naturally
13 on every continent and in every climate, including temperate, tropical, and boreal regions. They are so
14 widespread that they are now considered more numerous than perennial rivers (Messenger et al. 2021,
15 Datry et al., 2017; Schneider et al., 2017), and they are increasing in number in connection with climate
16 change (Döll and Schmied, 2012) and water withdrawals for human activities (de Graaf et al. 2019).
17 Intermittent rivers have a significant functional role within river networks (Fovet et al. 2021),
18 contributing to local and regional biodiversity and biogeochemical integrity, and providing a number
19 of ecosystem services such as flood regulation, aquifer recharge, and wood and food supply (Acuña et
20 al., 2014, Datry et al. 2018). There is therefore a need to preserve or restore their ecohydrological
21 functioning to maximize the biodiversity and ecosystem services they provide, even more so in the
22 current context of global change.

23 However, intermittent rivers suffer from a lack of specific legislative protection (Acuña et al. 2014,
24 Messenger et al. 2021), falling under the same regulations as permanent rivers (e.g., the 'Water
25 Framework Directive' in the EU, the 'Water Act' in the US), thereby denying their specific

26 ecohydrological functioning. In particular, Stubbington et al. (2018) and Cid et al. (2020) have
27 underlined the difficulties in defining the “reference conditions” for these dynamic ecosystems, as well
28 as the inappropriateness of current biomonitoring tools, which together undermine their protection.
29 Similarly, defining environmental flows in intermittent rivers remains a major challenge (Acuña et al.
30 2020). Intermittent rivers can even suffer from exclusion regimes from regulatory protection
31 frameworks because of their “atypical” functioning (e.g., in France, the decree Giraud, August 3rd,
32 2019). Last but not least, intermittent rivers are often not referenced and are *de facto* excluded from
33 protection schemes: for example, in the United States (Marshall et al., 2018) and France, intermittent
34 rivers are being gradually removed from maps and definitions of national streams, which ends their
35 official management as water courses and puts entire river networks at risk.

36 This lack of protection for intermittent rivers leads us to consider the underlying socio-political
37 processes. There is growing recognition in the scientific community that water management “is not
38 merely a technical field that can be addressed through infrastructure provision and scientific expertise,
39 but a political one that involves human values, behavior and organization” (Linton and Budds, 2014).
40 It is no longer just a matter of thinking of rivers as being related to society, but as considering them as
41 the result of a social and political process. Rivers and societies are co-produced, coevolve, and emerge
42 through continued engagement over space and time (Wantzen et al., 2016), which also means that
43 rivers are embedded in power relations (Linton and Budds, 2014). This paradigm recognizes the social
44 nature of rivers; according to this perspective, the poor protection of intermittent rivers could be
45 linked to their devaluation by society, a hypothesis formulated by several researchers studying
46 intermittent rivers (Acuña et al., 2017; Datry et al. 2018).

47 Three recent studies looked at the social value of intermittent rivers. Armstrong et al. (2012) pointed
48 out a lack of concern from landowners towards ephemeral or intermittent rivers in US headwater
49 regions. Leigh et al. (2019) and Rodríguez-Lozano et al. (2020) focused on student populations of
50 different nationalities and disciplines using (photo)questionnaires. Their findings converge, and
51 highlight a lower value given to intermittent rivers compared with perennial rivers. This lower value

52 was observed regardless of the evaluation criteria used, e.g., aesthetic, recreational, naturalness,
53 habitat for biodiversity, importance for human well-being, and conservation value. This devaluation
54 was relative to the degree of flow intermittence, with completely dry beds being less valued than dry
55 riverbeds holding disconnected pools. While these findings were true for all groups surveyed, both
56 articles showed slight variations according to the disciplinary profile of the students. They therefore
57 pointed to the critical role of knowledge and education in improving the social value placed on
58 intermittent rivers and in building societal support for policies to protect these rivers.

59 These initial studies have produced some challenging findings in the context of climate change and
60 open up important research perspectives. In particular, they underline the need to conduct territorial
61 approaches to better understand the relationships - in terms of perceptions and values - that develop
62 between the residents and stakeholders of a territory and the intermittent rivers that flow through it.

63 In response to this, our study adopts an original qualitative approach, focusing on one intermittent
64 river (the Albarine River, intermittent only on its downstream section), its riverine area and its
65 stakeholders, in such a way as to be able to consider all the complexity of the relationships that exist
66 between the stakeholders and the river. The Albarine is a particularly interesting case study for
67 studying these relationships: on a relatively small linear section, it has a perennial and then an
68 intermittent section, which facilitates the collection and comparison of data on the perceptions and
69 values of the river stakeholders. All the people surveyed in the study have close links with the Albarine
70 River, since they all live in an adjacent commune (except one) and have institutional links with the
71 river, whether through professional missions (river managers), political responsibilities (current or
72 former municipal elected officials) or associative memberships linked to their specific uses of the river
73 (fishers). In this respect, it provides a different perspective, more embodied in the reality of the field,
74 than the previous studies that have until now mainly studied the perceptions of groups of students.

75 More precisely, this paper aims to (1) characterize the perceptions and values of intermittent rivers
76 and how they interact with their management and (2) determine whether the prospect of climate
77 change leads the stakeholders to question their perceptions and values of intermittent rivers and the

78 way we should manage them. It aims to bring primary deductions that could be confronted with those
79 produced on other rivers and areas, or that could provide good candidate variables for potential more
80 systematic and more hypothetico-deductive inquiry with larger dataset.

81 2. Methods

82 The research is based on a qualitative approach - a survey using semi-structured interviews analysed
83 by content analysis - combining a hypothetical-deductive and inductive approach. Based on the
84 literature review, we proposed and tested three hypotheses: (H1) the intermittent section of the river
85 is devalued compared to the perennial section and this devaluation is primarily related to experiential
86 reasons, whether aesthetic or related to the recreational opportunities produced by the river. (H2)
87 This devaluation leads to neglect the intermittent section in the river's management plans. (H3) Finally,
88 we expect that the perspective of climate change leads stakeholders to question their relationship to
89 the river and to imagine more integrative management modalities, giving more care to the intermittent
90 section, as part of the river network. In parallel to this hypothetical-deductive approach, a more
91 inductive approach, open to ground truth aspects was conducted to enrich the analysis. Following the
92 principles of the grounded theory, we used an open coding of interviews which allowed us to bring to
93 light new "theories" (Corbin & Strauss, 1990; Strauss & Corbin, 1990) concerning the perceptions and
94 values of intermittent rivers and the links with their management.

95 2.1. Study area

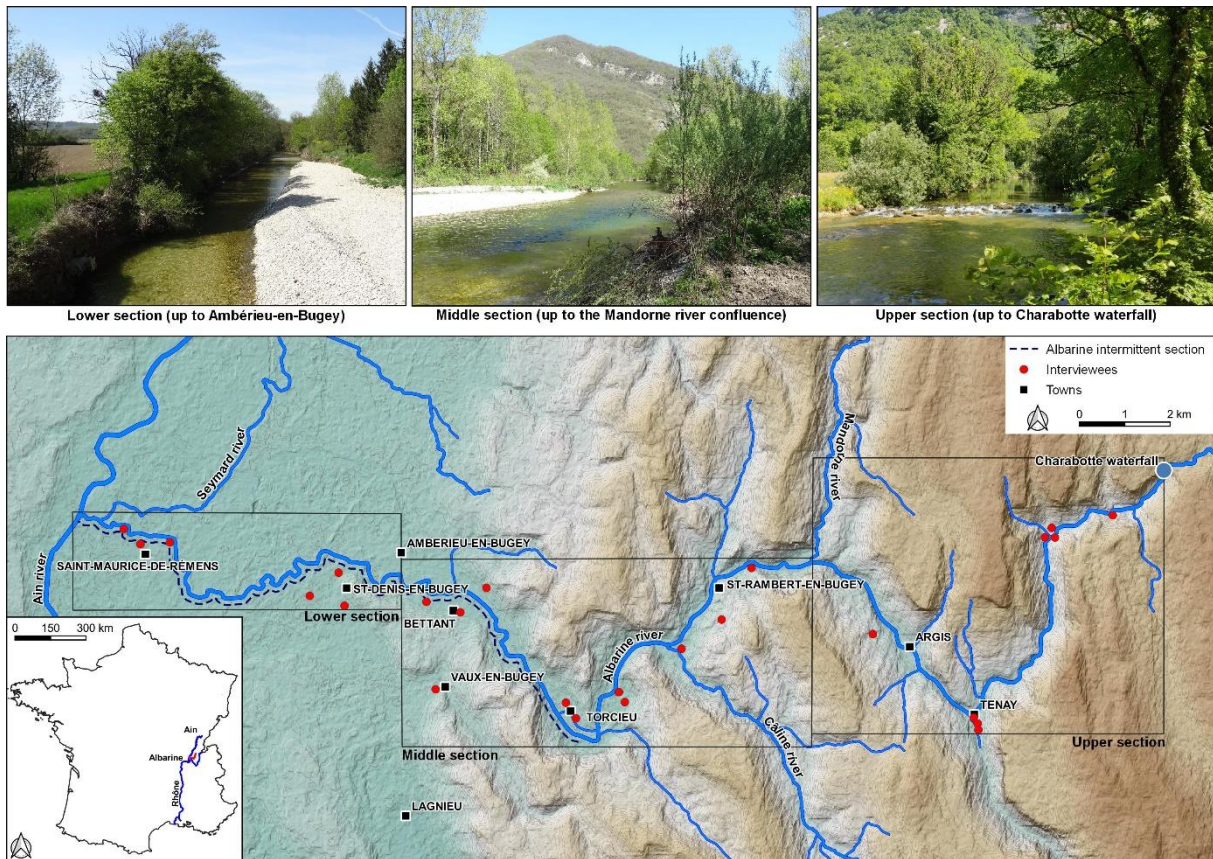
96 The Albarine River is located in temperate eastern France and drains a 313-km² catchment. Its sources
97 are in the Jura massif. The section of the river considered for this study is located between the
98 Charabotte waterfall, which represents a topographic break with its 115-m drop, and the confluence
99 with the Ain River. A perennial upstream section first flows for 15 km through gorges, then traverses
100 an alluvial plain for 15 km before reaching the confluence. Because this alluvial plain is underlain by
101 thick and highly permeable alluvium, and also because the river is generally perched 1–14 m above the
102 regional aquifer water table, the surface water continuously infiltrates into the aquifer along this

103 section (Datry 2012). As a result, this intermittent section dries completely during summer (Figure 1),
104 when rainfall cannot compensate for surface losses into the aquifer (Datry, 2012).

105 The Albarine flows across multiple landscapes, from an upstream narrow forested perennial mountain
106 torrent to a downstream agricultural alluvial plain with corn monoculture, while its intermediate
107 section passes through more open landscapes with a still marked topography (Figure 1). The course of
108 the Albarine crosses about ten small municipalities, all of which are in decline (the biggest having about
109 14 000 inhabitants), and all being marked by the relics of industrialization with many disused factories
110 (mostly from the silk industry active in the 20th century). The river is socially invested for recreational
111 uses, at least in its perennial part; people walk, cycle, or ride horses, but above all they fish. The river
112 — of category 1¹ — is well known and welcomes both local residents and many tourists (on average
113 2500 fishing licenses are sold per year) who come to practice fishing on the perennial part, most often
114 sport fishing, and sometimes "no kill". The sale of fishing licenses ensures an important economic
115 income to the local fishing society (named the "Albarine valley" society) and makes it a powerful river
116 stakeholder. The river is managed by a public establishment dedicated to the management of aquatic
117 environments and flood prevention (the SR3A, further referred to as the 'river management
118 syndicate'), which represents seven inter-municipalities belonging to the Ain watershed. In response
119 to the Water Framework Directive (WFD), one of the missions of the SR3A is to implement
120 management plans to achieve good water status.

121

¹ Rivers are classified into two distinct fish categories according to the populations they contain. The 1st category corresponds to waters where mainly Salmonid fish (trout, salmon, etc.) live.



122

123 Figure 1: The study area, showing the upstream perennial section and the downstream
 124 intermittent section, along with changes in topography and landscape

125 2.2. Data collection: interviews and mental mapping

126 In the spring of 2018, we conducted a survey of 28 stakeholders residing in the Albarine valley. The
 127 survey was performed using semi-structured interviews and was complemented by mental mapping.
 128 The study focused on four key categories of stakeholders because of their close links with the river:
 129 river managers (n=2), elected officials (n=8), fishers (n=8), and residents (n=8). The first three groups
 130 have institutionally structured links with the Albarine River, whether through professional missions
 131 (SR3A river managers), political responsibilities (current or former municipal elected officials) or
 132 associative memberships linked to their specific uses of the river (fishers). We also interviewed riverine
 133 residents since they have been able to create more informal links with the river (notably through their
 134 practices or because the river landscape is part of their living environment). All interviewed people
 135 were resident (except for one river manager) in riverine municipalities of the Albarine (i.e.

136 municipalities crossed or bordered by the river). People with institutional links to the river (river
 137 managers, elected officials or members of a fishing society) were contacted by e-mail or telephone via
 138 their respective institutions. People without such links were included in the study following on-site
 139 encounters. The interview guide is presented in Table 1. The interview was split into two sections; the
 140 first section focused on the entire Albarine River and aimed to better capture the perceptions, uses,
 141 and values associated with the river; and the second section focused on the intermittent reach. The
 142 aim of this second section was to better grasp the understanding of this phenomenon and its
 143 consequences on the river, as well as the possible strategies put in place — or that could be put in
 144 place — to outline a desirable future for the Albarine. Climate change and its possible consequences
 145 are discussed at the end of the interview in order to question this desirable future. This division into
 146 two sections was intended to prevent forcing the discourse onto the phenomenon of intermittence,
 147 to apprehend its true place in the field of perception of the interviewees. In addition to the discursive
 148 exchanges, which were fully recorded, the interviewees were asked to freely draw objects on a paper
 149 map to spatialize their perceptions and knowledge. For this purpose, a 1:25 000 scale IGN (the French
 150 national geographical institute) topographical map of the study area was given during the interview,
 151 as well as a box of different colored markers. The objects that were to be mapped are listed in Table
 152 1.

	Discursive objects	Cartographic objects
Sequence 1: The Albarine River	a. The Albarine in the life of the interviewees (frequentation, uses, contributions to their living environment). b. The landscapes of the Albarine (perceptions and values). c. The ecological state of the Albarine (perceptions of possible pressures and impacts).	Zones delineating: a) valued, and b) devalued landscapes

Sequence 2: Intermittence and the Albarine River	a. The mechanisms of intermittence (perceptions and knowledge related to the rhythms, causalities, and impacts of drying). b. The sources of this knowledge and the possible individual or collective adaptations. c. The future of the Albarine: expected evolution of intermittence and its impacts; strategies to adopt. Expected impacts of climate change and strategies to be developed accordingly.	Zones affected by intermittence
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153 Table 1: Structure of the interview and the topics covered

154 **2.3. Data analysis**

155 **2.3.1. Interviews**

156 The interviews were fully transcribed. We then analyzed the corpus following two principles.

157 First, we implemented a thematic content analysis based on the three previously mentioned
158 hypotheses. Thematic content analysis is “a method for identifying, analyzing and reporting patterns
159 (themes) within data” (Braun and Clarke, 2006). This “objective, exhaustive, methodical and, if
160 possible, quantitative examination of material consisting of verbal communications (...) with a view to
161 classifying and interpreting its elements” (Berelson, 1954)" enables us to identify how themes are
162 repeated from an interview to another, how they overlap, join, contradict or complement (Paillé and
163 Mucchielli, 2012). According to the methodological standards, we carried out an important phase of
164 pre-analytical work. This consists in carrying out, in an intuitive way, a first reading oriented by the
165 research hypothesis inviting to search in a certain specific field and allowing to define precise themes,
166 consistent with ground truth. We then classified, by coding the interviews, portions of discourse within
167 different sub-themes, following the hypotheses (Table 2). Each sub-theme is a variation of the main
168 theme according to the different meanings it can take in the discourse. Atlas.ti software (ATLAS.ti 8

169 Windows) was used to perform this classification. Quotes from interviews were used to illustrate each
 170 of the codes. The stakeholder's type of the person who produced this quote was systematically
 171 specified.

Hypotheses	Themes used to classify the discourse	Example of sub-themes
(H1) the intermittent section of the river is devalued compared to the perennial section and this devaluation is primarily related to experiential reasons, whether aesthetic or related to the recreational opportunities produced by the river.	Reasons mentioned in the interview to explain the valuation or devaluation of a section of the Albarine River	<ul style="list-style-type: none"> - Aesthetic reason - Recreational reason - Biological reason - Familiarity reason - Cognitive reason
(H2) the devaluation of intermittent sections leads to neglect them in the river's management plans.	Management projects mentioned in the interview and sections of the Albarine River concerned by the projects	<ul style="list-style-type: none"> - Connection of municipalities to sewage treatments plants (perennial section) - Restoration of fish habitats through the creation of gravel bars, wooden structures, and block additions (perennial section) - Geomorphological restorations (meandering and lateral connection with riparian habitats (perennial section))
(H3) the perspective of climate change leads stakeholders to question their relationship to the	Assumed consequences of climate change on the river and its value mentioned in the interview	<ul style="list-style-type: none"> - lack of drinking water - disappearance of fauna and flora

<p>river and to imagine more integrative management modalities, giving more care to the intermittent section, as part of the river network.</p>		<ul style="list-style-type: none"> - degradation of recreational opportunities linked to the river - rise of water temperature and consequent nuclear risk downstream
	<p>Reactions to these perspectives expressed during the interviews</p>	<ul style="list-style-type: none"> - A feeling of invulnerability - A feeling of powerlessness - A willingness of adaptation

172 Table 2: Analysis grid used for the content analysis of the corpus of interviews: themes researched in
173 response to the hypotheses and sub-themes used to code the different variations of this theme in the
174 interviews

175 2.3.2. In parallel to this hypothetical-deductive approach, a more inductive approach, open to
176 ground truth aspects was conducted to enrich the analysis. Certain unanticipated themes
177 concerning the perceptions and values of intermittent rivers and the links with their
178 management emerged from the interviews. They were also coded. An example of this, is
179 the existence of power plays between river managers and fishermen which orient
180 management plans and result in the negligence of intermittent sections.'Mental maps

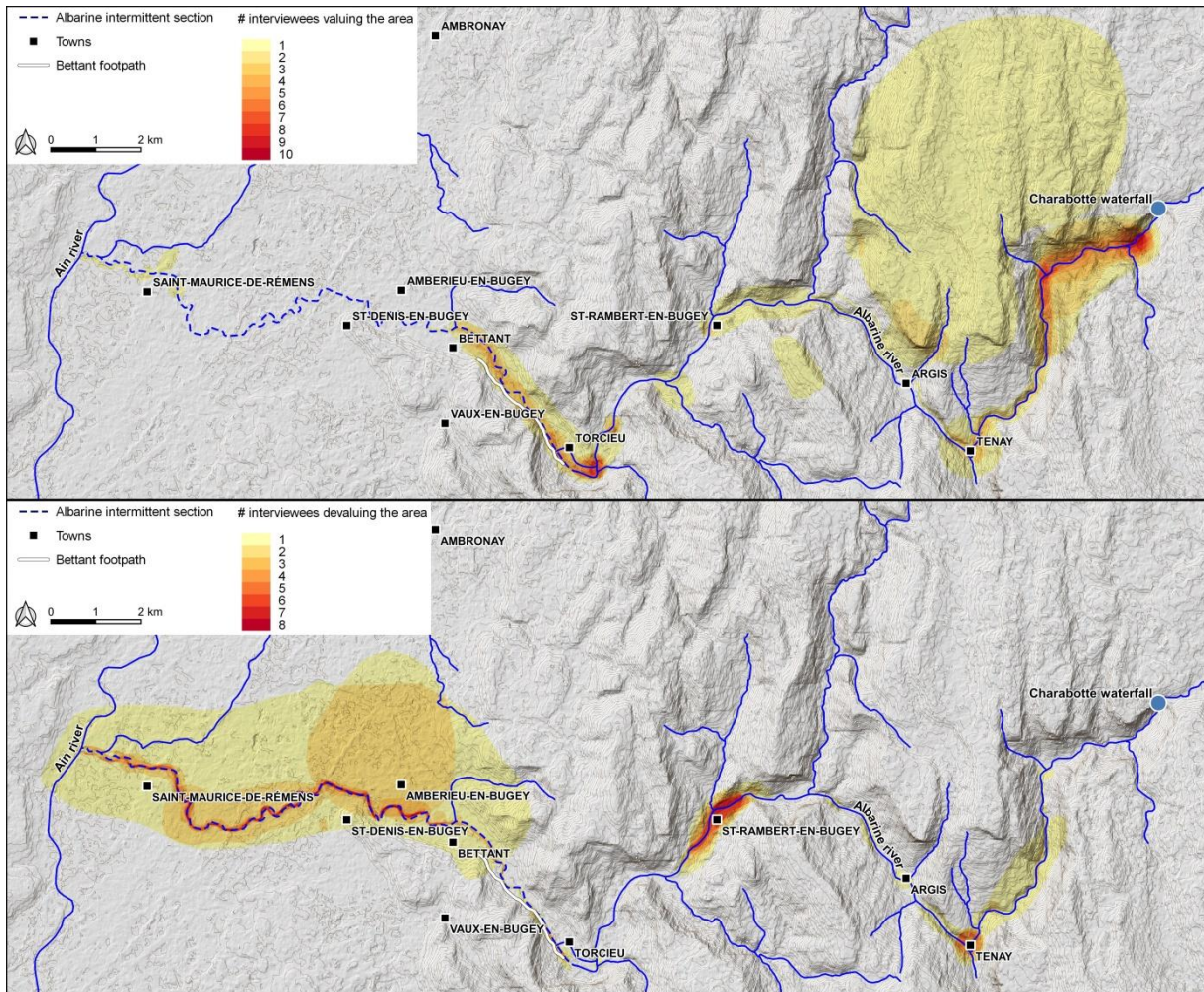
181 The areas (valued areas and devalued areas) drawn by the interviewees on the topographical maps
182 where digitized on a geographic information system (GIS) after scanning. The overlapping areas were
183 then added up to obtain the number of interviewees valuing or devaluing each point on the map. For
184 the valued sectors, the scores ranged between 0 and 10, whereas the scores for the devalued sectors
185 ranged between 0 and 8 (Figure 2).

186 3. Results

187 3.1. A highly socially-devalued intermittent section

188 Figure 2 shows a dichotomy in the values associated with the river between the highly-valued
189 upstream part and the highly-devalued downstream part. The topographic and landscape context of
190 the valley undoubtedly influences these opinions: the upstream mountain landscape is considered very
191 attractive, whereas the downstream agricultural plain landscape is not. However, beyond these
192 topographical and landscape criteria, the intermittent functioning of the river also explains these
193 opinions. The downstream drying of the river is a factor causing devaluation.

194 Low values associated with the intermittent section were consistently linked to three types of reason
195 — aesthetic, recreational, and biological (Table 3). This section of the river is considered unaesthetic
196 because of the absence of water that leaves a gravel bed visible. Beyond the unpleasantness of the
197 landscape, the downstream section is also considered to be unsuitable for recreation because the
198 absence of water prevents certain uses, such as fishing or bathing. Some interviewees also mentioned
199 that the use of the dry riverbed for recreation was risky because of the presence of snakes. Although
200 only a few marginal and socially castigated uses (e.g., quad biking, poaching in the pools during the dry
201 season) take place in this section of the river, it should be noted that the existence of a footpath along
202 the intermittent section contributes to making a part of this sector appreciated by many (see the
203 Bettant footpath on the map). Finally, a low biological value is associated with the intermittent section.
204 Drying is often associated with death; both of the landscape, but also of the associated aquatic
205 ecosystems. The trapping of fish in the pools during the dry period and the mortality that inexorably
206 ensues if the dry period exceeds a certain duration is a process regularly mentioned in the interviews.
207 However, this strong devaluation of the intermittent section is somewhat nuanced, with some
208 downstream residents expressing their attachment to the intermittent section, even if preferring the
209 perennial section, as though their familiarity with this sector contributes to a revaluation of this
210 landscape.



211

212 Figure 2: Mental mapping showing the valued (top) and unvalued (bottom) areas along the Albarine

213 River

Main sources of devaluation	Interviewee	Quotation
Aesthetic	Int. 7, fisher	"Because a river that has no water... [...] It's not beautiful, it's lunar."
	Int. 19, elected official	"From Ambérieu, the Albarine is an ugly river that is dry during the whole summer. Therefore it's true that it's a part that is not very interesting; sometimes there is water, but most of the time, it's a gravel bank."

Recreational	Int. 9, fisher	“Because it dries up there, there's nothing there. If you don't make a trout pond, there's nothing. There was a [fishing] society, but they have discontinued it.”
	Int. 15, resident	“We live a little bit at the rhythm of the Albarine. When it's dry, well we don't go there. For example, in the summer, when it's really dry, we know the places where there is still water to bathe the horses. We live a little bit at the rhythm of the Albarine, whether we are on horseback or whether we swim.”
Biological	Int. 24, elected official	“One could say It's a dead river. This does not make us the happiest.”
	Int. 26, elected official	“Truly, it's that the river is dead there. That's all.”

214 Table 3: Interview excerpts illustrating the main sources of devaluation of the intermittent section of
215 the river

216 Finally, the devaluation of the intermittent section of the river is constant over time even if the
217 interviewees are aware that the drying up is temporary: interviewees reported in the interviews the
218 significant variability of the landscapes over the seasons. However, the downstream section remains
219 in their discourses as the dry section, as if it was a constant, and as such is of little interest. It is also
220 important to mention that in no way did the discourses of the interviewees spontaneously focus on
221 the downstream section when they were asked to speak about the river (unless the interview was
222 explicitly centered on this section). It is as if the intermittent section were not, strictly speaking, the
223 river. Furthermore, certain of the interviewees would like to see the ‘river’ status of intermittent
224 sections removed, as the following excerpts attest: “It doesn't represent the Albarine, you know? It's
225 called the Albarine, but they should remove the sign on the highway. The Albarine... the guy, he
226 looks, it's just gravel, it's dry!” (Interviewee 9, fisher); or “it's always more delicate when everyone
227 says to us: “but you manage a river that doesn't flow”! Basically, I prefer a river that flows, otherwise
228 it is hard to say that it is a river.” (Interviewee 3, manager). These observations suggest that cognitive

229 reasons, related to the construction of knowledge – and to the definition of what a river is in essence
230 – may be linked to the devaluation of intermittent rivers.

231 3.2. An intermittent section neglected in actions to restore environmental quality

232 Substantial restoration efforts have been conducted in the past two decades on the Albarine River.
233 Interviewees mention three types of actions: the connection of municipalities to sewage treatments
234 plants to improve water quality, the restoration of fish habitats through the creation of gravel bars,
235 wooden structures, and block additions and finally, the geomorphological restorations to allow
236 meandering and lateral connections with riparian habitats. All these actions focused on the 15-km-
237 long perennial section and no actions were mentioned to be carried out in the intermittent section
238 (which is consistent with what the authors know about the management of the river).

239 The analysis of the interviews gives enlightening insights to explain the focus of restoration efforts on
240 the perennial section; namely the power plays that exist between fishermen and river managers that
241 likely orient the management plans. Various recurring themes in the interviews put us on this path. In
242 particular, the interviewed fishermen expressed a strong desire to influence the management of the
243 river. Their fishing society named “the Albarine Valley” has given itself the means to have a say in
244 decisions by acquiring the banks of multiple reaches to promote restoration (Table 4a). By purchasing
245 the land, the fishing society forces the managers of the syndicate to obtain their approval for any action
246 on the parcels it owns. Ownership of the land also allows the society to make improvements on its
247 own, without having to obtain the approval of the management syndicate. This power stems from the
248 historical importance of fishing in the valley, as well as the number of occasional or regular users. The
249 purchase of numerous fishing licenses brings substantial financial resources to the fishing society,
250 which make it a powerful stakeholder with a well-recognized role in the restoration of the river.

251 The members of the fishing society see themselves as a manager of the river, and as such, they feel
252 legitimate in influencing decisions and actions. Their posture orients restoration in favor of the fish
253 resources, particularly by creating the environmental conditions favorable to large fish (for example,

254 with the installation of large blocks that are favorable to fish growth). This perspective centered on
 255 fish issues is different to that of the members of the management syndicate, who advocate in the
 256 interview for a more integrated management of the quality of the river environments according to the
 257 WFD perspective (Table 4b).

258 Although a logic of compromise seems to be at the center of their mutual approaches (Table 4c), the
 259 management of the fishing resources takes a particular place in the management of the river, and
 260 focuses interests and actions on the perennial section.

261 Of note, is that there is little consideration of the river as a system. The interactions between upstream
 262 and downstream sections are seldom described, suggesting that the intermittent section is no longer
 263 considered the river. When interactions are described, they appear somewhat counter-natural to the
 264 normal intermittent functioning of the river. Accordingly, many interviews report the action of the
 265 fishing society, which during dry periods, manually transports fish trapped in the pools within the dry
 266 riverbed to the perennial section (an action called “rescue fishing”). More generally, at no time in the
 267 interviews was the intermittent section considered by anyone as an environment in its own right that
 268 should be managed (Table 4d).

Topic	Interviewee	Quotation
a. The weight of the fishers in the management	Int. 7, fisher	“We are not the ones who are in command. Yes, we bought the land, we bought all the land, we had to buy all the land.”
	Int. 8, fisher	“We, as managers, cannot say “we are going to participate financially in hatchery developments to have fewer fish afterwards than before”! For me, in my head, this is a problem. I can't conceive of anything like that. Afterwards, if we disagree with the syndicate, we can say to ourselves, we will at least make sure that

		there are at least as many fish. [...] That, I can conceive of as a manager.”
b. Contrasting views on management objectives	Int. 19, elected official	“The fishers see it as a way to give the trout healthier water, that's it. [...] For me, the water treatment plants are to preserve the drinking water resource. Drinking water, because all the agglomerations downstream, including the Ambérieu agglomeration and its soon-to-be 22 000 inhabitants, draw their water from the Albarine. All the municipalities all along. This is a subject to which they are absolutely insensitive.”
	Int. 22, manager	“The fishers are interested in large blocks that will produce large fish, and it's true that it works. The monitoring we do shows that producing big fish is something we know how to do [...]. Working on the diversity of habitats and flows will bring more biomass and more big fish. That's the fisher's objective. Is the river better because there are more big trout in it? I am not able to answer that.”
c. The logic of compromise for action	Int. 19, elected official	“We had to let go a little bit, but sometimes they [the fishers] were a little bit heavy handed. We left things as they were. [...], we couldn't afford to have the fishermen not be with us. That would make things totally impossible.”
	Int. 1, fisher	“On the other hand, there are times when there are compromises, like in Tenay, where we bought the land with the syndicate. There was a dike there, it was not mentioned, but it was there. And that one, we indented it, but we worked to ensure that when we lost fish habitat above, we regained it elsewhere within the same sector.”
d. The downstream	Int. 3, manager	“It flows in its median part, and sometimes for us, this means that we also intervene in a different way on this sector, which is always

section overlooked as an environment to be managed		with water, than on the other sectors. So for us, there are not many habitat and aquatic life issues downstream and upstream.”
	Int. 22, manager	“As for the lower part, there are fewer opportunities because the rivers are either dry or are on clay bedrock; therefore, we can't do much.”

269 Table 4: Interview excerpts illustrating how the weight of the fishing societies focuses the river
270 management objectives on the preservation of fish resources, and therefore on the perennial part of
271 the river.

272 **3.3. A ‘normal’ intermittence with little thought given to its temporal dynamics,**
273 **even in the context of climate change**

274 Interviewees perceived the intermittence of the Albarine river as "normal" or "natural" (which is true
275 for the Albarine; see Methods section), above all because they claim to have always seen dry events
276 on this river. Very few people noticed changes in the duration or the frequency of the dry events over
277 time. This perception is confirmed by the hydrological modelling performed previously (see Larned et
278 al. 2011). This lack of perceived evolution does not lead respondents to project any change in the
279 hydrological regime in the future and as a result, intermittence was therefore not really perceived as
280 a problem or concern.

281 However, if the interviewer voluntarily addressed the subject of climate change and the potential
282 increase in intermittence that it could cause, the discourse changed, and certain concerns sometimes
283 emerged. Those interviewees who were elected officials or managers often then mentioned the lack
284 of drinking water. In contrast, residents and fishers thought mainly of the harmful consequences on
285 the ecosystems and described the disappearance of fauna and flora. More rarely, they mentioned the
286 impacts on recreational uses of the river, such as reduced areas for swimming or fishing'. They even
287 occasionally mentioned certain risks, such as a rise in water temperature linked to the low flow and
288 the resulting inability to cool the nuclear power plants downstream on the River Rhône.

289 This confrontation with climate change induced three reactions: a feeling of invulnerability, a feeling
 290 of powerlessness, and willingness of adaptation (Table 5). For some people, vulnerability to climate
 291 change concerns the animals and plants that gravitate around the river, and not humans, who are seen
 292 as having the necessary resources to ensure their survival (Table 5a). For numerous other people, a
 293 feeling of powerlessness, or even fatalism, was expressed (Table 5b). This powerlessness is rooted in
 294 the mismatch between scales: the local scale being the scale of the perception of the intermittence
 295 phenomenon; and the global scale being the scale of the decisions likely to influence this phenomenon.
 296 This feeling of powerlessness in the face of a possible worsening of intermittence gave the respondents
 297 the impression that they did not hold the keys, and that no action was possible at their level. This
 298 incapacity to reverse the trend – or at least interrupt it – did not prevent some people from thinking
 299 in terms of ‘adaptation’. This was often limited to considering a restriction in terms of water
 300 consumption (Table 5c). The Interviewees did not address in their discourses the possibility of adapting
 301 the orientation of river management, except for one manager (Interviewee 22): “One day, we will be
 302 managers of wadis, and we will no longer be river managers.” With this analogy, even if it is humorous,
 303 the manager conjures up an imaginary state of aridity and envisages that his profession will evolve and
 304 move towards the management of a wadi, an environment with specific ecohydrological functioning
 305 and specific ecosystems.

Topic	Interviewee	Quotation
a. Invulnerability	Int. 20, elected official	“What worries me... Because we humans will adapt, we have the means, we will survive. However, the whole fauna and flora will be impacted, which, for their part, will not have [the means to adapt] ... This change will be bad for them because it's too violent.”
	Int. 17, resident	“That can have a consequence, not on us who are at the end, but a consequence for all fish life; [...] yes, it can be dramatic for them, if it happens, if it happens, yes.”

b. Powerlessness	Int. 3, manager	“In my opinion, the solutions are not at our scale, it is Donald who may have the solution!”
	Int. 20, elected official	“It's on a global scale, so the day that everyone will have understood... It will take centuries before this recovers, before it becomes normal again. But it won't happen. We shouldn't dream.”
c. Adaptation	Int. 15, resident	“At one time my horse was on the violet meadow and we filled the troughs from the river, then one day we thought (well, afterwards, we thought the impact of two horses wouldn't be huge)... but maybe we should stop doing that.”
	Int. 16, resident	“A general problem of water shortage because it won't just be the Albarine... So I think that in the long term, well even in the short term, the water tables will be impacted and therefore we'll have to modify our water consumption. I've already started.”

306 Table 5: Interview excerpts illustrating the reactions of interviewees to a hypothesis of increased
307 intermittence on the Albarine River induced by ongoing climate change

308 4. Discussion

309 4.1. Revaluation of intermittent sectors? Landscape is at the heart of the issue

310 The analogy of the Albarine with a wadi, even if anecdotal, reveals a paradox. The paradox is that wadis
311 have high social value as they often represent invaluable resources in regions where water is scarce
312 (Burmil, 1999). The situation in the Albarine basin is different, with water currently remaining in the
313 perennial upstream part in sufficient quantity to meet the multiple expectations required by the
314 people living along the river. In contrast, the intermittent downstream part is all the more devalued.
315 This lower value associated with the intermittent reaches and the corresponding lower propensity to
316 protect and restore them is in line with the conclusions of Rodriguez-Lozano et al. (2020). As in our
317 study, they identified landscape aesthetics as the main reason for this devaluation: the lack of water
318 and the strong visual presence of sediments are displeasing. This finding echoes previous work on

319 braided rivers where respondents denounced the “appearance of a riverbed that had been bulldozed”
320 (Le Lay et al. 2013). Since the 1960s, water is known to be one of the most important elements
321 contributing to the attractiveness of a landscape (Shafer et al., 1969; Zube et al., 1974, 1982; Kaplan,
322 1977; Ulrich, 1983). According to Litton (1984) and Brown and Daniel (1991), people are not attracted
323 to rivers with low flows, the attractiveness of the stream being defined by an inverted U-curve:
324 preferences increase with flow to a point, then decrease for further increases in flow (Brown and
325 Daniel, 1991). Beyond its importance for sustaining life, water has an important aesthetic, cultural, and
326 spiritual value, symbolizing purity, sanctity, and rebirth (Bachelard, 1942).

327 The presence of water within a landscape is so cognitively structuring that people cognitively
328 discriminate between landscapes with and without water by placing them into separate typological
329 categories (Palmer and Zube, 1976). This may explain the absence of spontaneous discourse about the
330 intermittent section in our interviews when the interviewees were asked about the river. The
331 intermittent section does not seem to belong to the river itself, and is not therefore categorized as
332 such. In cognitive psychology, the concept of categorization refers to the ability to classify and organize
333 knowledge into categories: “A category exists when two or more distinguishable objects or events are
334 treated in an equivalent manner. This equivalent treatment can take several forms, such as the
335 common naming of distinct objects or events, or the production of the same action on different
336 objects.” (Mervis and Rosch, 1981). Thus, a river without water is not cognitively read as a river, and
337 therefore should not be named as one. Traditionally, the classification of the natural world has
338 proceeded by identifying similarities and differences according to a binary logic that suggests that an
339 object can only belong to one category (Debarbieux, 2004). The hybrid character of intermittent rivers,
340 being neither totally aquatic nor totally terrestrial, is a deviation from such a classification (Datry et al.
341 2014, Allen et al. 2020). In this respect, they echo, on an epistemological level, the criticism formulated
342 by the French philosopher Michel Serres (1980) against “the theory of frontiers and markers”,
343 according to which the world is thought of as a system of juxtaposed and interwoven objects. Thus,
344 the issues relating to the valuation and protection of intermittent rivers question deep cognitive

345 mechanisms related to the production of knowledge. This is especially true, as categorization of the
346 objects that make up the natural world is eminently linked to action on these objects (Mervis and
347 Rosch, 1981). The way in which we categorize the environment influences our actions towards it, and
348 therefore the way in which we transform it. For example, Debarbieux (2004) clearly showed how the
349 categorization of 'mountain' has had an influence on the public policies linked to it and on the
350 transformations brought about.

351 How can intermittent rivers and their landscapes be socially revalued? The preceding reflections
352 underline the need to make the river more visible in the landscape so that it is identified and classified
353 as a river. They also point to the need to 'work' on the aesthetics of the river, particularly to
354 communicate human intentions, including the intention to care for the landscape (Nassauer, 1995).
355 Indeed, it is well-known that there is a link between aesthetic value and motivation to protect a
356 landscape or ecosystem (Nassauer, 1992; Gobster et al., 2007). However, the appearance of some
357 natural ecosystems, starting with intermittent rivers, can in many ways be judged as unclean, messy
358 (presence of sediment, spontaneous vegetation, pools), and in conflict with cultural aesthetical norms.
359 Even to an educated eye, ecological functions are sometimes invisible. A response is landscape design
360 used as a lever to place ecological functions in a recognizable context more in line with aesthetic tastes
361 (Nassauer, 1995). In particular, she proposes — as is done today in the field of differentiated
362 management of green areas in cities — to design "cues to care" that provide a cultural context for
363 ecological function (e.g., fences, landart, wildlife feeders, and wild animal houses).

364 Landscape value is not only linked to its aesthetic value but also to the experience one can have of it,
365 it seems important to recreate the conditions of such experiences. The development of footpaths
366 along the intermittent riverbed may be an option; on the Albarine, an existing footpath on the
367 intermittent downstream part seems very popular and appreciated. Festive events around
368 intermittent rivers can contribute to creating a positive emotional 'history' with the river and create
369 the conditions for a social reinvestment in the intermittent parts, while at the same time reminding us

370 that these atypical landscapes are indeed rivers. The Rotary Henley on Todd Regatta, a dry river boating
371 race in Alice Springs (Australia), where fun, quirky, and eclectic 'boats' compete each year on a dry
372 sandy bed (Figure 4), undoubtedly contributes to identifying this dry channel as a portion of a river and
373 to giving it social value (Steward et al. 2012).



374

375 Figure 4: Photographs of the Rotary Henley on Todd Regatta (Australia), a festive event likely to create
376 a positive emotional 'history' with the Todd River, and therefore the conditions for a social
377 reinvestment in this intermittent river

378 4.2. Acknowledging the socio-political dimension of intermittent river 379 management, especially in the context of climate change

380 Water management choices are far from being socio-politically neutral, being firmly embedded in
381 power relations (Linton and Budds, 2014). Our survey revealed the weight of fishing societies in the
382 management carried out on the Albarine River. The political power of fishers and their ability to
383 influence water management has already been noted on a national scale in France (Bouleau, 2009).
384 On the Albarine River, this weight is critical for the management of the river; it contributes to focusing
385 the management actions on the perennial section while neglecting the intermittent one. This choice
386 to privilege the perennial reaches, even if it today meets the expectations of certain categories of
387 stakeholders, can appear in many respects as an ecological and ethical pitfall. Intermittent rivers have
388 a systemic ecohydrological functioning, which relies on hydrologic, physico-chemical, and biological
389 flows in space and time at the scale of the catchment. Ignoring such interactions could be harmful for

390 the ecological integrity of these systems and the societies that benefit from their services. For example,
391 not ensuring a good ecological status for the intermittent section would have severe cascading effects
392 on downstream receiving waters in the Ain River. Moreover, the concentration of management actions
393 on perennial parts may indeed reinforce territorial inequalities in access to quality ecosystems, and
394 enhance the current devaluation of the intermittent section, acting in a vicious circle. The management
395 of intermittent rivers should be considered and discussed at the scale of the socio-ecosystem with all
396 stakeholders to preserve the ecohydrological integrity of these systems, as well as the equity between
397 the different stakeholders and territories.

398 This question of the management space given to intermittent sections of rivers is all the more acute in
399 the current context of climate change. Our survey highlighted different attitudes in response to a
400 possible accentuation of flow intermittence in the context of climate change, with the most widely
401 shared feeling being that of powerlessness. As climate change is a global phenomenon, individuals feel
402 that action must come from national or supra-national scales. This point of view opens up the debate
403 on climate policy strategies and questions the weight given to mitigation policies (which engage
404 national and supra-national scales) and adaptation policies (which shift part of the responsibility to the
405 local scale, to the territories) (Reghezza-Zitt and Rufat, 2015). Whatever the outcome of this debate
406 and the solutions to be implemented to address this environmental risk, the response is no doubt
407 political (Reghezza-Zitt and Rufat, 2019). The future of intermittent river management should be
408 discussed in political arenas open to all stakeholders. The realization of a distributed mechanistic
409 hydrological model for the Albarine basin is underway. It should provide downscaled climate change
410 scenarios forecast for the river and perhaps favor discussions between stakeholders about this
411 important issue.

412 Finally, our results point to the need to collectively re-examine the definition of environmental
413 references for intermittent rivers and the underlying indicators. Indicators are a political construction
414 as they constitute social conventions that group together, but also exclude, certain environmental

415 realities distributed in time and space (Bouleau and Deuffic, 2016). In particular, the indicators used
416 today to define the good ecological status of rivers in response to the WFD are part of a normative
417 framework in which a river is considered as flowing sections. They do not take into account the
418 diversity of ecohydrological functioning that characterizes intermittent rivers. This normative
419 conception ultimately leads to the detriment of intermittent rivers (Acuña et al. 2014, Stubbington et
420 al. 2018). There is thus a strong argument for widening the normative borders concerning the
421 definition of what is a river, and for this definition to assume the diversity of functioning that they
422 represent. This should find echoes in national legislation, which currently tends to remove intermittent
423 rivers from protection schemes on the basis of their flow intermittence (Marshall et al. 2018). Because
424 of the strong interactions between water sciences and water management (Bouleau, 2014), science
425 has a major role to play. It must reassess the paradigms within which it evolves and constructs its
426 questions. To this end, Messenger et al. (2021) call for a paradigm shift towards a new conceptual model
427 of rivers that includes flow intermittence as an intrinsic part of every river catchment.

428 5. Conclusions

429 Our work shows that the perceptions and values associated with intermittent rivers interact with their
430 management. We observed a strong social devaluation of intermittent sections, with river
431 stakeholders, including river management professionals, attributing lower aesthetic, recreational, and
432 biological value to them. We also observed power plays around the river management that tend to
433 favor the preservation of perennial sections of the river to the detriment of intermittent ones. In
434 particular, the human and financial capacity for action by fishers, who place a high value on fish
435 resources, contributes to prioritizing actions on perennial sections. More generally, the intermittent
436 sectors are not perceived as environments that should be preserved. These social and political
437 dynamics are likely to harm the ecological integrity of such rivers and the services they provide for
438 society. These dynamics are all the more alarming as our results show that river stakeholders have a

439 low propensity for thinking about the future of these intermittent rivers and their value in a context of
440 climate change.

441 This article identifies two levers to influence or at least question these dynamics of devaluation:
442 landscape and participation. The preservation of intermittent rivers leads to questioning of what a
443 river landscape is, and more specifically, what a beautiful river landscape is. Is a river that does not
444 flow really a river in our socio-cultural context? Intermittent rivers are hybrid landscapes that are
445 neither totally aquatic nor totally terrestrial, which questions our classification of the natural world
446 and therefore knowledge production. A scientific challenge is to widen the normative borders
447 concerning the definition of what is a river so that this definition can assume the diversity of
448 functioning that they represent. The preservation of intermittent rivers also questions the cultural
449 norms of aesthetics. Intermittent river landscapes are often judged as unclean and messy, and
450 ecological functions are sometimes invisible and therefore less considered when defining river
451 management issues. As aesthetic appreciation is mainly driven by emotion, education is not necessarily
452 the best way to produce a change in attitude towards these rivers, as is often seen (Leigh et al., 2019;
453 Rodríguez-Lozano et al., 2020). The second challenge for science is therefore to collaborate with other
454 professional communities (environmental managers, artists, mediators) to try to trigger new
455 perceptions of these landscapes.

456 The second lever concerns participation. Intermittent rivers, like rivers in general, are socio-political
457 constructs influenced by power plays between stakeholders. The future of intermittent rivers cannot
458 be thought of outside a framework of common good, where the integrity of ecosystems is thought of
459 in parallel with equity between humans. The creation of political arenas open to all stakeholders is an
460 indispensable key to this environmental justice. Here again, science must be part of this dynamic by
461 providing a critical view of water governance and by accompanying participatory approaches to
462 intermittent rivers. Current on-going efforts to promote citizen-science on intermittent rivers (Datry

463 et al., 2016; Puntenney et al., 2017; Allen et al., 2019) will undoubtedly help to acknowledge the
464 multiple ecohydrological and socioeconomical values they provide.

465 Acknowledgments

466 The authors would like to thank all the stakeholders who took part in this study, as well as the Rhône
467 Mediterranean Corsica Water Basin Agency which funded this project, through the framework
468 agreement with the Rhône Basin Long Term Environmental Research Observatory (RBLTER), Zone
469 Atelier Bassin du Rhône (ZABR) in French. They also would like to thank the reviewers for their
470 valuable comments that helped to improve the manuscript.

471

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