

Brummer, M.; Rodríguez-Labajos, B.; Thanh Nguyen, T. and Jordà-Capdevila, D. 2017.  
"They have kidnapped our river": Dam removal conflicts in Catalonia  
and their relation to ecosystem services perceptions.  
Water Alternatives 10(3): 744-768



---

## "They Have Kidnapped Our River": Dam Removal Conflicts in Catalonia and Their Relation to Ecosystem Services Perceptions

### Mathias Brummer

University of Bayreuth, GCE Koordination Lehrstuhl für Biogeografie Universitätsstr, Bayreuth, Germany;  
mathias.christian.brummer@gmail.com

### Beatriz Rodríguez-Labajos

Universitat Autònoma de Barcelona, Institut de Ciència i Tecnologia Ambientals, Barcelona, Spain;  
beatriz.rodriguez@uab.cat

### Trung Thanh Nguyen

Institute for Environmental Economics and World Trade, Leibniz University Hannover, Germany;  
thanh.nguyen@iuw.uni-hannover.de

### Dídac Jorda-Capdevila

Universitat Autònoma de Barcelona, Institut de Ciència i Tecnologia Ambientals, Barcelona, Spain;  
dd.joca@gmail.com

---

**ABSTRACT:** River restoration is essential to guarantee access to ecosystem services provided by free-flowing rivers. One mechanism to restore rivers is the decommissioning of run-of-the-river dams, but restoration can create opposition as anthropised landscapes form part of the environmental history and imaginary. To facilitate decision-making, actors' perceptions on ecosystem services for and against dam removal should be considered. We analyse perceptions on ecosystem services at two levels of study in Catalonia (Spain): the Catalan context and two local cases of dam removal in the Ter River Basin. Local case studies illustrate that combining participatory mapping and interviews makes contrasting values conspicuous and contributes to conflict understanding. Additionally, we acknowledge a dichotomy of perceptions between locals and outsiders, and the relevance of cultural values, environmental aesthetics, and history for actors' positioning. We propose the engagement of local stakeholders at the basin level through participatory approaches for the sake of understanding water conflicts, as decision making will rarely achieve social sustainability without local support.

**KEYWORDS:** Water conflicts, participatory mapping, Mediterranean River basins, cultural values, history

---

### INTRODUCTION

By capturing water and changing the magnitude and timing of its downstream flow, dams have contributed to the welfare of the human population (Nguyen et al., 2013). They even became an important part of the socio-environmental landscape and imaginary of progress in the 20th century (Richter et al., 2010). However, negative impacts of dams are nowadays widely acknowledged (Born et al., 1998; Bednarek, 2001; Pohl, 2002; Fencl et al., 2015) and so is the fact that decommissioning them can be beneficial for society and the environment (Pejchar and Warner, 2001; Foley, 2017). The majority of removed dams are so far small, old, often-abandoned, and no longer serving their initial purpose (Poff and Hart, 2002). In recent years reasons for dam removal have been mainly

environmental (Born et al., 1998; Doyle et al., 2000; Lejon et al., 2009) and proponents of dam removal argue that decommissioning can bare economic, environmental, and cultural benefits (de Loë, 1999; Baish et al., 2002; Gowan et al., 2006; Wyrick et al., 2009; Gosnell and Kelly, 2010; Opperman et al., 2011; Jorgensen and Renöfalt, 2013; Fox et al., 2016).

There is an emerging body of research on the importance of the social perception of restoring dammed ecosystems (Buijs 2009; Jacobs et al., 2011; Reilly et al., 2017). Related to the analysis of the perception of ecosystem restoration is the acknowledgement of the importance of historical, geographical, institutional, and place-based politics in dam-removal conflicts (Magilligan et al., 2017). Hence, it is crucial to gain a better understanding of social dimensions of conflicts over dam removal as decommissioning is unlikely to occur without local support (Pejchar and Warner, 2001) if local actors perceive that decommissioning brings more losses than opportunities. This lack of local support can presumably create opposition to dam removal. For example, reasons to oppose decommissioning may be cultural, since actors fear to lose recreational opportunities, cultural-historic values or an aesthetical beautiful landscape (Born et al., 1998; Lejon et al., 2009; Opperman et al., 2011). Stakeholders also relate dam removal with declining property value and hydropower production (Bednarek, 2001; Wyrick et al., 2009). All this points to the importance of stakeholder perception in landscape change. However, a better understanding of the importance of stakeholder perception for water management remains to be achieved. This is then further complicated as diverse stakeholders usually have contrasting perceptions of a given benefit (Jorda-Capdevila and Rodríguez-Labajos, 2015). This situation could potentially create conflict and hinder the achievement of the Water Framework Directive (WFD) goals.

In Spain, as in other countries of the European Union (EU), the WFD urged water policies to achieve good ecological status for all rivers. Non-compliance can result in reduced bargaining power in the EU, or even monetary fines (Honey-Rosés, 2007). In Catalonia (NE Spain), the *Agència Catalana de l'Aigua* (Catalan Water Agency, ACA) has proven to have made good progress in accomplishing the WFD's goals. The River Basin District Management Plan for the Internal Basins of Catalonia was the first to be approved in Spain in 2009. This, together with the more recent second cycle Management Plan for the period 2016-2021, considers demolition of small run-of-the-river dams (hereafter just referred to as dams) as a viable management option, and develops a strategy to prioritise actions in all Catalan River basins (ACA, 2009, 2015). In Catalonia, according to the ACA (2008), these small dams are structures up to 15 m high that interrupt the river flow. The diverted water is then conveyed through a canal and can be used for irrigation or energy production. Regulations on fishing at the regional level also drive measures to restore water-flow regimes. The Catalan Fishing Law of 2009 reinforced the requirement for the construction of fish passages, a provision of the previous Spanish law from 1942 that was rarely enforced (BOE 62, 1942; DOGC 5536, 2009).

Against these provisions, only a few out of the 761 run-of-the-river dams representing a connectivity barrier in Catalonia have been actually decommissioned and the principal barriers to removal remain unknown. The opposed interests of environmental restoration and energy production have high conflict potential in the region (Jorda-Capdevila and Rodríguez-Labajos, 2015), and could be part of the explanation of why only few dams have been decommissioned. On the one hand, there are some environmental organisations, e.g. *Associació per a l'Estudi i Millora dels Salmònids* (Association for the Study and Improvement of Salmonids, AEMS), and *Ecologistes en Acció* (Ecologist in Action), which strongly push for dam removal as a way to recover ecosystem functioning (AEMS, 2006). On the other hand, the resistance to dam removal is not restricted to hydropower producers – hydropower is the largest source of renewable energy in Catalonia, accounting for 6.3% of the raw energy production in 2014 (Idescat, 2016); opposition to decommissioning from local administrations also occurs. This calls for a careful examination of the relation between cultural aspects, landscape history, and stakeholder perception, an area barely analysed up to now, with the exception of the analysis by Jorgensen and Renöfalt (2013) of the respective positions and environmental perception of proponents and opponents to dam removal in Sweden, using the concept of ecosystem service/s (ES) based on media coverage.

Within this context, the ES framework has been considered as a valuable methodological approach to the study of environmental conflicts (Bullock et al., 2011; Jorda-Capdevila, 2016). For instance, landscape aesthetics provides a linkage between human and ecological processes that influence each other, and the capacity of ecosystems to provide services (Gobster et al., 2007). For the purpose of this study we define ES as the functional properties of ecosystems that contribute to human well-being (MEA, 2005) through the co-production of the environment and society (Fischer and Eastwood, 2016). ES can be classified in four categories: 'supporting', 'regulating', 'provisioning' and 'cultural services'. Their preservation is essential to human well-being in the present and future generations (MEA, 2005). Despite increasing popularity of the ES framework in research and policy (Perrings et al., 2011; Seppelt et al., 2011), the ES concept is contested, as according to some authors (Gomez-Baggethun and Ruiz-Perez, 2011; Kallis et al., 2013) ES can lead to the commodification of nature. However, Schröter et al. (2014) emphasise that despite the critique of ES as being anthropocentric, its vague definition, or its unclear relationship with biodiversity, there are valuable counterarguments. In this study, we do not enter into this debate although we are aware of it.

To understand the generation and distribution of ES, beyond the biophysical functioning of ecosystems, the material and non-tangible interactions between people and ecosystems have to be considered (Ernstson, 2013; Castro et al., 2016). Therefore, we focus on the perception of ES from actors' perspective, with special attention to cultural services. Cultural services are important as their social relevance can help address real-world problems (Milcu et al., 2013; Reilly and Adamowski, 2017). Cultural services can be crucial for actors' decision making, as landscapes with high aesthetic values appear to be the most resistant to change (Tielborger et al., 2010). This highlights the importance of values and perceptions of actors to achieve sustainable management (Kaye-Zwiebel and King, 2014).

Taking into consideration the ES approach, our aim is to analyse how the perception on ES and their distribution contribute to the understanding of conflicts over dam removal in Catalonia. We specifically identify and analyse: i) the situation of dam removal in Catalonia including the historical background, arguments given for decommissioning dams or not, and the imaginary of dam removal; ii) the factors limiting dam removal in two case studies; and iii) how ES perception and their distribution configure conflicts at the local level. With this, the study seeks to shed some light on the social consequences of dam removal conflicts, an underdressed area in socio-environmental research.

As specified below, our methodology consists of interviews and participatory mapping (PPGIS), a well-tested approach to analyse ES provision in their complexity (García-Nieto et al., 2015; Jorda-Capdevila and Rodríguez-Labajos, 2015). However, such a combination has never been used to analyse conflicts over dam removal. In addition, we also present an innovative approach to assess the relevance of ES, based on an indicator that contributes to a better understanding of actors' perception of ES.

PPGIS integrates mapping and GIS to address environmental problems, collect stakeholder perceptions and empower people (Brown and Fagerholm, 2015). Place-based mapping of ES can help to make plural values visible and understandable, contributing to decision making. Place-based mapping reveals how actors perceive place and what visions and values they bring to assess the importance of past and future environmental change (Potschin and Haines-Young, 2013). Consequently, PPGIS has been deemed as a valuable tool to understand specific dam removal conflicts, particularly in relation to its potential to reveal environmental knowledge, imaginaries, and the history of landscape (Fox et al., 2016).

In the next sections, we organised the paper as follows. In the section on methods we present the study area and how data were collected and analysed. The results section in turn is divided into two subsections: i) the situation for dam removal in Catalonia; ii) two emblematic case studies; Molló and the view of outsiders against local residents, and Manlleu and the importance of culture in environmental management. These results are then discussed according to: i) the dichotomy of perspectives between local and non-local actors and its importance for scale; ii) the role of culture and

aesthetics as limiting factors for dam decommissioning; and iii) how ES can make plural values visible and contribute to conflict analysis. Finally, we expose the conclusions of the study.

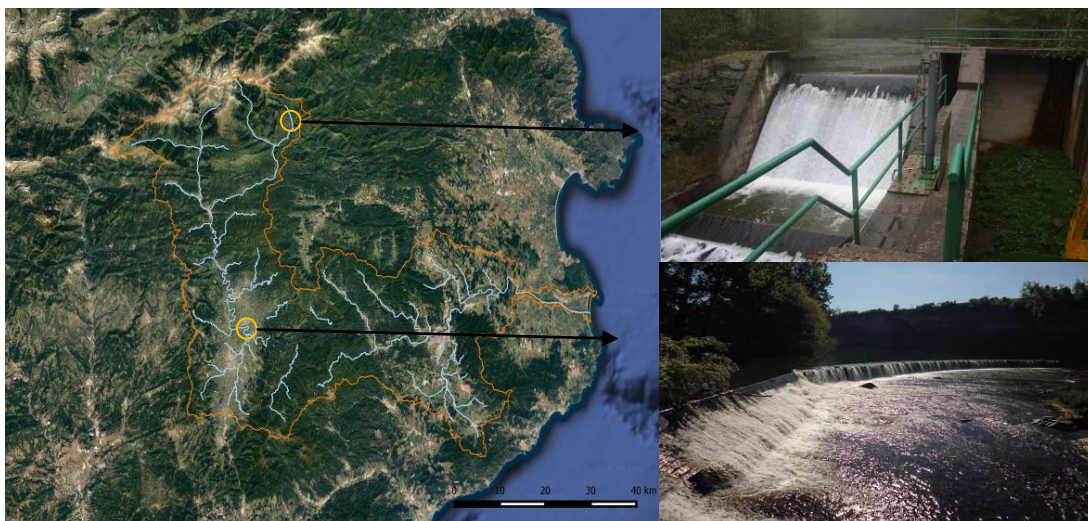
## METHODS

### Study area

In the present study, the variety of views on conflicts over dam removal were analysed at two levels. On the one hand, the Catalan level, which presently allows us to understand the context and setting in which potential dam removals take place and, on the other, two local case studies: Ritort and Can Buixó dams, both in the Ter River Basin, which were earlier analysed to understand how this general setting is translated into practice.

The local case studies are the demolitions of the Ritort Dam, in the Ritort River (tributary of the upper Ter), and of the Can Buixó Dam, in the middle section of the Ter River (see Figure 1). These two emblematic cases were selected, based on their representative power in relation to the Catalan case, which highlights that non-compliance and abandonment of the initial purpose of dam usage are primordial reasons for decommissioning. The first dam is located next to the Pyrenean village of Molló (Girona Province). The area is characteristic of an alpine landscape with little anthropogenic alteration, and the case is representative of an advanced state of dam demolition. The Can Buixó Dam is located in Manlleu City (Barcelona Province), in the Vic Plain. This dam is part of an anthropogenic landscape with agriculture and industry and represents one of those cases in which demolition has been stopped.

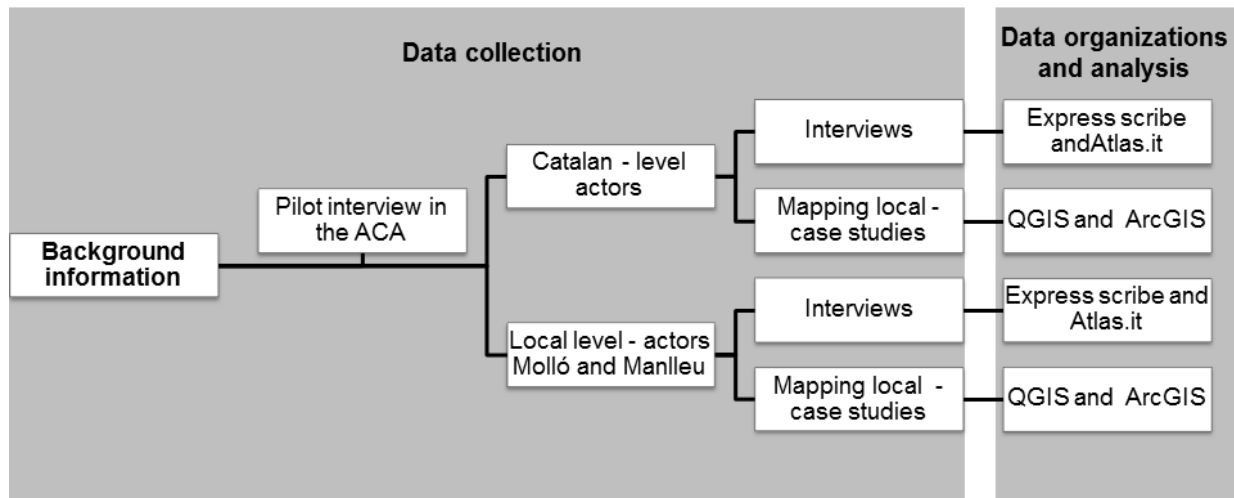
Figure 1. Case study sites. Location in Catalonia (I) of the Ritort (top) and Can Buixó (bottom) dams. Watershed of the Ter River (orange) and main rivers and streams (blue).



### Data collection

The methods used in the present study consist of interviews at the Catalan and local level and a participatory mapping process (see Figure 2). Interviews allowed the collection of information about the historical development in Catalonia, the Catalan context and trend, actors' positioning, and the imaginary of dam removal. Mapping allowed to spatially depict actors' value conceptions and preferences upon their desired management scenario and to acknowledge the plurality of values. The combination of these methods allowed us to analyse how actors frame their position about dam removal while making visible contrasting perceptions of ES and their spatial distribution.

Figure 2. Conceptual map of the process of data collection, organisation and analysis.



Before carrying out the interviews, background information was gathered about the case studies by reviewing regional press, legislation, and webpages of activist groups. From such information, we developed an interview script that was improved after a pilot interview (with a technician of the ACA) (see supplementary material, S1). Then, we interviewed relevant actors from the two levels of study: Catalan and local-level in both localities, Manlleu and Molló. Interviewees were selected by using a judgment sampling method of actors found in the same region by others (Jorda-Capdevila and Rodríguez-Labajos, 2015). Such interviewees were then asked to provide two further contacts for interviewing, following a snowball sampling system. Altogether, 24 interviews with people from different policy cultures (public, private sectors and NGOs; see supplementary material, Table S1) were undertaken. Those interviews allowed collecting information upon the historical development in Catalonia, the Catalan context and trend, actors' positioning, and the imaginary of dam removal. Moreover, a non-monetary valuation technique was employed to assess ES relevance. Each interviewee was then asked to value each ES with scores from 0 to 3 with 0, not being valuable, 1, marginally valuable, 2, valuable, and 3, very valuable.

For the participatory mapping process interviewed actors received printed DNA 4 maps of Molló, Manlleu or both case studies, depending on actors' familiarity with each case study. We provided maps at different scales to allow actors to map more accurately and depict ES which are only present at specific scales. Three maps per region were delivered representing: i) the site level, including the location of the dam in an orthophoto at a scale of 1:10,000; ii) the community level, including the dam and the village in an orthophoto at a scale of 1:30,000; and iii) the river-basin level, in a topographic map at a scale of 1:715,000. According to the methodologies followed by Brown and Fagerholm (2015) and Forrester et al. (2015), once actors situated themselves on the maps, they were asked to draw the location of ES generated under their perspective that emerged during the interview. Additionally, commentaries and rationales were recorded at all times.

### Data organisation and analysis

Interviews were transcribed manually by using Express Scribe and ATLAS.it to organise information for further analysis. In the results section, we cite the information provided with superscript numbers according to the information that providers listed (see supplementary material Table S1).

Maps generated during the PPGIS process were analysed by using QGIS 2.8.4 and ArcGIS 10.3. First, maps were digitalised with the CRS ETRS89 EPSG: 25831 at a scale of 1: 30,000 as all drawn polygons

could be fit and digitalised at this scale. Each polygon included information about the ES: ES category (MEA, 2005), actor name, and value attributed by each actor. Resulting vector layers were split according to ES and grouped for each region into actors proposing removal of dams and actors opposing it. After that, all ES were grouped into 'supporting', 'regulating', 'provisioning' and 'cultural' categories. Then, an ES intensity index was developed (see Figure 3).

Figure 3. ES intensity index formulation.

$$\text{ES intensity index} = \frac{\frac{\sum \text{op}}{\text{Total polygons}} + \frac{\sum \text{vop}}{\text{Total value}}}{2}$$

Note: op is the number of overlapping polygons and vop is the value given to overlapping polygons. Total numbers and values refer to the sum of polygons and values given by actors under a certain positioning in one region.

The ES intensity index highlights the importance of each ES category considering the number of actors. The index allows comparing ES categories for actors in favour of, or against, removal within each region. So, we created a grey scale where tonalities are in line with the ES intensity index. Besides, the index was applied to evaluate the composition of each ES category by substituting the number of overlapping polygons and the total number of polygons, for the number of times an ES type within a category has been mentioned and the total number of ES types. Finally, the analysis of the maps and interviews was fed back to all actors to enhance the understanding of the conflicting dam-removal situation.

Finally, some limitations of this study are noteworthy: i) we could not interview the owner of the dam in Molló, Salvador Serra SA as he strongly refused it; ii) limitations regarding the number of interviewees, especially in Molló where actors were reluctant to speak, can be a drawback. We compensated for this by having informal discussions in the village to confirm if the interviews accurately represented the opinion of Molló; and iii) during the valuation process, most actors valued ES highly on a scale from 0 to 3. Consequently, a spatial-mapping method using scores could have slightly changed outcomes. However, we believe that it would not have changed general trends since a strong consistency between all maps was found.

## RESULTS

### The situation for run-of-the-river dam removal in Catalonia

At the Catalan level, actors can be divided into those proposing and opposing demolition (see supplementary material, Table S1). According to the ACA, dams should be demolished if they are not in use for more than three years, if the dam authorities fail or refuse to comply with the terms given in the permits,<sup>1</sup> or if owners decide to demolish them.<sup>8,18</sup> However, there are five main difficulties when the ACA tries to launch a decommissioning process. First, right holders can present unproven claims and hinder the process.<sup>3</sup> Second, the owners sometimes abandon their dams and, if they are not found, public authorities should assume secondary liability regarding the demolition costs.<sup>1,3</sup> Third, according to the ACA officials, local administration can deny permits and block the related activities. Fourth, there are some legal obstacles<sup>9,24</sup> such as the difficulty to require owners to demolish dams or the difficulty to justify demolitions under the umbrella of minimum instream flows. Finally, the long-lasting duration of permits hinders an effective management of dam decommissioning.<sup>24</sup> Apart from this, some actors believe in technical and management solutions. Along with the above-mentioned difficulties, determining how many dams have been demolished in Catalonia is difficult, since decommissioning was not officially notified in the past.<sup>1</sup> What is clear is that the few demolitions already undertaken are of

dams with heights up to 5 m. The ACA is planning the total or partial demolition of 16 dams that mostly range between 0.5 and 7 m in height and will extinguish up to 14 permits in the near future (ACA, 2016).

A range of actors of the public, private, and non-profit sectors conceive that dams have been an essential part of the Catalan industrial development, as they were the energy source for its textile industry (Amiguet, 2016). These actors think that dams have an historical value since without them we cannot understand the social and cultural reality<sup>20</sup> of Catalonia.<sup>1,3,6,10,11,15-17,19,20</sup> However, a large number of dams have been abandoned and it is only after the oil crisis of the 70s that the liberal-conservative government of *Convergència i Unió* (Convergence and Union, CiU) started to subsidise their restoration.<sup>11</sup> The restoration was done with celerity in order to safeguard hydropower rights as right holders knew that a paradigm shift was about to happen.<sup>24</sup> The safeguarded permits often allow diverting more water than actual instream flows.<sup>24</sup> Nowadays, the paradigm is apparently shifting, as demolitions are conceived as a valuable management option.<sup>5</sup>

Despite the apparent paradigm shift, there are diverging opinions among those who defend the removal of dams. On the one hand, the most optimistic actors see that awareness of the need for river restoration is increasing and it is acknowledged that dams cannot be allowed to be abandoned.<sup>5,7,8,19,23</sup> Furthermore, the ACA, the watershed authority, is for the first time actively working to analyse which dams can and should be removed.<sup>24</sup> On the other hand, the most worried stakeholders<sup>2,4,9-12,20</sup> see that the ACA only takes action when permits end or technical or environmental problems arise.<sup>1,4</sup> The latter actors think that even abandoned dams are difficult to remove<sup>2,4</sup> due to the lack of political will.<sup>2,9,12</sup> In fact, the Second Cycle Management Plan for the period 2016-2021 is perceived to be less stringent<sup>2</sup> and has a smaller budget.<sup>1,3</sup> Finally, actors opposing dam removal have a negative perception upon dam management as the Spanish government has cut energy bounties and the ACA is increasing pressure and requirements over dam owners.<sup>13,18</sup>

The historical development and the present situation have given place to two contrasting lines of arguments between actors proposing and opposing decommissioning. Actors proposing demolition consider that, in Catalonia, there is social pressure for taking action as only a few demolitions have been completed,<sup>1,2</sup> in contrast to other regions in Spain such as Navarra and the Bask Country<sup>8</sup> (Cerrillo, 2016). They think that dams should be removed because of their large environmental impacts (Ordeix, 2016),<sup>8,10,12,17</sup> and also because restoration of rivers such as the Ter and Llobregat is impossible without decommissioning:<sup>9</sup> "(...) Llobregat and Ter are in reality a succession of one dam after the other".<sup>9</sup> Restoration would contribute to improved river functioning and a more naturally regulated system.<sup>7</sup>

AEMS claims that "they kidnapped the river" as dams do not respect minimum instream flows and the argument of the benefits generated by hydroelectricity is not valid because it neglects environmental impacts.<sup>10</sup> In a meeting with representatives of the hydropower sector, AEMS advanced the following argument: "I am breathing, right? I breathe well, correctly. Now I take out 80% of my breathing capacity, which is what you do with dams. What happens? I would die. In practice, we proved that the low instream flow [discharged by] many dams has killed the river".<sup>10</sup> Finally, river restoration is apparently in line with local development plans in the Pyrenean regions, where environmental tourism is paramount.<sup>23</sup>

In contrast, actors refusing decommissioning believe that before demolishing dams, 'technical' or management solutions for improving river connectivity (for example, through the construction of fish passes) are possible.<sup>13-15,17-19,22</sup> They also argue that clean and local energy production is of great value,<sup>6,14,15,17,18</sup> since it reduces energy transport costs<sup>13,15</sup> (Vila, 2010). Moreover, since life cycle studies acknowledge that hydropower is the cleanest renewable energy<sup>13,14</sup> and easy to manage,<sup>15</sup> they defend that decommissioning should only be applied to abandoned dams.<sup>13</sup> Cultural benefits are also used<sup>7,17-19</sup> to oppose decommissioning, like in Manlleu where dams are deemed essential to understand the development of the city.<sup>17,19</sup> Finally, some actors conceive that the alteration of an 'adapted' ecosystem



and the waterscape associated with the dam are important.<sup>11,13,23</sup> Meanwhile, others call for a compromise to respect ecological integrity while making use of a renewable energy resource.<sup>5,6,21</sup>

Obstacles perceived by actors opposing decommissioning are mainly the environmental and legal requirements for dam management.<sup>14</sup> The principal environmental problem considered is that environmentalist organisations claim for an increased instream flow and even demolitions, when dams have little environmental effect, according to actors who are against dam demolition. There are as well increasing legal disputes since the ACA wants to establish high ecological instream flows which opponents refuse. Furthermore, when demolition is pushed forward there is a big dispute about the liability of demolition. Finally, the reduction of subsidies for hydropower production in 2012 by the Spanish government is considered problematic.<sup>6,17</sup>

The contrasting perspective upon dam removal confers a divergent vision of a future scenario of decommissioning. For actors proposing demolition, dams are an artificial barrier in a natural landscape,<sup>1-5,7-9,11,24</sup> which reduces naturalness and hinders river functioning of the river.<sup>7,9</sup> After decommissioning, actors conceive a recovery of the 'natural' waterscape.<sup>1-4,8-10,12,18,24</sup> As an environmentalist puts it "you would have one barrier less in the river, an artificial barrier, and therefore the river would be a bit more in harmony with what a mountain river should be (...)".<sup>12</sup> Accordingly, the naturalisation of the river ecosystem would allow a higher velocity in water flow.<sup>4,5,18</sup> However, actors opposing demolition ask: "Is there a moment in which the landscape is as it should be and not in another way?".<sup>20</sup> They argue that humans form part of nature, thus legitimising environmental modifications.<sup>6,20</sup> Consequently, "applying concepts of pristine and natural landscapes does not reach people emotionally".<sup>24</sup> Additionally, actors opposing decommissioning value the waterscape created by dams<sup>6,14,17</sup> and conceive that after the demolition the waterscape will change towards a reduced water level.<sup>16,17</sup> An actor even claimed that "(...) if there weren't dams a few times in the year you couldn't see water anywhere".<sup>17</sup> Moreover, the alteration in the ecosystem associated with the demolition could have negative effects for the associated fauna and flora.<sup>6,11,13,14,24</sup> Finally, some actors for or against demolition conceive few or no changes after dam decommissioning<sup>11,17,19,22</sup> or they question the relevance of landscape changes for decision-making<sup>20</sup>.

## Two emblematic case studies in Catalonia

### *Molló and the view of outsiders against local residents*

In the case of Molló, according to the local authorities the energy demand of Molló increased substantially during the 1970s and 1980s. To cover that demand, between 1984 and 1985 the Council planned the construction of a dam system<sup>22</sup> with a power capacity of 382 kW (ACA, 2003a). Two run-of-the-river dams, one in the Ritort and the other in the Favert River, were constructed and connected through underground pipelines,<sup>22</sup> and permits were given to the company Salvador Serra SA.<sup>22</sup> A third dam was foreseen in the project but not eventually constructed (ACA, 2003a).

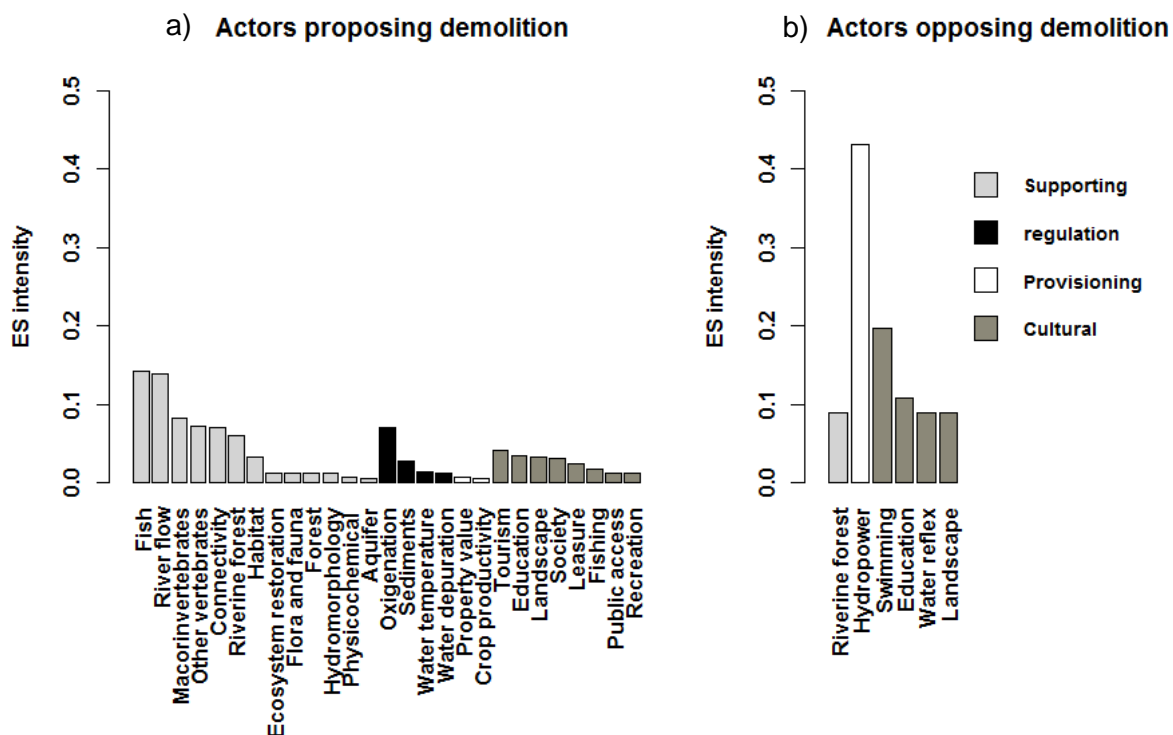
In 2000, AEMS reported that the Ritort Dam breached the minimum flow requirements (Llargués, 2000) and lacked telecommand, and a fish ladder.<sup>10</sup> This had negative effects on biodiversity and property value of buildings, leading AEMS to claim that "they killed our river".<sup>10</sup> The refusal to comply with requirements of minimum flows was brought to the Catalan Parliament that agreed to revise the permit.<sup>22</sup> Actors against demolition claim that water diversions had to be high to ensure minimal profitability.<sup>22,23</sup> Reportedly, that led to a systematic non-compliance of instream flows.<sup>16</sup> In 2002, the ACA required the closure of the dam (ACA, 2003b) and made it effective in 2003 (ACA, 2003b). Yet, local residents were generally against demolition.<sup>10,22,23</sup> Therefore, the town council and Salvador Serra SA made an administrative appeal in 2003.<sup>22</sup> During the trial, and together with Salvador Serra SA, the council defended the use of the permit<sup>10,23</sup> with a strong personal positioning.<sup>10,15,22</sup> In fact, the mayor of the city was working in the dam regulating the water flow.<sup>23</sup>



The court decision issued in 2006 required the demolition of the dam, so an environmental restoration had to be implemented<sup>1,10,23</sup> (Juzgado Cont. Admn. número dos de Girona, 2006). That was the first reported case in Spain where a dam had to be decommissioned because of not complying with the requirements of instream flows<sup>10</sup> (AEMS-Rius amb Vida, 2006). The environmental restoration project was planned but not executed, as Salvador Serra SA did not agree with the sentence.<sup>1,3,23</sup> Apparently, the ACA should demolish the dam with an approximate cost of €400,000.<sup>1,3,10</sup> However, AEMS is against this: "(...) right holders (...) have to pay restoration costs, not the citizens of Catalonia". Recently, the Molló Council tried several times to get a new permit for the dam but without success.<sup>1,3,4,10,15,22</sup>

When requested, actors described a series of benefits related to river restoration or the maintenance of the dams (see Figure 4). Actors favouring the demolition (see supplementary material, Table S1) prefer 'supporting' over 'cultural' values, followed by regulation services, and barely appreciating provisioning services. The main ES category highlighted by actors favouring demolition is supporting<sup>1-3,5-8,10-12,21,23</sup> through restored connectivity,<sup>1,3,5,7,11,12</sup> and river flows.<sup>1,3,7-11,21,24</sup> Benefits to biodiversity linked to the recovery of fish populations<sup>5,6,8-11,21,24</sup> and other fauna and flora.<sup>2,5,8,10,12,24</sup> are particularly important<sup>1,2,6,8,10-12,21,23,24</sup>. Moreover, quality of the habitat would improve in the riverine forest.<sup>1,2,5,7,9,10,12,24</sup> With restored supporting services, regulation benefits emerge<sup>1,5,7,9,12</sup> namely sediment regulation,<sup>1,5,7,12</sup> water depuration,<sup>9,12</sup> and temperature regulation.<sup>9</sup> Provisioning benefits are mentioned less frequently, in relation to crop productivity and property value.<sup>2,10</sup> The relevant cultural benefits are tourism,<sup>2,10,21,23</sup> fishing,<sup>5,7,10,11</sup> the appreciation of the waterscape,<sup>1-3,5,7,23</sup> and education through a pioneer demolition project.<sup>1</sup>

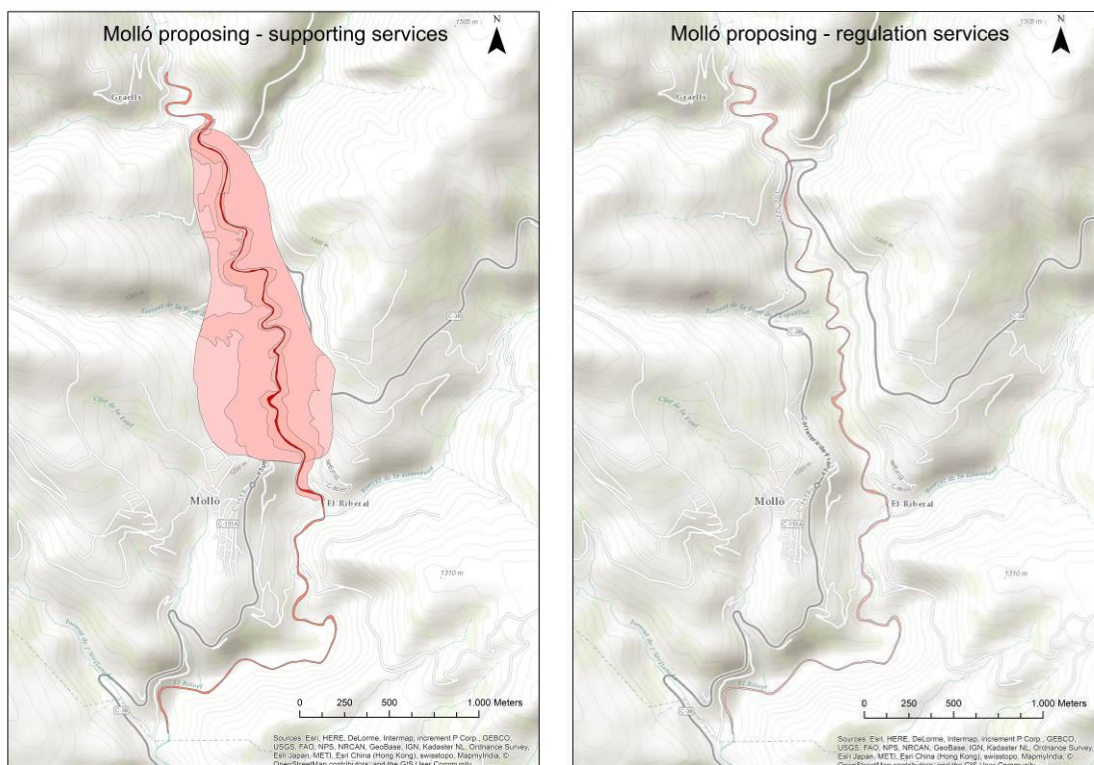
Figure 4. ES intensity index for service types in Molló. In (a) the ES intensity index for the ES perceived by actors proposing removal is represented and in (b) the ES perceived by actors opposing removal is presented.



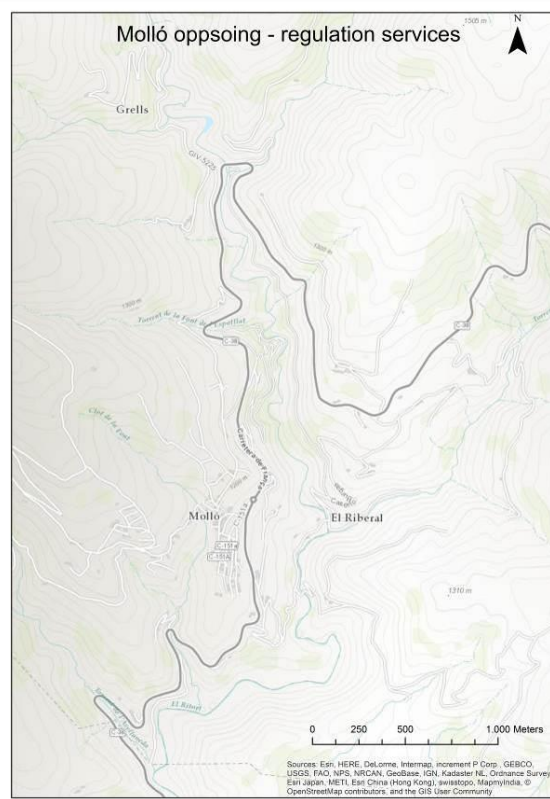
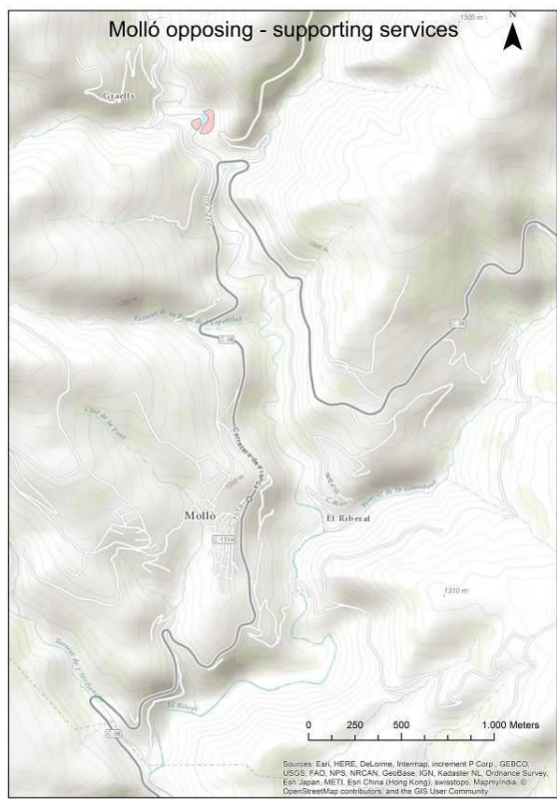
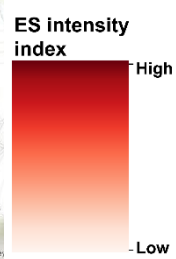
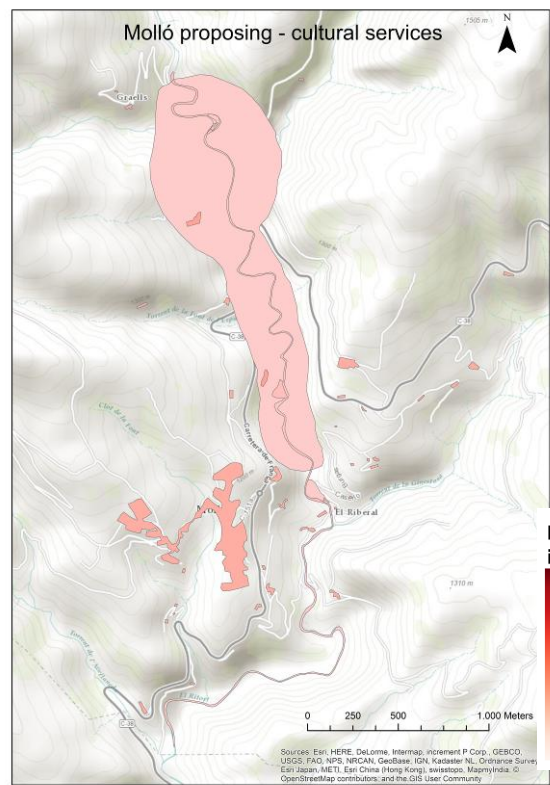
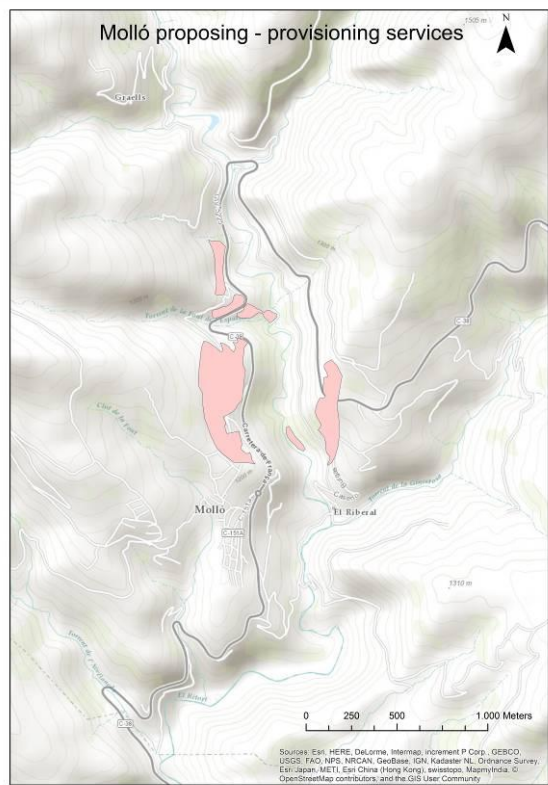
However, actors against demolition (see supplementary material, Table S1) prefer provisioning to cultural services, followed by supporting services (see Figure 4). Remarkably, regulation services are not mentioned. Opponents value provisioning benefits like renewable energy,<sup>13,15,22</sup> and cultural benefits<sup>1,2,5,7,10,21,23</sup> like education<sup>15</sup> and leisure.<sup>13,22</sup> Although actors proposing decommissioning depict a wider set of ES, actors opposing decommissioning do it with a higher intensity, particularly for provisioning and cultural services.

From a spatial point of view, actors generally depict a wide variety of ES for diverse regions in a large spatial area which are often services provided by, and consumed in, the river itself (see Figure 5). Supporting values are strongly linked to the river channel and have its greatest value in the area between the dam and the hydropower station, followed by upstream and downstream areas. Then, the value decreases in the nearby riverine forest and fields. Regulation values are only present in the river channel and are higher between the dam and hydropower station followed by upstream and downstream regions. Regarding provisioning services, they are only marginally valued in fields surrounding the dam. Cultural aspects are important, especially in the river stretch between the dam and hydropower station and in the village of Molló. For actors opposing decommissioning, supporting values are only marginally important in the riverine forest surrounding the dam. In contrast, provisioning services are highly valued within the village. Cultural services are of great value at the tail end of the dam where people formerly used to swim. Noticeably, no value is attributed to the river channel, but the greater part of the value is related to urban areas.

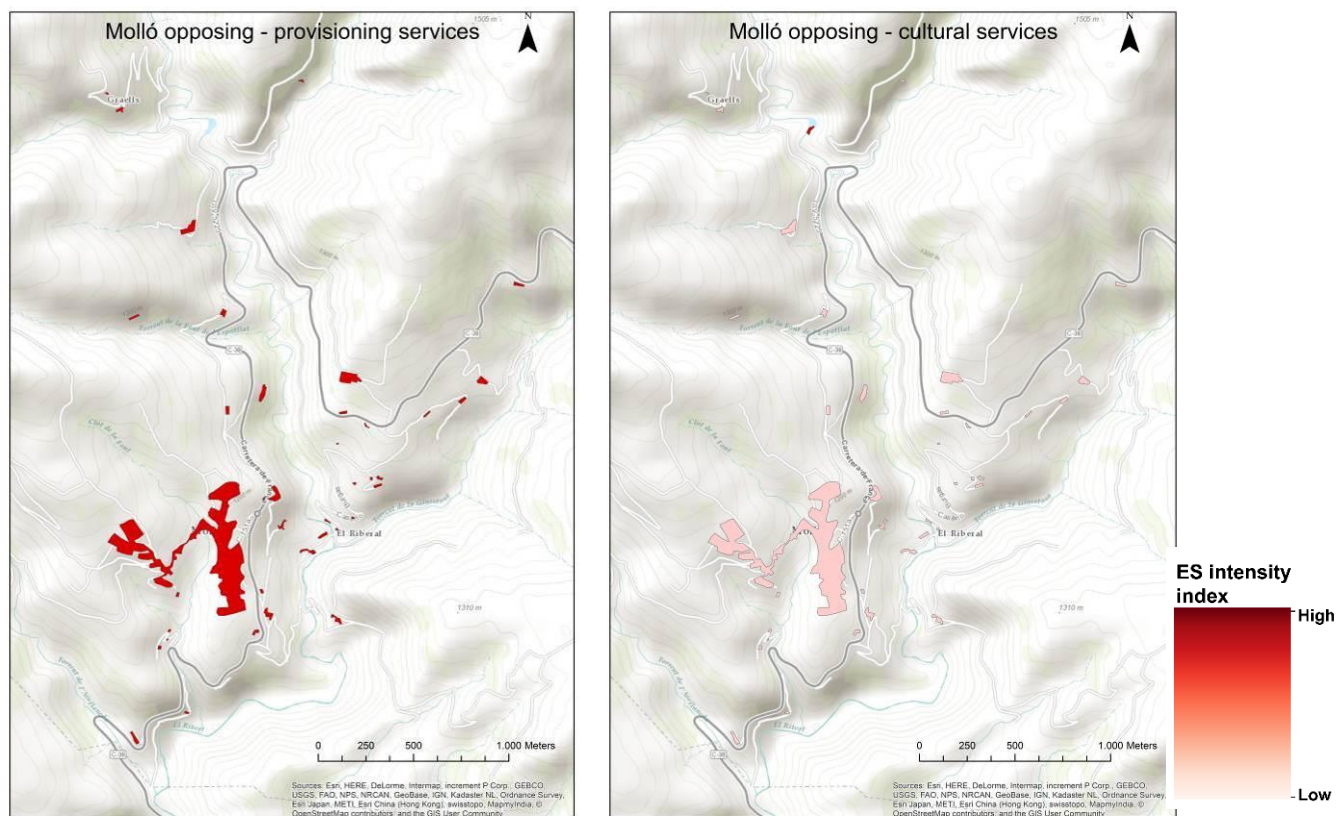
Figure 5. Spatial distribution of ES provision in Molló, described by actors for and against decommissioning, and classified by supporting, regulating, provisioning and cultural services.



Note: The intensity index of the ES is depicted in the legend.







### *Manlleu and the importance of culture in environmental management*

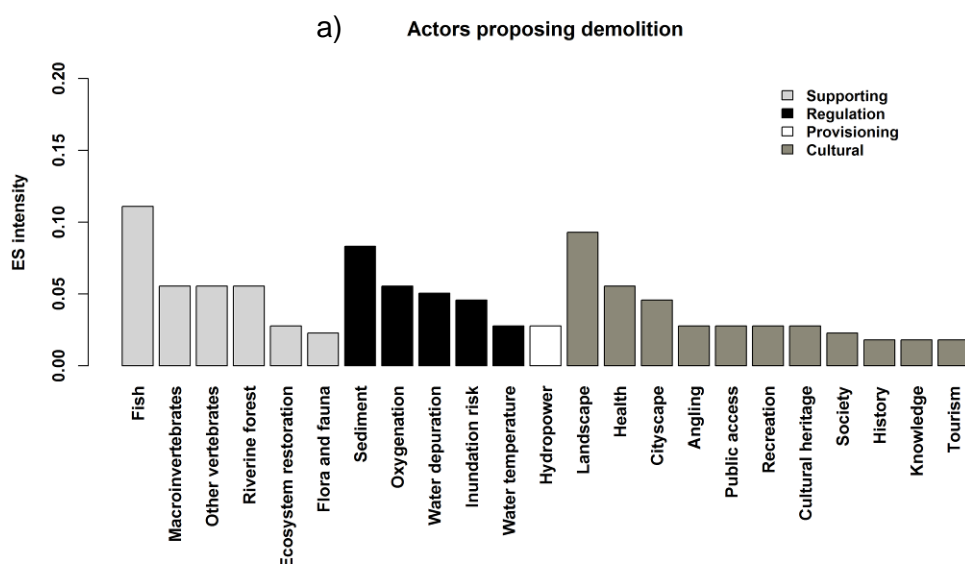
In Manlleu, the Can Buixó Dam was constructed late in the 19th century<sup>16</sup> for the textile industry. In the 1990s, Fundició Dúctil Benito, a private company discontinued its operations.<sup>17</sup> In 2003, the private company Novatilu SL, one of whose members was the owner of Fundició Dúctil Benito that still owned the dam, wanted to use the dam for production of energy.<sup>16</sup> Against this, AEMS presented allegations against Fundició Dúctil Benito<sup>10</sup> and the ACA required technical modernisation of the dam. As Novatilu SL did not contemplate a long-term investment, they agreed with the ACA to discontinue the permit (Grau, 2004) and demolish the dam.<sup>16-18</sup> The company paid for the demolition project, designed by the Centre for the Study of Mediterranean Rivers.<sup>8,17</sup>

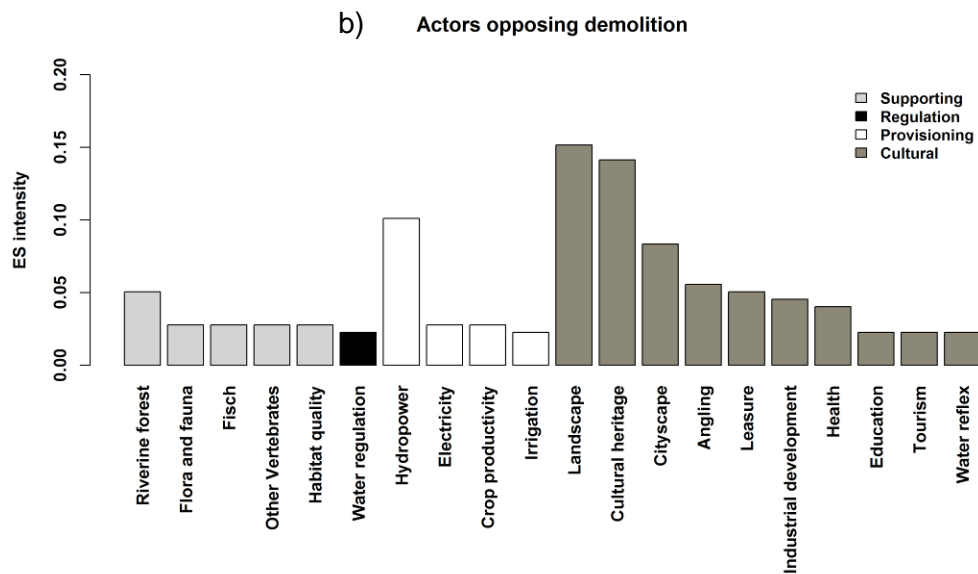
In the following years, doubts about cultural and environmental viability of decommissioning emerged.<sup>5,16,20</sup> Some ancient and wooden elements in the construction confer architectural heritage values to the dam<sup>8,10,16,18</sup> (this is questioned by the Centre for the Study of Mediterranean Rivers). Additionally, the waterscape<sup>11,20</sup> "(...) was a symbolic landscape (...). Why do you [interviewer] think that it formerly generated opposition? It was a reaction to the disappearance of one of the best-known landscapes in Manlleu where people spent their leisure time".<sup>20</sup> Furthermore, the environmentalist *Grup de Defensa del Ter* was against demolition in order to preserve "the ecosystem that the dam created, because it is a special place of the Ter River", with special fauna and flora that "have matured during the 100 years the dam has been there". Consequently, the Town Council opposed demolition.<sup>17</sup> A lateral river project to solve environmental problems was planned and evaluated, but never implemented due to budget constraints.<sup>8,17</sup> Finally, the Ter Museum prepared a heritage report<sup>20</sup> that prevented the dam from being demolished. In the future, the Council aims to expand the Ter promenade at least 2 km until Can Buixó to improve the waterscape near the dam and to urbanise the surrounding land, which belongs to private owners at the moment.<sup>18</sup> However, actors believe that the dam may burst in the future as no maintenance is done currently.<sup>8,10,18</sup>

Benefits for actors proposing and opposing dam removal are diverse. Actors favouring demolition (see supplementary material, Table S1) prefer supporting services to cultural ones, followed by regulation services while provisioning services are marginally preferred or valued (Figure 6). For these supporting actors services will recover<sup>3,8-10</sup> and become crucial as river connectivity is restored.<sup>3,8</sup> Consequently, fish biodiversity would increase<sup>3,8-10</sup> due to the improvement of migration,<sup>8,9</sup> spawning areas, and refuges<sup>8</sup> as well as mobility of mammals and invertebrates.<sup>8</sup> Moreover, these actors think that the quality of the habitat would improve through recovery of the riverine forest.<sup>9,10</sup> Apparently, regulation services are benefited<sup>6,8-10</sup> by favouring autodepuration,<sup>8,9</sup> sediment circulation,<sup>8-10</sup> flood regulation<sup>9</sup> and temperature regulation. Finally, there are cultural benefits<sup>3,9,10</sup> of waterscape restoration<sup>3,10</sup> and leisure.<sup>9,10</sup>

However, actors against demolition (see supplementary material, Table S1) prefer cultural to provisioning services, followed by supporting services, while regulating services are of little importance (see Figure 6). Actors mention few supporting services as sustained by the dam, such as particular fauna and flora that support biodiversity.<sup>3,11,16,24</sup> Yet, some actors claim that the riverine forest exists precisely because of the dam.<sup>11,18</sup> Regulating services are marginally valued in relation to regulation of the water level.<sup>6</sup> However, cultural benefits play a major role to oppose demolition.<sup>6,7,11,13,16-20</sup> The cultural heritage of the dam<sup>6,16,19</sup> is believed to create a particular cityscape<sup>2,16,19</sup> and to be of historic value to Manlleu. Moreover, the waterscape created by the dam is appreciated as it provides a still water body and a fresh environment<sup>11,13,17,20</sup> where angling is possible.<sup>8,17,24</sup> From there some educational benefits or health<sup>24</sup> benefits can emerge, for example, the enjoyment of the waterscape.<sup>18</sup> Finally, there are several provisioning benefits<sup>6-8,13,17,20</sup> as clean energy<sup>6,7,13,14,20</sup> and irrigation.<sup>7,17</sup> Contrary to Molló, actors proposing or opposing decommissioning describe a similar proportion of ES, although actors opposing removal do it with a higher intensity for cultural services.

Figure 6. ES intensity index for service types in Manlleu. In the top (a) image the ES intensity index for the ES perceived by actors proposing removal is represented and on the bottom (b) the ES perceived by actors opposing removal is presented.





From a spatial point of view actors in Manlleu are able to identify a diverse set of ES provided by different regions over a large spatial extension (see Figure 7). Supporting services receive their highest value in the river channel and in areas near the dam, and decrease when away from to it. Regulating services have a considerable importance in the river sections near the dam and decrease in river sections upstream and downstream. Concerning provisioning services, they are of a small size and only marginally important. Finally, cultural services are highly valued in urban areas, important in the river channel and generally decrease when away from the dam. Actors opposing demolition conceive the value of supporting services in the riverine forest next to the dam. Regulating services are only marginally considered, while provisioning services are highest for the company that owns the dam and the nearby town. Cultural services have their highest value in urban areas of Manlleu, followed by other urban regions and the river and its riverine forest. For actors opposing demolition in Manlleu ecosystem services provided by the dam are tightly linked to urban areas.

**DISCUSSION**

In the following sections we relate the positioning of local actors within the Catalan context and highlight the need to assess dam removal through the integration of geographical scales and comparison between case studies. Then we analyse the importance of the various sets of ES identified by actors that go beyond the traditional dichotomy of nature against hydropower. Finally, we analyse the importance of cultural and historic aspects in the way dams are conceived.

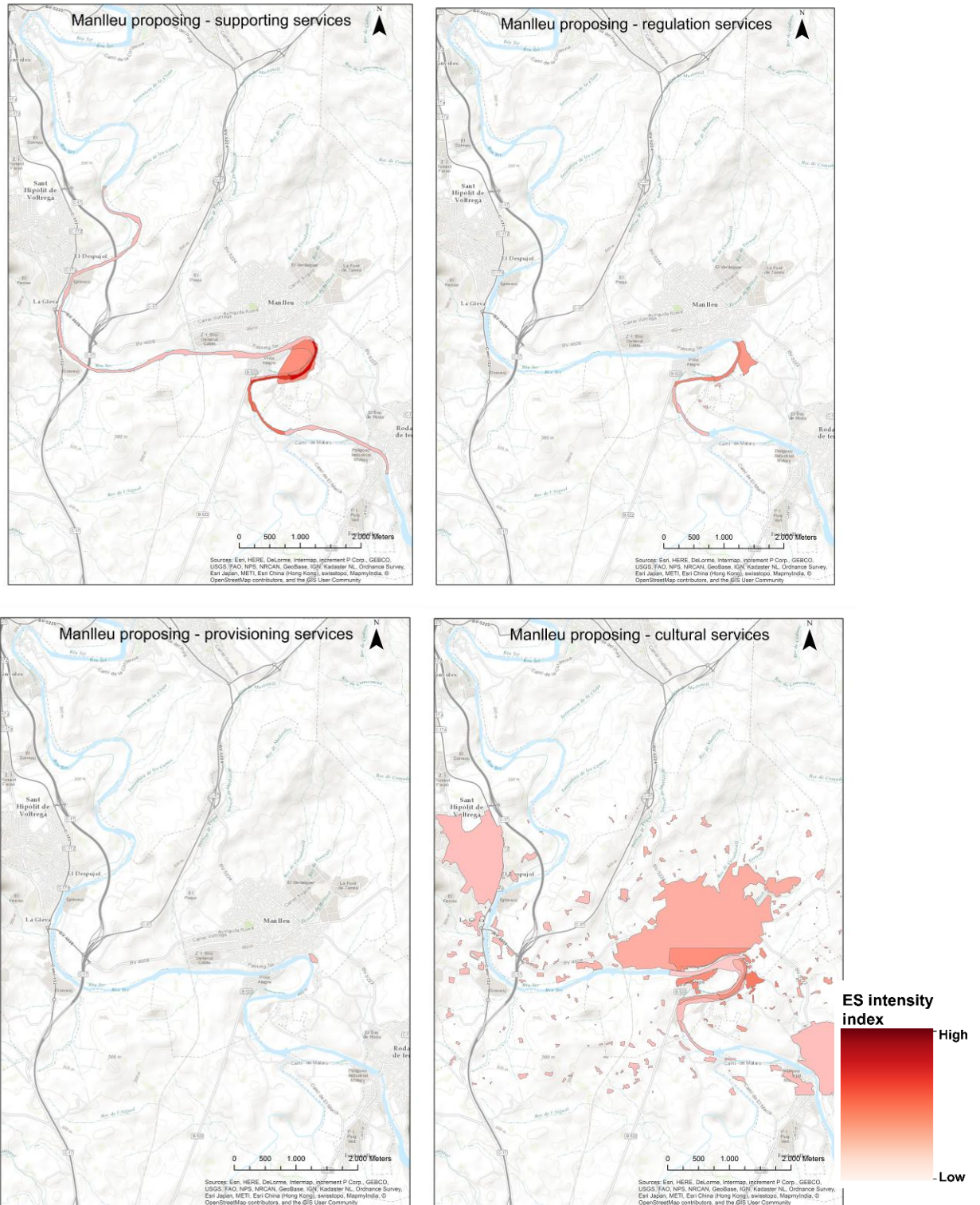
**The relationship between regional and local levels**

Molló and Manlleu cases illustrate the common situation for the construction of dams due to demands of energy, industry, and irrigation. Just as Lejon et al. (2009) found, the present study highlights that decommissioning of dams is considered as a means of restoring artificially regulated ecosystems. The environmentalists’ claims and requirements from the WFD have been important to push actions forward. However, there is limited operational space, as decommissioning opportunities emerge through not complying with the regulations connected to permits, as in Molló, or when the dam is old and does not serve its initial purpose, as in Manlleu. Hence, actions of demolition in Catalonia take place in a few cases of strategic opportunism, as also observed in New England (Fox et al., 2016). Fencel et al. (2015) criticise this strategic opportunism as dam management has to be analysed in an

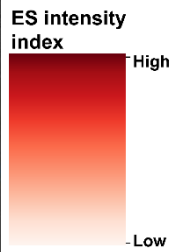
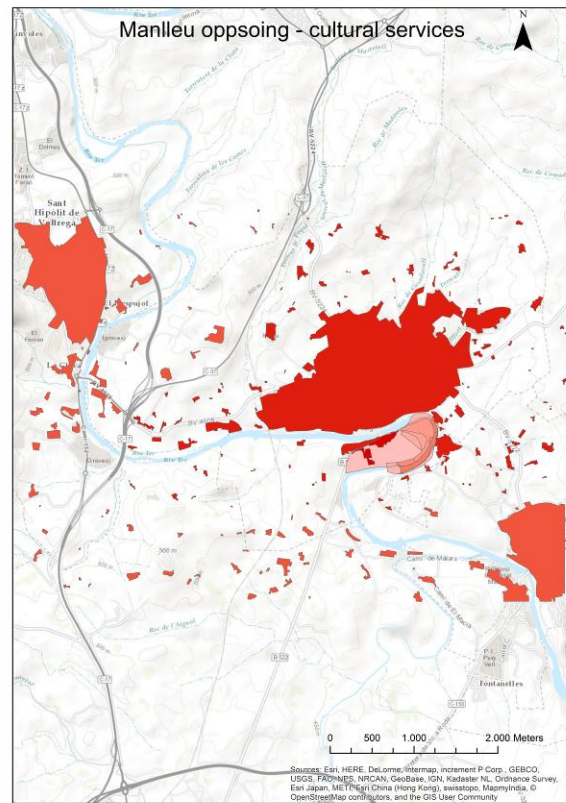
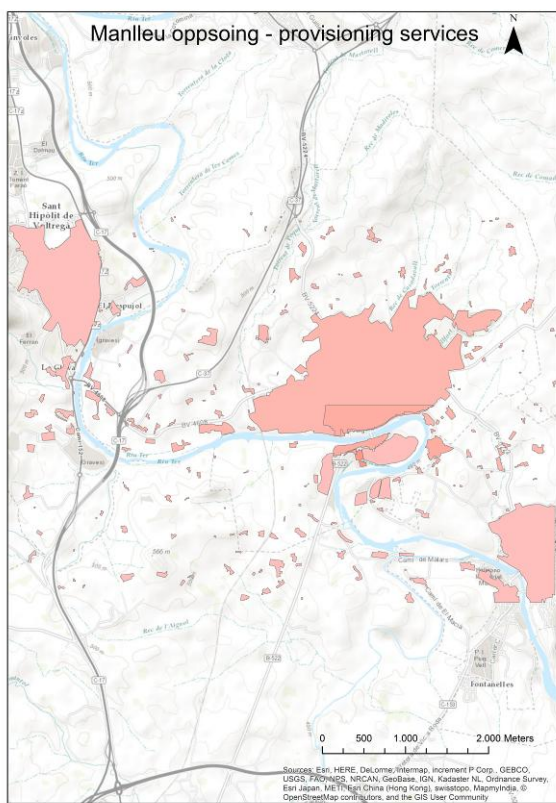
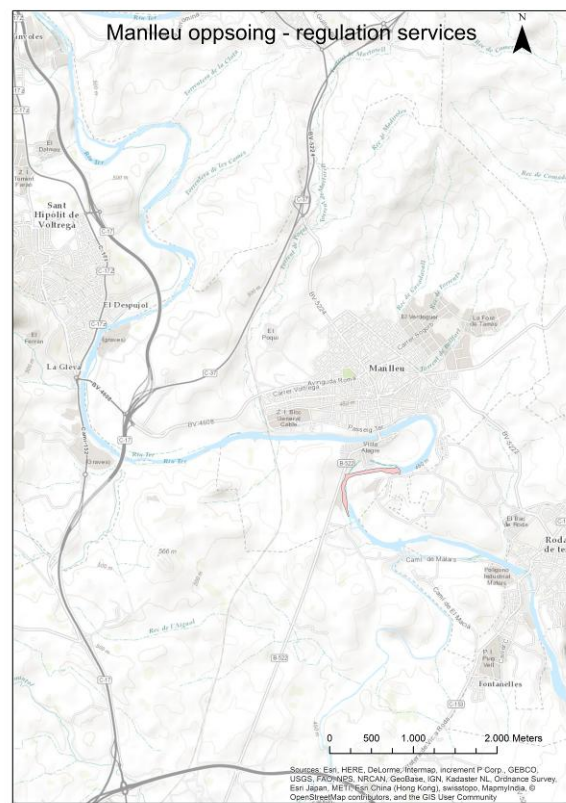
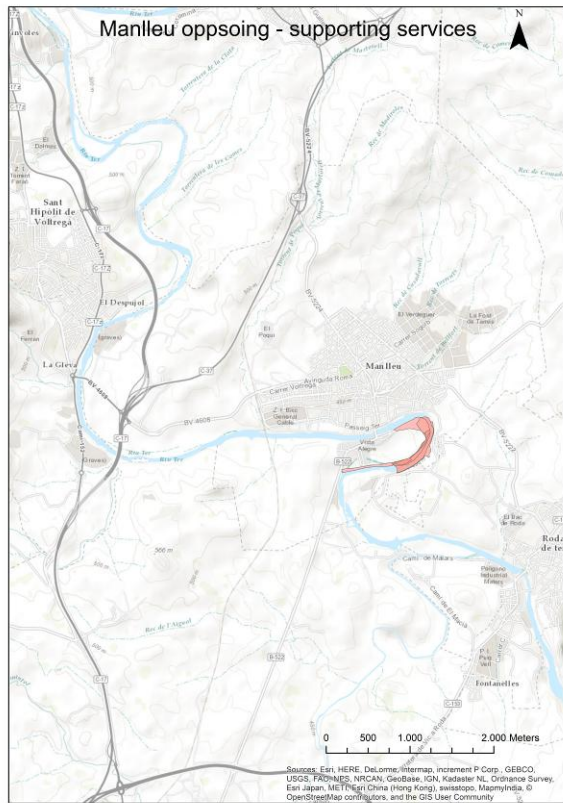


integrated manner. This strategic opportunism makes an increase in demolition rates unlikely in the case of Catalonia despite the policy prescription in this respect.

Figure 7. Spatial distribution of ES in Manlleu. Ecosystem services depicted by actors for and against decommissioning in Manlleu.







Note: In the legend the intensity index of the ES is depicted.

Doyle et al. (2000) and Lejon et al. (2009) found in their studies that opposition arises first from owners who generate arguments related to legality and demolition costs when dams do not form part of the cityscape, as in Molló. Besides, there are other sources of opposition to dam removal. Demolition is further hampered by cultural values, legal limits, cost, and political constraints that manifest themselves at different levels. Opponents to dam removal propose technological solutions instead of complete decommissioning, and highlight the crucial role of energy-generation profitability. These actors defend the strategic relevance of hydropower as a renewable source of energy that reduces the effects of climate change. Moreover, opponents value the cultural aspects of a beautiful and adapted ecosystem mentioned in other studies (Born et al., 1998). This supports the first findings of Palmer et al. (2008) who indicate that dams have a great influence on the society and culture of a place, which is not only true for the case of Manlleu, but for Catalonia in general.

The influence of small dams on society and culture can be related to the dichotomy of perceptions between actors proposing and opposing decommissioning, which connects the local and Catalan levels. We support the findings of Jorda-Capdevila and Rodríguez-Labajos (2015), which show that actors have the ability to identify a wide variety of ES over a large area, particularly cultural services. Actors proposing removal of dams conceive of a restoration that targets several ES types having, therefore, a more holistic perspective of nature. The tight link of these ES to the river is in line with the imaginary of restoration of a natural waterscape, which was within the framing of actors at local and Catalan levels, such as environmentalists and the ACA. Hence, we confirm the first findings of Jorgensen and Renöfalt (2013) and Reilly and Adamowski (2017) that actors proposing removal frame river restoration as a mechanism for returning the naturalness of the river.

However, actors against demolition conceive cultural and provisioning services as related to urban areas. By evidencing humans as part of nature, this position legitimises interventions in the environment. In Manlleu, it highlights the importance of dams in the historical conception of the city and its cityscape. This brings further evidence to the conceptual framework developed by Gobster et al. (2007), according to whom the disappearance of a particular landscape can be an important obstacle to environmental restoration. Consequently, as Dufour and Piégay (2009) have stated, we stress that the contrasting perceptions of the waterscape reflect the complexity to achieve reference-based strategies for river restoration and to highlight the need of integrating cultural and provisioning services in an efficient management. This is in line with the findings of Milcu et al. (2013) and Reilly and Adamowski (2017) who pointed out the relevance of culture services for solving real-world problems.

This complex set of arguments is well present in Molló. Dam removal is a proposal from the scientific community to restore river functioning (Bednarek, 2001), usually defended by non-local actors. However, local actors like the former mayors of Molló highlight, even in the courts, the profitability of hydropower production, a situation also seen in cases in California (Pejchar and Warner, 2001). This is in line with Lejon et al. (2009), who evidenced that owners and local communities often have a negative view of dam removal. Johnson and Graber (2002) indicated that decision making could be hindered by local actors if removal was an idea new to the community and promoted by outsiders. We evidence that local actors in Molló like the former mayor partly opposed decommissioning because it was promoted by outsiders, such as AEMS and the ACA. This highlights that, for a concise analysis of perceptions upon removal of small dams, it is not sufficient to analyse the local or global context but both perspectives should be integrated. Put another way, the integration of local and regional geographical scales, as well as the integration between local cases, is key to a sound analysis.

### **Lessons on the importance of history and aesthetics**

In Catalonia, dams had a central role in the expansion of the textile industry, which gave Catalonia the basis of the current domestic affluence. Dam Can Buixó in Manlleu is one of these dams that is intertwined with history, culture, and society. Similarly, as dams became part of the industrial heritage

they became ingrained in the collective memory of residents, becoming a key component for opponents. As has been found in a case of introduced fauna such as wild horses (Rikoon, 2006), dams form part of history, local identity, and are considered a cultural heritage whose value is linked to personal experiences. Therefore, river restoration proposals that do not account for the influence of history may be doomed to failure. In line with Fox et al. (2016), our findings show how interpretations of past landscapes became a source of conflict. While, these cultural-historic values are often in conflict with the needs of the river ecosystems (Lejon et al., 2009) they also create ecologically valuable environments. For instance, some environmentalists – locals from Manlleu – are actually in favour of the maintenance of the Can Buixó Dam.

The framing of actors proposing removal is in line with research done elsewhere claiming for a return to the natural condition of the river, where free-flowing water is equated with naturalness (Jorgensen and Renöfalt, 2013). For proponents of removal, dams only represent an artificial element that hinders natural functioning of the river. Thus, actors proposing decommissioning conceive the ecosystems as an idealised landscape devoid of interactions between humans and nature. However, when dams have been part of the environment for as long as in Manlleu, opponents to removal present a complex human-nature relationship between dams and their own history. It is not only there but also in other cases (Doyle et al., 2000; Fox et al., 2016), that opponents defend the singularity of the co-created ecosystem, with cultural heritage values and a particular interpretation of the waterscape.

Jacobs and Buijs (2011) found that, in cases where the dam is integrated in the imaginary of residents, opposition can go beyond cultural values. That has been confirmed in Manlleu, where opposition includes aesthetics and the personal experience of place. In the present study, as found by Fox et al. (2016) in New England, opponents perceive through a potential demolition the loss of access to an aesthetically beautiful environment that generates benefits beyond the local scale. The environmental restoration at the basin scale emphasised by Lejon et al. (2009) conflicts with the concept of cultural landscapes analysed by Gobster et al. (2007), which contributes to attachment of place and local identity. In sum, aesthetic experiences, sense of place, and history create place attachment and inspire the defence of dammed landscapes. In fact, in Manlleu, the cultural and historic value inspires defence even despite its inconsistency with ecological functioning. This capacity of aesthetics to limit ecosystem functioning implies a limitation of ecosystems to provide ES affecting human well-being, as theorised by Gobster et al. (2007).

### **The role of ecosystem service perceptions in dam-related conflict analyses**

The results presented above show that, besides legal, economic, and environmental constraints, like in other studies (Pejchar and Warner, 2001) local opposition can be a main limiting factor for effective dam removal. The present study goes a step beyond the analysis of Jorgensen and Renöfalt (2013) and highlights how an ES perception assessment of dam decommissioning can contribute to understand the economic, ecologic and social aspects of different positions. Cultural values in particular are of crucial importance for infrastructures that have had an effect on the ecosystem for a long time (Fox et al., 2016). Like Reilly and Adamowski (2017), we acknowledge the importance of the perception regarding cultural ecosystem services for proponents and opponents of dam removal. This is especially evident in actors opposing decommissioning which always value cultural services more than proponents do. We also confirm the findings of Jorda-Capdevila and Rodríguez-Labajos (2015), who acknowledged that locals in the Ter River Basin consider that many of the potential ES are hampered by dams. Thus, in order to optimise resources and time, a strategy needs to be found to assess social values attributed to dams.

Combining PPGIS and ES perception analysis has proven to be valuable to understand processes of dam removal. We made the contrasting values of actors visible, since all implied actors received feedback from the maps and interviews. PPGIS as a tool for place-based mapping of ES allowed us to

make plural values visible and understandable by connecting special place locations with their underlying perceptual rationale (Brown, 2005). This way to address conflict analysis can contribute to decision making and spatial planning (Klain and Chan, 2012; Potschin and Haines-Young, 2013). Aligning with Bryan et al. (2010), we evidenced how PPGIS allowed targeting management of ES values in the landscape by depicting not only high-priority areas but which ES should be managed. We agree on the findings of Brown and Fagerholm (2015) who highlighted the potential of PPGIS for the identification of ES, with special relevance for cultural services. The valuation of supporting and cultural services points out values of the waterscape beyond economic purposes. In contrast, to a large extent, actors contesting demolition prefer provisioning services to cultural services.

At this point, we will turn to the aesthetic matters. For instance, in Manlleu, actors opposing the demolition relate their opposition to the ecosystem created by the dam with the personal experiences in that place. Thus, opposition is a product of a combination of place attachment and nature. The contrasting views found upon cultural services by Darvill and Lindo (2014) and Reilly and Adamowski (2017) highlight the importance that cultural ES can play in decision making.

The participatory-mapping methodology and the use of interviews could be expanded to the river-basin level for the sake of understanding conflict, as environmental management decisions will rarely achieve social sustainability without local support. This way, we support the idea of Doyle et al. (2000), that these tools can be sufficient to build interactions between different positions regarding dam removal, rather than the top-down approach used by the water management authorities. Therefore, we propose the combination of ES and PPGIS to facilitate decision making for river management. It is noteworthy that ES potentially provided by decommissioning may vary considerably whether we assess an individual action or integrated action at the basin scale. This is why strategic opportunism might be limited in scope for a sustainable management of the river basins.

## CONCLUSION

In the present study, we used a combination of PPGIS and ES to analyse the perception of actors proposing and opposing dam removal at two levels of study in Catalonia: the Catalan context and two local case studies of dam removal. Despite increasing efforts in river restoration in Catalonia, cultural and environmental criteria perceived by actors are important limiting factors for dam removal, which is in general approached by strategic opportunism. Based on our study we highlight three main findings: i) opposition to dam removal goes beyond the traditional dichotomy of hydropower against naturalness; ii) naturalness is differently perceived by diverse groups of actors, and the role of actors in the co-creation of this nature is a point of contention. Cultural and environmental limitations are based on the contrasting views of naturalness against complex human-nature relationships; and iii) PPGIS allowed us to identify the diversity of services valued by actors while taking into consideration their intensity, relating special place locations to their underlying perceptual value. Interestingly, actors proposing demolition identify a larger diversity of ES while actors opposing it identify a higher intensity of ES.

Eventually, we suggest that: i) the combination of PPGIS and ES has is a useful tool to understand conflicts over dam removal; ii) cultural-historic and environmental aspects have to be integrated in decision-making processes of dam removal in order to achieve social sustainability; and iii) this approach can be extended to a river-basin scale to assess conflicts related to dam removal in order to achieve social sustainability.

Finally, we want to highlight the need for further research to understand social implications of dam removal and other environmental restoration projects, since the social context of dam-removal decision is as important as environmental, economic, and legal aspects. For instance, it would be valuable to analyse conflicts related to dam removal beyond local case studies but at the river-basin scale through the lens of ES and PPGIS. Moreover, it is important to further analyse the historical perspective of actors when river restoration projects are planned. Finally, there is a need to develop easy-to-adapt

tools that enable local actors to examine their own contrasting positions which affect their landscape and their relationship to it.

## ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support of the Master Programme in Global Change Ecology and the Max Weber Program des Freistaats Bayern. Then, we would like to thank all actors who have participated in the interviews for their patience and willingness to cooperate in the present study. Last but not least, we would like to thank three anonymous reviewers for their valuable and insightful comments.

## REFERENCES

- ACA. 2003a. Informe tècnic extraordinari en relació amb l'expedient de caducitat de la concessió per a ús hidroelèctric a nom de l'Ajuntament de Molló. Molló (Ripollès, Girona). Barcelona.
- ACA. 2003b. Resolució extinció de concessiópp. 1-4. Barcelona, Spain, 2003.
- ACA. 2008. Manual de control i sensorització de les derivacions d'aigües superficials. Agència Catalana de l'Aigua, pp. 1-45. Barcelona: Generalitat de Catalunya Departament de Medi Ambient i Habitatge, 2008.
- ACA. 2009. *Pla de gestió del districte de conca fluvial de Catalunya*. Agència Catalana de l'Aigua. Barcelona.
- ACA. 2015. *Programa de mesures del pla de gestió del districte de conca fluvial de Catalunya 2016-2021*. Barcelona.
- ACA. 2016. Inventari actuacions millora connectivitat 2016. Barcelona: Agència Catalana de l'Aigua.
- AEMS-Rius amb Vida. 2006. AEMS-Rius amb Vida, aconsegueix l'empar judicial en la protecció dels rius. <http://aems-riusambvidanoticiesconcesions.blogspot.com.es/2006/11/aems-rius-amb-vida-aconsegueix-lempar.html> (Accessed on 5 April 2016)
- Amiguet, L. 2016. "Aquí el que menos agua gasta es el que más cara la paga". *La Vanguardia*. [www.lavanguardia.com/lacontra/20160831/412452382/aqui-el-que-menos-agua-gasta-es-el-que-mas-cara-la-paga.html](http://www.lavanguardia.com/lacontra/20160831/412452382/aqui-el-que-menos-agua-gasta-es-el-que-mas-cara-la-paga.html) (Accessed on 3 November 2016)
- Baish, S.K.; David, S.D. and Graf, W.L. 2002. The complex decision making process for removing dams. *Environment* 44(4): 21-31.
- Bednarek, A.T. 2001. *Undamming rivers: A review of the ecological impacts of dam removal*. *Environmental Management* 27(6): 803-814.
- BOE 62. 1942. Ley de 20 de febrero de 1942 por la que se regula el fomento y conservación de la pesca fluvial. Spain.
- Born, S.M.; Genskow, K.D.; Filbert, T.L.; Hernandez-Mora, N.; Keeper, M.L. and White, K.A. 1998. Socioeconomic and institutional dimensions of dam removals: The Wisconsin experience. *Environmental Management* 22(3): 359-370.
- Brown, G. 2005. Mapping spatial attributes in survey research for natural resource management: Methods and applications. *Society & Natural Resources* 18(1): 1-23.
- Brown, G. and Fagerholm, N. 2015. Empirical PPGIS/PGIS mapping of ecosystem services: A review and evaluation. *Ecosystem Services* 13: 119-133.
- Bryan, B.A.; Raymond, C.M.; Crossman, N.D. and Macdonald, D.H. 2010. Targeting the management of ecosystem services based on social values: Where, what, and how? *Landscape and Urban Planning* 97(2): 111-122.
- Bullock, J.M.; Aronson, J.; Newton, A.C.; Pywell, R.F. and Rey-Benayas, J.M. 2011. Restoration of ecosystem services and biodiversity: Conflicts and opportunities. *Trends in Ecology and Evolution* 26(10): 541-549.
- Castro, A.J.; Vaughn, C.C.; Julian, J.P. and García-Llorente, M. 2016. Social demand for ecosystem services and implications for watershed management. *Journal of the American Water Resources Association* 52(1): 209-221.
- Cerrillo, A. 2016. El gobierno de Navarra elimina las presas sin uso en el Bidasoa. *La Vanguardia*.



[www.lavanguardia.com/vida/20160807/403744113555/los-salmones-remontan-otra-vez-el-bidasoa.html](http://www.lavanguardia.com/vida/20160807/403744113555/los-salmones-remontan-otra-vez-el-bidasoa.html)

(Accessed on 26 October 2016)

- Darvill, R. and Lindo, Z. 2014. Quantifying and mapping ecosystem service use across stakeholder groups: Implications for conservation with priorities for cultural values. *Ecosystem Services* 13: 153-161.
- DOGC 5536. 2009. 22/2009, del 23 de desembre, d'ordenació sostenible de la pesca en aigües continentals. Spain.
- Doyle, M.W.; Stanley, E.H.; Luebke, M.A. and Harbor, J.M. 2000. Dam removal: Physical, biological, and societal considerations. In *American Society of Civil Engineers Joint Conference on Water Resources Engineering and Water Resources Planning and Management*, pp. 1-10. Mineapolis, 2000.
- Dufour, S. and Piégay, H. 2009. From the myth of a lost paradise to targeted river restoration: Forget natural references and focus on human benefits. *River Research and Applications* 25(5): 568-581.
- Ernstson, H. 2013. The social production of ecosystem services: A framework for studying environmental justice and ecological complexity in urbanized landscapes. *Landscape and Urban Planning* 109(1): 7-17.
- Fencl, J.S.; Mather, M.E.; Costigan, K.H. and Daniels, M.D. 2015. How big of an effect do small dams have? Using geomorphological footprints to quantify spatial impact of low-head dams and identify patterns of across-dam variation. *PLoS ONE* 10(11): e0141210.
- Fischer, A. and Eastwood, A. 2016. Coproduction of ecosystem services as human-nature interactions-An analytical framework. *Land Use Policy* 52: 41-50.
- Foley, M. 2017. Dam removal – Listening in. *Water Resource Research*. (Accepted).
- Forrester, J.; Cook, B.; Bracken, L.; Cinderby, S. and Donaldson, A. 2015. Combining participatory mapping with Q-methodology to map stakeholder perceptions of complex environmental problems. *Applied Geography* 56: 199-208.
- Fox, C.A.; Magilligan, F.J. and Sneddon, C.S. 2016. "You kill the dam, you are killing a part of me": Dam removal and the environmental politics of river restoration. *Geoforum* 70: 93-104.
- García-Nieto, A.P.; Quintas-Soriano, C.; García-Llorente, M.; Palomo, I.; Montes, C. and Martín-López, B. 2015. Collaborative mapping of ecosystem services: The role of stakeholders' profiles. *Ecosystem Services* 13: 141-152.
- Gobster, P.H.; Nassauer, J.I.; Daniel, T.C. and Fry, G. 2007. The shared landscape: What does aesthetics have to do with ecology? *Landscape Ecology* 22(7): 959-972.
- Gomez-Baggethun, E. and Ruiz-Perez, M. 2011. Economic valuation and the commodification of ecosystem services. *Progress in Physical Geography* 35(5): 613-628.
- Gosnell, H. and Kelly, E.C. 2010. *Peace on the river? Social-ecological restoration and large dam removal in the Klamath basin, USA*. *Water Alternatives* 3(2): 362-383.
- Gowan, C.; Stephenson, K. and Shabman, L. 2006. The role of ecosystem valuation in environmental decision making: Hydropower relicensing and dam removal on the Elwha River. *Ecological Economics* 56(4): 508-523.
- Grau, J. 2004. Apellations AEMS, Can Buixop. 1, 2004.
- Honey-Rosés, J. 2007. Estimating the social benefits of protecting minimum instream flows the case of the Ter River in Catalonia, Spain. May, p. 39. Agència Catalana de l'Aigua, 2007.
- Idescat. 2016. Idescat. Anuario estadístico de Cataluña. Producción de energía primaria. Por tipo. 2014. [www.idescat.cat/pub/?id=aec&n=499&lang=es&t=2014](http://www.idescat.cat/pub/?id=aec&n=499&lang=es&t=2014) (Accessed on 2 December 2016)
- Jacobs, M.H. and Buijs, A.E. 2011. Understanding stakeholders' attitudes toward water management interventions: Role of place meanings. *Water Resources Research* 47(1): 1-11.
- Johnson, S.E. and Graber, B.E. 2002. Enlisting the social sciences in decisions about dam removal. *BioScience* 52(8): 731-738.
- Jorda-Capdevila, D. 2016. *Water flows to multiple stakeholders: An ecosystem services-based approach to conflicts in the Ter River basin*. Universitat Autònoma de Barcelona.
- Jorda-Capdevila, D. and Rodríguez-Labajos, B. 2015. An ecosystem service approach to understand conflicts on river flows: local views on the Ter River (Catalonia). *Sustainability Science* 10(3): 463-477.
- Jorgensen, D. and Renöfalt, B. 2013. Damned if you do, dammed if you don't: Debates on dam removal in the Swedish media. *Ecology and Society* 18(1).

- Juzgado Cont. Adm. número dos de Girona. 2006. Sentencia N° 89/06. Spain.
- Kallis, G.; Gómez-Baggethun, E. and Zografos, C. 2013. To value or not to value? That is not the question. *Ecological Economics* 94: 97-105.
- Kaye-Zwiebel, E. and King, E. 2014. Kenyan pastoralist societies in transition: Varying perceptions of the value of ecosystem services. *Ecology and Society* 19(3).
- Klain, S.C. and Chan, K.M.A. 2012. Navigating coastal values: Participatory mapping of ecosystem services for spatial planning. *Ecological Economics* 82: 104-113.
- Lejon, A.G.C.; Renöfält, B.M. and Nilsson, C. 2009. Conflicts associated with dam removal in Sweden. *Ecology and Society* 14(2): 4.
- Llargués, F. 2000. Denúncia Mollópp. 1-7. Manresa, 2000.
- de Loë, R.C. 1999. Dam the news: Newspapers and the Oldman River dam project in Alberta. *Journal of Environmental Management* 55(4): 219-237.
- Magilligan, F.J.; Sneddon, C.S. and Fox, C.A. 2017. The Social, Historical, and Institutional Contingencies of Dam Removal. *Environmental Management* 1-13.
- Milcu, A.I.; Hanspach, J.; Abson, D. and Fischer, J. 2013. Cultural ecosystem services: A literature review and prospects for future research. *Ecology & Society* 18(3): 44-88.
- Nguyen, T.T.; Pham, V.D. and Tenhunen, J. 2013. Linking regional land use and payments for forest hydrological services: A case study of Hoa Binh Reservoir in Vietnam. *Land Use Policy* 33: 130-140.
- Opperman, J.J.; Royte, J.; Banks, J.; Day, L.R. and Apse, C. 2011. The Penobscot River, Maine, USA: A basin-scale approach to balancing power generation and ecosystem restoration. *Ecology and Society* 16(3).
- Ordeix, M. 2016. Sobren rescloses i falta aigua. [www.naciodigital.cat/osona/opinio/14025/sobren/rescloses/falta/aigua?platform=hootsuite](http://www.naciodigital.cat/osona/opinio/14025/sobren/rescloses/falta/aigua?platform=hootsuite) (Accessed on 3 November 2016)
- Palmer, M.A.; Reidy Liermann, C.A.; Nilsson, C.; Floerke, M.; Alcamo, J.; Lake, P.S. and Bond, N. 2008. Climate change and the world's river basins: Anticipating management options. *Frontiers in Ecology and the Environment* 6(2): 81-89.
- Pejchar, L. and Warner, K. 2001. A river might run through it again: Criteria for consideration of dam removal and interim lessons from California. *Environmental management* 28(5): 561-575.
- Perrings, C.; Duraiappah, A.; Larigauderie, A. and Mooney, H. 2011. The Biodiversity and Ecosystem Services Science-Policy Interface. *Science* 331(6021): 1139-1140.
- Poff, N.L. and Hart, D.D. 2002. How dams vary and why it matters for the emerging science of dam removal. *BioScience* 52(8): 659-668.
- Pohl, M.M. 2002. Bringing down our dams: Trends in American dam removal rationales. *Journal of the American Water Resources Association* 38(6): 1511-1519.
- Potschin, M. and Haines-Young, R. 2013. Landscapes, sustainability and the place-based analysis of ecosystem services. *Landscape Ecology* 28(6): 1053-1065.
- Reilly, K.H. and Adamowski, J.F. 2017. Stakeholders' frames and ecosystem service use in the context of a debate over rebuilding or removing a dam in New Brunswick, Canada. *Ecology and Society* 22(1).
- Richter, B.D.; Postel, S.; Revenga, C.; Scudder, T.; Lehner, B. and Chow, M. 2010. Lost in development's shadow: The downstream human consequences of dams. *Water Alternatives* 3(2): 14-42.
- Rikoon, J.S. 2006. *Wild horses and the political ecology of nature restoration in the Missouri Ozarks*. *Geoforum* 37(2): 200-211.
- Schröter, M.; van der Zanden, E.H.; van Oudenhoven, A.P.E.; Remme, R.P.; Serna-Chavez, H.M.; de Groot, R.S. and Opdam, P. 2014. Ecosystem services as a contested concept: A synthesis of critique and counter-arguments. *Conservation Letters* 7(6): 514-523.
- Seppelt, R.; Dormann, C.F.; Eppink, F. V.; Lautenbach, S. and Schmidt, S. 2011. A quantitative review of ecosystem service studies: Approaches, shortcomings and the road ahead. *Journal of Applied Ecology* 48(3): 630-636.



- Tielborger, K.; Fleischer, A.; Menzel, L.; Metz, J. and Sternberg, M. 2010. The aesthetics of water and land: A promising concept for managing scarce water resources under climate change. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 368(1931): 5323-5337.
- Vila, J. 2010. Minicentrals i l'ACA. *Diaridegirona.cat*. [www.diaridegirona.cat/opinio/2010/11/07/minicentrals-laca/443843.html](http://www.diaridegirona.cat/opinio/2010/11/07/minicentrals-laca/443843.html) (Accessed on 1 January 2001)
- Wyrick, J.R.; Rischman, B.A.; Burke, C.A.; McGee, C. and Williams, C. 2009. Using hydraulic modeling to address social impacts of small dam removals in southern New Jersey. *Journal of Environmental Management* 90(Suppl. 3): S270-S278.

## APPENDIX

### Supplementary material S1. Interview protocol.

The portrayed protocol was used in the 24 interviews.

The interview starts with:

- Agreement on confidentiality
- Project description
- Overview of interview

*Catalan level:*

1. Do you consider your position as favourable or unfavourable for dam removals?
2. Which interest do you have in dam management in a scale of 0 to 3 where 0 is no interesting, 1 a little interesting, 2 interesting and 3 very interesting?
3. Which obstacles do you find to your positioning?
4. Do you consider the situation for dam removals at Catalan level as positive or negative and why?
5. Is there a historical reason for how dam management is carried out?
6. Which actors influence decision process and why?
7. Which influence do you play in the process of dam management?

*Local level:*

8. What do the dams and the environment it creates represent to you?
9. How will the landscape look like after dam removal?
10. Which benefits emerge under your positioning and which role do they play for that positioning?
11. Value the benefits from 0 to 3 if they are 0 not interesting, 1 a little interesting, 2 interesting and 3 very interesting.
12. Are there trade-offs between benefits that emerge under your positioning and benefits for other actors?

*Mapping:*

13. Where are benefits generated under your positioning located? Could you please draw them on the map?

*Conclusion:*

14. Is there any aspect which you would like to comment that you think was not included in the interview?
15. Could you facilitate two more actors I could interview?

Table S1. Interviewed actors. This table presents the interviewed actors' organisation, the codes for the actors referenced in the texts, the sector and subsector they belong to and on what case study they gave their opinion and participated in the PPGIS.

Code	Actors	Sector	Subsector	Level	Manlleu for Demolition	Manlleu against Demolition	Molló for Demolition	Molló against Demolition
1	ACA Dpt. de control i qualitat de les aigües	Public	Water management	Catalan	No	No	Yes	No
2	ACA Unitat singular de Participació i Cooperació	Public	Water management	Catalan	Yes	No	Yes	No
3	ACA Dpt. de concessions and Director àrea d'abastament d'aigua	Public	Water management	Catalan	Yes	No	Yes	No
4	ACA Unitat d'Inspecció a la Demarcació de Girona	Public	Water management	Local	Yes	No	Yes	No
5	Dpt. de Territori i Sostenibilitat, Direcció General de Polítiques Ambientals i Medi Natural	Public	Catalan Government	Catalan	No	No	Yes	No
6	ICAEN	Public	Energy management	Catalan	No	Yes	Yes	No
7	Consorci del Ter	Public	Municipal	Local	No	Yes	No	No
8	CERM	Public	Research/management	Catalan	No	No	Yes	No
9	Researcher of the FEM (UB)	Public	Research	Catalan	Yes	No	Yes	No
10	AEMS	NGOs	Fishers	Local	Yes	No	Yes	No
11	Grup de Defensa del Ter	NGOs	Ecologists	Local	No	Yes	Yes	No
12	GEDENA	NGOs	Ecologists	Local	No	No	Yes	No
13	APUEE	Private	Industry	Catalan	No	Yes	No	Yes
14	APPA	Private	Industry	Catalan	No	Yes	No	Yes
15	PIMEE energy	Private	Industry	Local	No	No	No	Yes
16	Novatilu	Private	Private company	Local	Yes	No	No	No
17	Council Manlleu: environment and engineering	Public	Municipal	Local	No	Yes	No	No
18	Council Manlleu: architect	Public	Municipal	Local	No	Yes	No	No
19	Council Manlleu: tourism and history	Public	Municipal	Local	No	Yes	No	No
20	Ter Museum	Public	Education	Local	Yes	Yes	No	No
21	Council Campordón: tourism	Public	Municipal	Local	No	No	Yes	No
22	Council Molló: former mayor	Public	Municipal	Local	No	No	No	Yes
23	Council Molló	Public	Municipal	Local	No	No	Yes	No
24	Dpt. d'Agricultura, Ramaderia, Pesca iAlimentació	Public	Catalan Government	Catalan	No	Yes	Yes	No

THIS ARTICLE IS DISTRIBUTED UNDER THE TERMS OF THE CREATIVE COMMONS *Attribution-NonCommercial-ShareAlike* LICENSE WHICH PERMITS ANY NON COMMERCIAL USE, DISTRIBUTION, AND REPRODUCTION IN ANY MEDIUM, PROVIDED THE ORIGINAL AUTHOR(S) AND SOURCE ARE CREDITED. SEE [HTTP://CREATIVECOMMONS.ORG/LICENSES/BY-NC-SA/3.0/LEGALCODE](http://creativecommons.org/licenses/by-nc-sa/3.0/legalcode)

