What future for decommissioned historic irrigation canals? Crafting new identities in the Lower Ter (Spain)

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Historic irrigation canals are valuable socioecological systems capable of delivering several ecological and cultural services. However, ecological modernization initiatives are leaving decommissioned ditches in limbo. A case study strategy is used to analyze the history of a decommissioned 700-year-old canal network in northeastern Spain and the unexpected intervention of several stakeholders who have attempted to redefine the former canals through new uses. The study relies on the analysis of documents and eight semistructured interviews with key stakeholders. We argue that this case reflects a policy failure in the application of multifunctionality, integrative planning and social participation principles presumably ingrained in European policies. The replacement of such principles with monosectoral action under a productivity paradigm, function segregation and a neoliberal management approach should be balanced with greater institutional commitment, increased coordination between stakeholders and rigorous planning controls if ecological and cultural functions and services are to be preserved.

Keywords: ecological modernization; ecosystem services; green infrastructure; landscape planning; multifunctional agriculture; stakeholders

Introduction

Historic irrigation canals are recognized in the scientific literature as valuable socioecological systems with highly connected social and ecological dimensions that are capable of fulfilling a variety of functions, delivering ecological and cultural services and structuring "water landscapes" around them (Fiege, 1999; Haines-Young & Potschin, 2010; Vallerani & Visentin, 2017). Nevertheless, traditional unlined canals are also likely to generate some disadvantages for farming activities, including the loss of water through seepage and the spread of pests (Fernald, Baker, & Guldan, 2007). In addition, the costs associated with maintaining earth ditches to prevent erosion, periodically removing sediments from the canal beds and maintaining the vegetation

growing on the banks tend to be very significant. To counter these inconveniences, many governments have opted to either waterproof the earth canals or replace them with pipelines, particularly in water-scarce and arid or semiarid regions (I. Gómez & Araujo, 2008; Sueltenfuss, Cooper, Knight, & Waskom, 2013).

Statistical data and scientific research on the expansion of irrigation, irrigation methods, waterproofing technologies and the balances of consumed water and energy for these projects are abundant, but little information exists about the forgotten by-products or "residues" of modernization, namely, the decommissioned historic irrigation canals and the wider traditional agricultural landscape (C. M. Gómez & Pérez-Blanco, 2014). Nevertheless, their existence and the conservation of their desirable former functions and services requires –and sometimes captures– the attention of public authorities, land use planners, conservationists and researchers, who are faced with several questions. We have grouped these questions into three categories.

- Definition. How should unused historic irrigation canals be defined? Are they only abandoned infrastructure? Do they still have ecosystem features? Can they still provide cultural services?
- Management and planning. How should these canals be optimally managed? What are the targets to pursue? Should they be abandoned, maintained, restored, or enhanced? How does uncertainty about their future value affect management decisions today?
- Responsibility. Who cares for the hydrological and architectural elements they contain? In the case of private canals, should the eventual costs be borne by the owner/s or, insofar as they may provide services to society in general, should they be addressed by public support? In the case of publicly owned canals, how

much public investment should they receive, and is there a sufficient return (in whatever ways it is measured)?

In this study, we address these questions by focusing on the evolution of the historic canal network of the Lower Ter River irrigation district in northeastern Spain. A process of modernization culminated in 2011 with the opening of a network of underground pipelines that replaced the 700-year-old capillary network of naturalized earth ditches. After some years of neglect and degradation, a number of initiatives have been recently developed, and they combine different goals and visions for the canals and the wider territory.

The paper is structured as follows. The subsequent literature review section is divided into two sub-sections. In the first sub-section, we characterize the ecological and cultural services that historic irrigation canals have been identified to provide. In the second sub-section, we review the existing theoretical and policy frameworks that address the conception, management and planning of similar socioecological systems. The methods section describes how data were obtained from documental sources and semi-structured interviews and subsequently analyzed. The findings for the case study are presented in the subsequent section. The discussion is structured around the three groups of questions previously presented and connects the local history of the canals in the Lower Ter with the theoretical constructs identified in the literature review to offer insights on the different management options available for the future of traditional agrarian landscapes threatened by ecological modernization processes. The paper is closed with a brief conclusion section.

Literature review

Historic irrigation canals: functions and services

In their traditional unlined form, historic irrigation canals can fulfil multiple functions, which often translate into the delivery of several ecological and cultural services for the benefit of local and global societies (De Groot, Wilson, & Boumans, 2002; Haines-Young & Potschin, 2010). Historically, these canals have transported and distribute water to ensure the irrigation of crops while also facilitating the drainage of water from precipitation and irrigation excesses (Herzon & Helenius, 2008). In addition, water seepage in permeable canals can serve significant hydrological functions by refilling shallow aquifers, improving groundwater quality, flowing into rivers and refilling ponds and lakes (Fernald et al., 2007; Sueltenfuss et al., 2013). In the presence of water, earthen canal beds and ditches quickly develop into rich freshwater and riparian habitats that function as analogues to natural ecosystems (Chester & Robson, 2013). In fact, in many intensive agricultural areas, these anthropogenic habitats constitute regional biodiversity hotspots, green corridors and refuges. For instance, in territories such as Europe, riparian zones cover only approximately 2% of the terrestrial surface (Clerici et al., 2011); however, the global meta-analysis of the literature carried out by Sabo et al. (2005) suggests that the presence of earthen canals in a landscape increases regional species richness by >50% on average. The high-intensity management of agricultural areas where canals exist and the drift of nutrients and pesticides from adjacent farmland are known to negatively affect seminatural riparian and aquatic communities. However, some studies have revealed that these habitats are home to some faunal and plant species not commonly found in other freshwater bodies (Williams et al., 2003); thus, these canals act as movement corridors and refuges (Chester & Robson, 2013).

Canals are a fundamental element of several cultural landscapes, such as those formed around the polders of the Netherlands, the *Alfjaj* in Oman, the *subaks* in Bali, the Jianan irrigation system in Taiwan or the heritage site of Champaner-Pavagadh in India (Al-Marshudi, 2001; Braaksma, Jacobs, & van der Zande, 2016; Roth, 2014; Sinha, 2018; Wang & Fu, 2014). Some of these landscapes are recognized as having outstanding value and historical significance and are sometimes protected (Roth, 2014; Sinha, 2018; Wang & Fu, 2014). The presence of associated structures, such as dams, mills, bridges, docks or fishing devices, in a better or worse state of use and conservation provides a connection with past and traditional human activities and interactions with the environment (C. M. Gómez & Pérez-Blanco, 2014; Siebert et al., 2015). The role of these canals as early examples of natural resource management systems and associated legal and institutional structures is being increasingly studied (Al-Marshudi, 2001; Green, 2008). Their contribution to the construction and expression of local identity has also been explored (Boelens, 2015). All types of manmade canals and their banks, which often spread as complex networks throughout flat lands, have historically been used for the mobility of people and are currently adapted to serve the recreational and touristic use of the canal (Prideaux, 2018).

As shown in the scientific literature, ecological modernization projects can have a profound effect on functions and services provided by historical canals. By decoupling the water transportation function from the canal, the bundles of ecosystem services that those canals had been providing may be threatened (Queiroz et al., 2015). If canals are lined with impermeable materials, most ecological and many cultural services will inevitably disappear. If water is diverted to new pipelines, the management and volume of water resources flowing in the remaining ditches will change; therefore, the services and benefits they provided may begin an adaptation process or will simply cease to exist

(Fernald et al., 2007). At a wider scale, the landscape character will inevitably change, thereby decontextualizing the heritage elements that it may contain and in certain cases, challenging the grounds on which designation status was granted (Romero & Melo, 2015).

Management and planning of agricultural landscapes with modernized canals

In semi-arid regions or in areas where the seasonal and year-by-year distributions of rainfall are uneven, modern irrigation infrastructures increase the likelihood of sustained yields, profits and food security with minimized dependence from meteorological conditions (Siebert et al., 2015). Purely econometric cost-benefit analyses often reveal the benefits of the ecological modernization of irrigation infrastructures (C. M. Gómez & Pérez-Blanco, 2014). Given these advantages, policymakers and governments in developed countries as well as many other regions have commonly been keen supporters of projects to line earth canals that are perceived as inefficient, outdated and costly or to replace them with pipelines. Such projects are claimed to be aligned with the interests of the farming sector, engaged with the productivity paradigm in agriculture and committed to increasing the competitiveness of farming businesses and their products in the markets as a source of economic development (Tscharntke et al., 2012).

This type of strategy for rural development rests upon a broader neoliberal approach to natural resource management, land use planning and governance. In the scope of irrigation projects, it can be summarized in three principles:

a. Commodification of nature (or water in the case of irrigation projects) as a step towards enabling its economic valuation. In turn, value will guide the optimal allocation of exploitation rights among aspiring parties and interests, generally belonging in the private domain. Such exploitation will occur in a

competitive market that will favor the most efficient use of the resource in terms of productive economic performance (Roberts, 2008).

b. In regards to governance, public authorities and governments at regional and national scales must act as managers and facilitators (Peck, 2001) and use their power and resources to ensure that the aforementioned principles and conditions are observed. They will also correct any market failures that might be hindering an optimum allocation of resources and their use to maximize wealth creation. In the case of irrigation modernization projects, this usually entails their declaration as initiatives of general interest and public funding provisions for their execution before handing the infrastructure over to private agricultural businesses for exploitation.
c. To enhance decision-making, decentralization of resource governance to local authorities and non-state actors must occur. However, as observed by Fletcher (2010), the transfer will not generally be coupled with the devolution of power, competences or increased economic resources to implement policies. In the frame of irrigation projects, such decoupling means that local institutions willing to undertake restorative, mitigative or remedial action against environmental impacts or develop projects building upon the canals' cultural heritage and values will be forced to use or raise their own human and economic resources.

In stark contrast with the neoliberal doctrine and its narrow focus on agricultural productivity and the private sector as engines for rural development, alternative paradigms conceive agricultural landscapes as complex socioecological systems (Rivera-Ferre, Ortega-Cerdà, & Baumgärtner, 2013). In landscapes where irrigation

infrastructure may exist, such infrastructure would be just one of many elements that act in conjunction with other biophysical constituents to compose a landscape. These elements are in constant interaction with societies' multiple and often contradictory preferences, needs and demands, which determine how the landscape should be managed and, eventually, even planned or protected (Dachary-Bernard & Rambonilaza, 2012). While the scientific literature does not offer a unifying concept or label to characterize this broader approach to defining and guiding the management of agricultural landscapes, as in the case of neoliberalism, some shared principles can be recognized.

a. Multifunctionality is a trait of many traditional and modern agricultural landscapes that should be preserved (Wilson, 2009). These landscapes may simultaneously produce food and fibers, regulate water flows, shelter species, capture atmospheric carbon, provide a pleasant scenery and preserve tangible and intangible cultural heritage (Ricart, Kirk, & Ribas, 2018). In performing these functions, the landscapes contribute with bundles of ecosystem services to human populations' wellbeing by helping to increase food security, prevent flooding, protect biodiversity, attain climate action targets, facilitate healthy lifestyles, provide educational opportunities, etc. (Queiroz et al., 2015).
b. An integrated management and planning approach to facing changes in multifunctional agricultural landscapes can maximize the benefits these landscapes bring to communities (Chan, Shaw, Cameron, Underwood, & Daily, 2006). The role of public authorities must not solely focus on maximizing the economic performance of private farming businesses but must also ensure that their activity is sustainable and coupled with the preservation and enhancement of agricultural landscapes, their multiple functions and services (Alons, 2017).

Such objectives would be achieved by collaborative planning that involves a variety of sectoral authorities in the institutional sphere at all scales to ensure that the resulting economic and land use planning is integrative of all dimensions: farming viability, demographic change, environmental protection, public use, etc.

c. Since the benefits of multifunctional agricultural landscapes are reaped by society at large, multiple stakeholders must be involved in decision-making processes (Ricart, Rico, et al., 2019). Farmers and administrations are engaged as central actors in all discussions affecting the landscape. However, the literature reveals the multiple benefits of opening participation processes to the wider society (Zasada, 2011). Alongside the conventional dichotomy of private and public institutions guiding decisions, a case exists for giving agency to community-based (non-market, non-state) stakeholders committed with preserving and enhancing the communal value of agricultural landscapes and water resources (Ostrom, 1990).

In most of the world and Europe in particular, agricultural policies and practices are known to be heavily influenced by the postulates of neoliberal thought (Grant, 2015) and underlie the intensification of agrarian practices, the replacement of family-based operations with larger businesses enjoying the advantages of economies of scale and the promotion and financing of the ecological modernization of irrigation infrastructures, which are of particular interest for this research. On the other hand, a wide range of regulatory provisions aim to implement a more comprehensive approach to managing agricultural landscapes. For instance, the Common Agricultural Policy promotes the adoption of agroecological measures to minimize the negative impacts of farming

activities on ecosystems; the European Landscape Convention transversally integrates landscape quality objectives in other sectoral policies; the Water Framework Directive advances a culture in which water is not only a commodity but the pillar that supports a variety of functions and ecosystem services; and the Aarhus Convention, by setting standards to public participation requirements, ensures fairer decision-making processes with key stakeholders.

Methods

The methodology uses a case study approach divided into two parts. The first stage seeks to characterize the origins and evolution of the Lower Ter agricultural landscape, the network of historic irrigation canals and their functions. This stage is based on a documental analysis of scientific literature and, mostly, local publications on the history and ecology of the Lower Ter. For the most recent period (2004-2019), the canal modernization projects and newspaper pieces on the issue have been systematically consulted.

The second part explores the drivers and conditions that have recently led to the proposal of three projects that focus on the recovery of certain functions of the decommissioned canals. To this end, semistructured interviews were conducted with eight stakeholders directly responsible for or involved with each of the initiatives. Contents from the notes generated during the meetings were coded according to the three categories of questions guiding the research with the support of computer-assisted qualitative data analysis software.

Findings. Lower Ter irrigation canals and agricultural landscape: history, functions and prospective

Spatial context

The sedimentary action of the lower course of the Ter River, which is located on the Mediterranean coast of Girona in northeastern Spain, created a deltaic floodplain surrounding the mountains of the Montgrí Massif (311 m). The original landscape of marshes, swamps and dunes has been heavily modified by humans for centuries. Pivotal to those transformations were a series of waterworks that diverted the course of the Ter River and facilitated the construction of the traditional irrigation network (Fig. 1). Three main canals and a complex capillary network of secondary ramifications distributes the water extracted from the Ter River to each parcel, thus allowing for the gravity-fed irrigation of approximately 15,000 hectares of corn, fodder, orchards and rice.

The cultivation of the land is still the activity that structures the economy in the small villages that dot the plain, although currently, the main sector in the region is the service sector (linked to tourism activity), which is present in the larger towns. For decades, the demands of visitors were centered on the sun and beach model characteristic of the Costa Brava touristic destination. Over the last few years, two new tourism trends have emerged: rural tourism in restored farmhouses and nature tourism focused on the diversity of environments, some of which have been protected since 2010 by the Natural Park of the Montgrí, Medes Islands and Lower Ter (NPMMT).

[Figure 1 HERE]

Traditional landscape

The origins of the irrigation network can be traced back to the 13th century because of the construction of ditches and three weirs in the Ter River. The network was

consolidated in the 17th and 18th centuries when the Ter River was diverted to its current bed, the three weirs were upgraded, and mills were built along the course of the three main canals. Designed as water-powered flour and rice mills in the late 19th century, most of these mills were adapted as hydroelectric power plants. By the 1960s, regardless of their purpose, all the mills stood abandoned (Ribas, Llausàs, Saurí, & Roset, 2012).

The canal network provides habitat and corridors for reintroduced otter (*Nutra nutra*) populations and operates as a refuge for freshwater mussel species (*Potomida littoralis*, *Unio mancus*, *Anodonta anatina*), which were decimated in the region after various episodes of severe water pollution in the 1980s. Cultural functions and services can also be identified in the traditional canal network. Centuries-old trees planted at regular intervals on the banks of some sections point to the historic use of the canals as a mobility network for local societies, and it is likely that they were used as extensions of planted promenades in urban centers. Older local farmers are able to recall the time when they used the canals as a resource for recreation, swimming and fishing for carp (*Cyprinus carpio*) and eels (*Angulla anguilla*). More widely, the presence of the traditional irrigation network has been recognized as one of the constituents of the agricultural landscape of the Lower Ter and one that imprints character and a local identity onto the territory (Observatori del Paisatge, 2010).

Modernization works

In 2005, modernization of the irrigation infrastructure of the Lower Ter began to be discussed. Some farmers argued that water seepage in the unlined canals and high maintenance costs (associated with collapsing earth walls, removal of vegetation, etc.) were threatening the viability of their professional activity. Engineering studies soon followed, and they envisaged the construction of an underground pipeline as a

replacement for the canals. These works would prevent the infiltration of up to 10 hm^3 of water annually. Funding was obtained from land owners, the Catalan government and the European Union. Among other minor observations, environmental impact studies imposed the condition of establishing a flow of 0.3 m^3/s for the maintenance of ecosystems in each canal, and this value represented one-tenth of the original flow. Construction took place between 2009 and 2011.

The main canals remained untouched or minimally altered by the works, although after they were stripped of one of their functions, their physical transformation was dramatic. The canal network was still expected to provide drainage, but without maintenance, incoming rainwater flowed quickly along eroded ditch banks and deposited sediment on the canal beds. The ecological flow proved insufficient to mobilize the sediment, and its infiltration during dry periods prevented water from reaching the most distant sections and branches of the network. With a reduced or even non-existent water sheet in the ditch, aquatic environments were lost, and their characteristic species were replaced by a thick homogeneous cover of spontaneous vegetation, mainly of common reeds (*Phragmites australis*), which is a refuge and corridor for pests, such as the wild boar (*Sus scrofa*),

Projects and prospects

To address the current path of the lack of canal maintenance and degradation, three initiatives have materialized.

The landscape surrounding the lower transect of the Rec del Molí de Pals Canal, in the municipality of Pals, is a combination of rice paddies and wetlands (protected by the NPMMT) and residential-touristic developments, including a campsite adjoining the rice fields. The landlord of the agricultural parcels is also the owner of the campsite. He foresaw the use of his agrarian property and the canal as an extension of the green areas

of the campsite for the enjoyment of his customers. The pathways separating the parcels were arranged to facilitate walking and cycling activities. A two-story observational deck was built, and information panels were provided along with screens to guarantee the tranquility of the populations inhabiting the wetlands. Finally, a visitor center was installed. Maintenance of this transect of the canal is performed regularly by his employees.

In 2015, a research group at the University of Girona started to participate in an international EU-funded project (EUWATHER) that aims to describe the heritage values of artificial waterways and to make them known and hopefully revalued by society through a geo-spatial infrastructure and the design of heritage and landscape itineraries. Three itineraries corresponding to each of the main canals were offered in the Lower Ter area (Ricart, Ribas, Pavón, Gabarda-Mallorquí, & Roset, 2019). Visitors can download a free app and the itineraries on their smartphones become geo-located audio guides that offer information on the natural environment, architectural heritage, local traditions and artistic expressions related to the existence and history of the canals.

The Ter Vell Canal is the smallest of the three in the floodplain, although it represents a productive strip of vegetable gardens placed between the Ter River and the urban center of Torroella de Montgrí. In the urban transect, the canal is crossed by different roads and meanders through houses, making its maintenance a matter of importance. In response to the progressive decay of the course, the government of the municipality announced in early 2017 their intention to acquire the ownership of the canal and develop a recovery project that will guarantee its integration with the urban fabric and ecological functioning downstream. Officially, little is known about the project, although the mayor confirms that its main function must be public use as a restored resource for exercising and discovering the “natural world”.

Discussion

Definition

Based on the case study, it may be argued that unless historical irrigation canals can serve their single productive function (i.e. water distribution to crops), then they do not exist for governance structures at the European, national and regional scales. The regional administration promoted and conjointly financed the modernization project under the premise that it was necessary for the viability of the farming sector. National and EU structures also contributed financially. Once the works were completed, none of these institutions expressed concern for the future of the decommissioned network and none were involved in any of the projects that have been taking shape in the latest years. Water management policies in alignment with European regulations do not recognize irrigation canals as natural water bodies; hence, these canals are not even subjected to the water and habitat quality monitoring programs prescribed by the Water Framework Directive and its regional deployment. Biodiversity conservation strategies ignore these canals and only grant generic protection to the transects within the domain of the local natural park. Paradoxically, catalogued as part of the Natura 2000 Network, the last transect of the Ter River, which has a similar anthropogenic origin and ecological values as the historic canals, enjoys a very high degree of protection. By decoupling the productive function of the historical irrigation network from all other functions and treating the decommissioned canals as an obsolete and abandoned infrastructure, the involved public administrations adhered to the principles of neoliberal governance described in previous sections.

The views outlined by local stakeholders through document analysis and interviews reveal a definition of canals as either utilitarian assets or natural resources that are useful for draining excess rainfall, diluting grey water discharge, providing

habitats for biodiversity and connecting populations. The vast majority of new initiatives building upon the legacy of irrigation canals do so with a strong focus on cultural uses, with leisure, exercise and heritage discovery commonly shared by all of them. In accordance with these views, multifunctionality seems to be an indispensable component in the past and future configuration of the system, and it is defined as an amalgam of functions and services (Wilson, 2009). Nevertheless, while this conception brings the canals closer to the alternative principles presented in the literature review, it is difficult to define any of the emerging projects as truly integrative of the various dimensions and scales of the landscape and its processes.

The initiatives proposed for the urban transects of the Ter Vell Canal and the touristic discovery of rice paddies in Pals at the end of the Rec del Molí Canal adopt a very local perspective that could still be extended in similar forms to other sections of the network. The inventory and mobile app audioguide designed by the University of Girona offers a larger-scale approach but is solely focused on the heritage strictly linked to the canals, and it seldom considers the wider landscape and how the irrigation from the canals shaped it. Holistic initiatives involving the totality of the territory and several stakeholders, such as the inclusion of canal banks in the cycle path network or the creation of an organization to manage water in the Lower Ter, are in early discussion stages.

Planning and management

Since the completion of the works in 2011, the dominant management approach for the remaining canals has been the apparently most economic advantageous option: abandonment. From the narrow perspective of the neoliberal approach in conceiving canals as conduits for irrigation water, this outcome is fitting for ditches that no longer distribute water to the fields. However, this option has been observed to mask the

indirect costs in terms of ecosystem and cultural disservices, such as ditch erosion, habitat composition homogenization, pest dispersal, and built heritage structural decay.

In contrast, emerging projects promote a vision of the disused canals, their banks and associated heritage as a resource to support nonconventional local development strategies based on tourism, aesthetics, education and their use for recreational mobility and the promotion of public health. Nevertheless, in the context of the case study, each active stakeholder has unilaterally initiated action (according to that stakeholder's own criteria and preference) well before agreeing to or even considering the convenience of coordinated intervention. This situation has resulted in a range of management regimes, with most of them focused on very small transects and pursuing different goals, namely, from vegetation clearance for urban regeneration to investment in information panels and wildlife observation facilities. A proper integrated management and planning regime based on the enhancement of multifunctionality in the traditional agricultural landscape would require three ingredients at least:

1. Upscaling. Thus far, initiatives working on the canals affect individual courses or even some of their small transects. The maximization of cultural services and the delivery of ecological services in particular must target and treat the traditional irrigation network holistically (O'Brien et al., 2017; Riechers, Noack, & Tscharntke, 2017).
2. Resources. The failure of imposed minimum ecological flows to deliver the expected services indicates that a greater volume of water would need to be committed to maintain hydrological functions and support riparian and aquatic habitats. For public use, canal banks as well as the trees and routes alongside these banks would need to be adapted and looked after to ensure users' accessibility and safety.

3. Coordination. The diversity of competing views and management strategies does not necessarily imply the selection of one and the exclusion of others. In fact, research by Haase et al. (2012) and Queiroz et al. (2015), among others, suggests that synergies may exist in the delivery of ecosystem services. Despite potential positive interactions, trade-offs may also exist between different services; thus, planning prospectively and in coordination for the conditions that may grant their delivery is required (Haase et al., 2012).

Responsibility

Before the modernization of the irrigation infrastructure, agency and responsibility were very clearly and simply defined: private owners received money from the farmers' irrigation communities, who also took care of maintenance tasks (vegetation clearance, bank consolidation, bed dredging), to sustain the only function of the canals that was demanded and valued, i.e., water distribution. The leadership by stakeholders from the farming sector was also manifested during the modernization process, with the Department for Agriculture of the Catalan government yielding to the demands of farming organizations and jointly funding the pipeline construction project. In successive years, the same administration would ignore the canals and assign agency to the private owners of the ditches while arguing that such action limits public intervention in restorative projects.

This course of action seamlessly fits the neoliberal approach to manage the modernization of irrigation infrastructures described in previous sections, and it conceives water as a commodity to be consumed in the most cost-efficient way with the aim of maximizing agricultural yields and private profit. The scheme relies on an infrastructure that is made possible by the mobilization of state-like power and the vast

capacity of its institutions to provide public funding. The privileged relationship between the government and the irrigation communities provides yet another indication as to how power is leveraged to obtain the desired output for the most influential groups under the neoliberal doctrine (Robbins, 2012). The resignation of the government from the planning of the future of the historic canal network validates what Jessop (2002) identifies as a neoliberal rescaling of governance and the transfer of responsibilities to local levels, which frequently lack the resources to assume those responsibilities. In the case study, so far, these responsibilities have been borne by a municipal government, a university and an individual entrepreneur, who raised resources on their own.

These groups and other sympathizers testify to a change in the social perception of many ecosystem functions and services of agricultural landscapes from unproductive to valuable for tourism growth, local development, biodiversity conservation and obtaining the support of the electorate (Gandy, 2006; Gössling, 2002). While such changes are in alignment with the alternative paradigm to neoliberalism described in the literature review, it is difficult to describe the practice as community-based decision-making because each initiative has been led by a single stakeholder without coordination with other groups and lacking an integrated or holistic vision of the impact their actions may have on future land uses.

This spontaneous approach to landscape management has advantages as well as some pitfalls. In comparison with cases where a particular vision is served from the top down, the active involvement of local stakeholders guarantees a good alignment between local preferences and pursued targets. Local ecological knowledge as well as a deep understanding of the needs and demands of the local stakeholders and communities should also be expected to lead to better decision-making by local groups (Berkes, Colding, & Folke, 2000). Conversely, the legitimacy of private individuals or

even organized groups to transform the character of the shared landscape may be questioned (Stenseke, 2009). While the interviews indicated that all the initiatives were seen sympathetically by the rest of the consulted stakeholders, a greater saturation of projects or incompatible actions in the future may be the source of potential conflicts. Other disadvantages of not relying on a public authority to coordinate and support landscape planning and management efforts include the scarcity of funding and a shortage of power to negotiate specific policies, such as water flow regulation, with regional and national governments.

Conclusions

Socioecological systems constructed around historic irrigation canals are widely recognized as capable of satisfying multiple productive, environmental and cultural functions at different scales, thereby delivering concurrent ecosystem services that enhance biodiversity conservation efforts, assisting water management and favoring recreational purposes; thus, these canals hold value for local communities and visitors. The protection of the multifunctionality of agricultural landscapes, their integrated management and planning, and a requirement for inclusive decision-making processes are all enacted in EU policy. Our research has focused on the historical evolution and current condition of a historic irrigation network in Spain that has been recently replaced by pipelines. By exploring how the canals were conceived in the past and defined in the present and analyzing the management and planning regimes that have been applied and the role that different stakeholders have played and intend to play, our results and discussion indicate that work associated with historic canals represents a policy failure.

In the Lower Ter, the collusion of interests held by farmer irrigation communities and the regional government, which are arguably the most powerful

stakeholders in the territory, united around an ecological modernization discourse and under a productivity paradigm facilitated the advancement of monosectoral action, the segregation of functions and a severe disregard for the future of the decommissioned infrastructure and landscape functionality at large. The implementation of environmental impact mitigation has been revealed as insufficient to maintain ecological processes and cultural significance. This approach, which is characterized as typically neoliberal, collides with several EU regulations and endangers the perdurable existence of multifunctional agricultural landscapes and the multiple ecosystem services delivered by unlined historic irrigation canals.

Nevertheless, the research has also revealed how the inaction from state and regional public authorities has thus far been partially ameliorated by a private owner, a local council and a university spearheading a range of projects aiming to restore or build a new identity for the historic canal network. Overall, these initiatives reflect a "tertiarization" of uses and demands, with cultural and amenity functions replacing a productive vocation in the agricultural landscape and natural resources for the profit of private businesses. These results indicate that the complex reality of the Lower Ter is not completely aligned with the neoliberal project because counter-balancing dynamics are promoted by side-lined stakeholders that embrace the principles of multifunctionality, integrated planning and inclusive decision-making. Greater support from public authorities to facilitate coordination, boost the holistic planning of interventions, upscale them to the landscape level, increase water resources and execute maintenance works could greatly enhance the role of green infrastructure resulting from ecological modernization processes in the agricultural sector. Decommissioned historic irrigation canals could still make a significant contribution to nationwide strategies of biodiversity conservation, sustainable natural resource management, heritage

preservation and discovery, and public health enhancement.

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Figure 1. Location and detail of the study area. The main frame illustrates the courses of the Ter River, the three historic prime canals and the approximate irrigated domain (in gray).