Collaborative organizations involving outdoor recreational users in the management of biological invasions: A coproduction perspective

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Abstract

There is growing interest in collaborative actions in the field of biological invasion control. These actions now cover a wide range of situations, and it is important to better understand them in order to promote their development. This article proposes to reflect on this question based on the case of aquatic invasive plants through a study of projects involving the recreational users of lakes located along France's southwestern coastline. Drawing on analytical tools from service economics, I approached these organisations as coproduction processes. A mixed methods analysis showed that the organisations involving recreational users valorised the users' operational and relational competences but not their creative or expert competences. These organisations were conditioned as much by the settings in which the plants developed as by the plants themselves. In this context, the recreational users' involvement added a place-specific dimension to the management of the action, with flexible boundaries. However, this process was also accompanied by a tendency towards the micro-localisation of tasks as well as a certain specialisation in terms of responsibilities, neither of which were very compatible with the spatial dynamics of the plants. Only the professional technicians and managers seemed able to overcome these obstacles. This study hopes to fill a gap in the economic literature on biological invasions and to offer a complementary approach to the traditional public intervention strategies.

Introduction

With a view to developing more inclusive and participatory forms of governance, the idea of opening up the management of invasive species to a wider range of stakeholders, beyond just the specialists and professional experts, is gradually gaining ground (McNeely 2001, Niemiec et al. 2017, Pagès et al. 2019, Sa Dechoum et al. 2019, Shackleton et al. 2019). From this perspective, the recreational user is a highly sought-after actor (Bryce et al. 2011, Cole et al. 2016, Mameno et al. 2020, Levers and Pradhananga 2021). These individuals are often familiar with the environments and species in question. They spend time in the location and have resources at their disposal (financial, technical). Moreover, they can actually be the potential cause of an invasion because they may intentionally or unintentionally introduce the new species (Coetzee et al. 2009, Bruckerhoff et al. 2015, Cole et al. 2016). Opening up the management of invasive species ultimately implies the successful coordination of a group of stakeholders who are not necessarily used to working together. This is not necessarily an easy task given that, among other things, the group will have to deal with problems typically associated with the management of public goods and common goods (Perrings et al. 2002, Epanchin-Niell 2017, Graham et al. 2019). Although these two situations are not strictly identical, both carry the risk that some individuals might develop opportunistic individual behaviours and therefore not work in the collective interest (Perrings 2001, Van Vugt and Snyder 2002). To overcome these obstacles, one of the solutions favoured by economists is to identify the users' preferences (Garcia-Llorente et al. 2008, Mameno et al. 2020, Bougherara et al. 2022) in order to produce a socially optimal level of protection (Perrings 2001, Epanchin-Niell 2017, Courtois et al. 2018) and to put in place (financial) incentives to encourage a contribution from the stakeholders that is in line

with the benefits they will derive from managing the invasive species (Bravo-Vargas et al. 2019, Levers and Pradhananga 2021).

Many authors have pointed out the limitations of such strategies based on “command and control” type logics, including their inability to explain the emergence of collaborative actions (Lubell et al. 2002, John et al. 2006, Epanchin-Niell et al. 2010, Graham 2013, Ervin and Frisvold 2016). In the field, these actions cover a wide range of situations and have been grouped together under various designations, including “collective actions”, “grass roots community actions” and “community based actions” (Ayer 1997, Epanchin-Niell et al. 2010, Graham et al. 2019, van Dujin et al. 2021). Their diversity makes these “organisations” difficult to characterise (Epanchin-Niell et al. 2010, Uetake 2013, Graham et al. 2019). However, clarification is essential if we are to identify the conditions that foster their emergence and the levers of action for developing them. In this study, I propose to analyse these organisations from a coproduction perspective.

The concept of coproduction was first defined by Ostrom (1996, p.1073) as a “process through which inputs used to produce a good or service are contributed by individuals who are not ‘in’ the same organisation”. This initial notion has since been extended to clarify the nature of these “new” relationships linking producers and consumers (Prahalad and Ramswamy 2004, Filipe et al. 2017). Coproduction is notably at the heart of service (Gallouj and Weinstein 1997, Hill 1999, Gadrey 2000). The models that have been developed in this field are, moreover, not restricted to the service sectors stricto sensu, because the distinction between services and manufactured goods is becoming increasingly blurred (Saviotti 1996, Gadrey 2000). This is the case with the Gallouj and Weinstein (1997) model used here.

Inspired by Lancaster’s (1966) approaches to consumption, Gallouj and Weinstein (1997) proposed a general representation of services using vectors of characteristics (Fig. 1). These characteristics relate to human competences C_i and technical factors X_i (which both participate in the production process) and the end product Y_i that emerges as a result.

Figure 1: Economic representation of services according to Gallouj and Weinstein (1997)

Competences can be operational, relational, scientific, technical or creative depending on the tasks they relate to (Gallouj and Weinstein 1997). As their name indicates, operational competences are mobilised in the actual implementation of production operations. Relational competences refer to the activation and exploitation of relationship networks. Scientific and technical competences aim at productive knowledge and know-how, while creative competences refer to the capacity to imagine new solutions, generally by recombining available resources and options. Technical factors include both the material (capital, finance) and organisational (procedures, administration, etc.) components of production. Although Gallouj and Weinstein (1997) have never applied their analytical framework to the management of biological invasions, I believe it is well suited to the task for several reasons. Many operations in this area already come under the traditional service sector category (Delaney et al. 2008, Nuñez and Pauchard

2010, Richardson D.M. (ed) 2011, Cole et al. 2016, Hester and Cacho 2017). In addition, the restoration of an affected environment to combat an invasion is very much like a “physical” service (Miles 2003) or an “environmental service” (Perriet-Cornet and Aznar 2004), which can be defined as an intervention on a natural (non-commercial) good to allow its environmental use with the environmental attributes of the setting being either enhanced or left unchanged. The management of biological invasions also fits quite well with the dual interpretation of service activities (Djellal and Gallouj 2007) as either the nature of the operation carried out (the output) or the utility actually derived from it (the outcome). In the case of biological invasions, the output can be described by the management activities (monitoring, restoration, repair), and the outcome by the effects obtained. These effects cannot be defined a priori because they are dependent on the local ecological and social context. A number of studies have in fact shown the great diversity of potential associated impacts (Lovell and Stone 2005, Pimentel et al. 2005, Villamagna and Murphy 2010).

In summary, I propose to understand the coordination between the different actors involved in the management of aquatic invasive plants via the combinations of competences C_i and technical factors X_i mobilised as well as the outcomes Y_i produced. In this context, I will seek more specifically to characterise the organisations that involve recreational users.

Material And Methods

Study site

The lakes along the Aquitaine coastline began to form less than 4,000 years ago. Varying in size, they are characterised by a shallow average depth (generally <3m) and heterogeneous trophic levels (oligo-mesotrophic to hypereutrophic). They are interlinked by (artificial and natural) hydrographic networks within several drainage basins. The aquatic plant communities present specific features that are directly linked to the geological nature of the drainage basins and their water quality, which makes them important components of the regional natural heritage (Cellamare et al. 2012, Bertrin et al. 2017). However, these plant communities have been subject to the introduction of new species, some of which have been invasive since the early 1970s, in particular *Ludwigia spp, Lagarosiphon major, Myriophyllum aquaticum* and *Egeria densa* (Bertrin et al. 2017, Ribaudo et al. 2018).

At the time of the study, the spread of these plants had impacted human uses, especially recreational uses. These areas are popular for activities such as walking, bathing, angling, hunting, boating and many other nature-based sports (Dehez and Lyser 2021). Locally, the dense mat formed by the plants on the water’s surface hindered the navigation and movement of boats, particularly in some marinas, where the boats were no longer able to exit. In addition, the plants had blocked access to some shorelines, which was particularly problematic for angling areas. They had also disrupted the flow of some watercourses and drainage ditches, notably those with low flow, causing them to fill up and rendering them unable to act as a buffer when the water levels rose.

It is therefore hardly surprising that these aquatic invasive plants have been the focus of specific attention in this region of France for several decades (Thiébaut and Dutartre 2009, Ribaudo et al. 2018). On a technical level, the majority of interventions have consisted of the mechanical or manual removal of plants. These interventions are generally managed by local actors. This situation is symptomatic of a lack of provision in French policy at national level. For more than a decade now, the local authorities in question have been gradually replacing top-down actions with collective approaches, which have notably involved the recreational users of these lakes (Thiébaut and Dutartre 2009, Le Floch and Ginelli 2021).

Data collection

I took a twofold approach to analysing these organisations. One was focused at individual level, the other at collective level. Several different types of data were collected and processed using mixed methods.

In terms of the individual-level approach, the analysis was based primarily on semi-structured interviews conducted with individuals who were already involved or likely to be involved in the management of aquatic invasive plants. In addition to containing questions on the respondent's background and their roles and responsibilities within the organisation, the schedules addressed perceptions, knowledge and intervention methods relating to aquatic invasive plants (operations carried out, objectives targeted, effects observed, organisations and resources available, partnerships). In all, 28 interviews were conducted between 2018 and 2019, resulting in approximately 40 hours of fully transcribed recordings. A list of the interviewees is provided in the appendix 1. The sample was made up of individuals for whom plant management was a professional assignment (classified as "managers", n=17) and individuals who used the sites for recreational activities and engaged in plant management in an extra-professional capacity during their free time (classified as "users", n=11).

Regarding the collective-level approach, I compiled a database of 37 organisations reporting a local intervention on one or more aquatic invasive plants. Each observation was described using a set of 23 quantitative and qualitative variables (Appendix 2). One group of variables related to technical factors X_i: technological (techniques used), environmental (surface area of the lake, setting, plants observed), institutional (land ownership) and financial (presence of subsidies). Another group related to operational competences C_i and distinguished between those provided by the recreational users and those provided by the non-recreational users. These two categories were not mutually exclusive, thus allowing for the possibility of observations with offers of labour from both types of actors. Three of the variables represented the output (shoreline length treated, surface treated, duration of intervention). After examining the situation on the ground, I decided to retain three outcomes Y_i: "outdoor recreation", "biodiversity" and "hydraulics". The "outdoor recreation" outcome corresponded to the existence of a recognised leisure practice, possibly (but not necessarily) indicated by a facility. The "biodiversity" outcome referred to the presence of a notable species or environment that the invasive plants were competing with. The "hydraulics" outcome related to the capacity of the plants to limit the flow of water when too numerous. There were also four variables relating to the geographical location of the

observation (project name, *commune* name, lake name, *département*[1] name). A final variable was added to identify any other forms of involvement from the recreational users. This variable had two categories: a financial contribution from the user targeted specifically at the invasive plant problem (technical factors offer) and a contribution to the intervention specifications (expert competences offer).

I drew on multiple information sources: administrative documents, operation reports, interviews with actors and personal observations. As far as possible, the sources were crosschecked. The data analysed related to the year 2019. In terms of interventions, there were no unusual actions carried out in 2019, so the results give a fairly accurate picture of the usual type of management in place. Finally, it should be noted that all the case studies corresponded to a level of invasion that might be described as “intermediate”, in other words the plants were already present but had not reached levels beyond which the existing means of control would be considered futile.

I used nonparametric Fisher’s exact test due to the small sample size.

Ultimately, the observations were varied and, without claiming to be completely exhaustive, were spread over the entire Aquitaine coastal region (see Figure 2).

Figure 2: Geographical distribution of the 37 organisations

The eleven lakes included in the study had surface areas ranging from 6 Ha to 5,700 Ha and were located across 16 *communes* (5 in Gironde and 11 in Landes). Manual removal operations were the most common (n=20, 54%) followed by mechanical removals (n=9, 24%) and finally other techniques. The interventions lasted between a few hours and 50 days per year (a little over 8 days per year on average). They were located primarily on the shorelines (n=17, 45%) but also on watercourses flowing directly into or out of the lakes (n=8, 22%), in marinas (n=4, 11%), in protected areas (n=2, 6%), on private land (n=1, 3%) and on a sand trap (n=1, 3%). More than half of the interventions (n=25, 68%) were carried out annually, while the remainder were conducted on a more ad hoc basis (n=12, 32%). Almost all the observations related to public land (n=33, 89%). This last result is revealing on two counts. It shows, first, that it is much more difficult to collect information on private land than on public land and, second, that access constraints (linked to private land) shift the management of invasive plants onto collectives rather than individuals. In terms of the plants themselves, the most frequently managed was *Ludwigia spp* (n=16, 57%), followed by *Myriophyllum aquaticum* (n=11, 30%), *Lagarosiphon major* (n=9, 22%) and lastly *Egeria densa* (n=6, 16%).

Finally, although not an original objective of the study, I tried to triangulate the case studies with the semi-structured interviews, in particular by searching the actors’ discourses for the sites in which they were likely to be involved. I also therefore hoped to identify possible connections between the sites through the involvement of the same actor in different places.

[1] *Commune* and *département* are the names of administrative divisions in France.

Results

The valorisation of a quality workforce

Almost half of the organisations (n=16, 43%) involved recreational users in some way. These users were either local residents, boaters or members/representatives of angling or hunting associations. Other actors were present in 78% of the observations (n=29). This second group included local public authority representatives, protected area managers, nonprofit back-to-work organisations, private companies and schoolchildren. The recreational users' main contribution was operational competences (75% of cases). The statistical analysis showed that these competences were mobilised for specific actions.

Hence, the indicator variable for the recreational users' operational competence was significantly linked to type of setting (Fisher's exact test, P=0.0362) (predominantly shorelines (83%)), presence of *Ludwigia spp* (Fisher's exact test, P=0.00416) and intervention technique (Fisher's exact test, P=0.00285) (predominantly manual techniques (60%)). These results clearly related to *Ludwigia spp* removal projects, which are difficult to undertake by mechanical means except in physically and legally accessible places. The analyses also revealed no statistical association between this variable and the "outdoor recreation" outcome. However, this outcome was identified in two thirds of the observations involving recreational users. It could therefore be argued that, in this context, the objective of restoring recreational uses was a necessary but not sufficient condition for the recreational users' involvement. In the marinas and sailing zones, for example, this form of involvement did not seem to exist (Table 1), probably due in part to the parking charges and sailing fees that the boaters had to pay.

Table 1: Recreational users' operational competences offer according to setting

It should be noted that the users themselves were aware of the value of this contribution. One angling association member said: "you've got some technicians who are more – no offence – used to doing office work and then others who are more hands-on like us. So they realised we were doing a lot of the work"[2]. From the managers' point of view, this type of workforce was not just valuable because of its low cost. It was also seen as producing "very, very good results as far as the mechanics of the operation were concerned. And actually I'd say we exceeded the initial objectives of keeping the vegetation under control, because it's (the plant) been eradicated in some sections" (river technician). This labour quality then impacted at a financial level because "on the costs, well right, to give you an idea, from memory, the first year, we had 20,000 euros and did 5 kilometres worth of work. This time, we've got 15,000 euros, and we're gonna do, say, about 25 kilometres" (river technician).

With regard to relational competences, the recreational users mobilised were generally members of associations or at the very least members of established networks. Membership of some kind of a

collective was thought to increase the potential number of volunteers. For example, one municipal technician working in the Landes *département* said: “it’s really hard to get members or even people from the office to come along. It’s really the people who are the driving force in their organisation. Because I know that here you can normally always rely on them when it comes to X. The president, Mr Y, who’s also quite aware of this, generally always brings along 4 or 5 people with him when he comes”. Similarly, one hunting association member explained that the volunteers were “people who know us very well. They know what we do. They come along, well I’m not gonna say they come for us, but because it’s us. Cos they know that if we’re doing it, there’s no problem. We’re quite well supported in these things”. This is an important point. It could explain the relative failure of numerous calls for volunteers launched without an organisation as an intermediary. One river technician, although experienced in organising these projects, confirmed that “you need associations behind you”. He told us: “we tried getting volunteers like that by putting up posters, especially on X, like, on such and such a day we’ll be carrying out manual removal works in coordination with the *communauté de communes* (local federation of *communes*) and Y. Everybody’s welcome. Bring your friends. (…). We never got a single soul”.

By contrast, any potential expert or creative competences were rarely made use of: “anyway he (the river technician) also tells us what to do and what not to do. And thank goodness! Thank goodness! It’s only right cos, if not, we, we haven’t got the knowledge they have either or that they can have, or you. We haven’t studied these things, we definitely need guidance, it’s important (…)” (angling association member).

In order to be valorised, it seems the users’ operational competences also had to be linked to complementary characteristics or, on the contrary, to be substituted for others. It was therefore quite surprising to find that only 11% of the projects simultaneously combined the operational competences of recreational and non-recreational users (Table 2).

Table 2: Distribution of organisations according to origin of operational competences (recreational and non-recreational users)

In other words, these competences were apparently mutually exclusive. When one type of competence was mobilised, there was little chance the other would also be active. All in all, based on these admittedly rather crude indicators, this result ultimately reveals a reality where cooperation is not necessarily self-evident.

The financial factor, on the other hand, was found to be an important lever. The results showed that the presence of financial support was statistically linked to the techniques used (Fisher's exact test, P=0.00124), the frequency of operations (Fisher's exact test, P=0.00074), the type of setting (Fisher's exact test, P=0.0362) and the presence of users’ operational competences (Fisher's exact test, P=0.0727). Financial support was targeted principally at manual operations (representing 80% of the observations with financial support) carried out by recreational users (83% of the observations with financial support) and repeated annually (80% of the observations with financial support). The presence of financial support was also statistically linked to the *département* in which the project was located (Fisher's exact

test, P=0.00588). The localised nature of the economic instrument was not the only factor that led to this spatialisation. As we shall see, the demand for outdoor recreation also played a determining role at this level.

I have already shown that the users were mobilised to carry out specific tasks. The triangulation of the 37 collective actions and 28 individual interviews confirmed that this involvement was, moreover, very geographically localised. The recreational users were involved in a mean of less than one site per individual (0.82), with a median of 1. By comparison, the mean involvement of the managers was 5.36 per individual[3], with a median of 3. Of course, this distribution was not entirely unrelated to the status of the people interviewed. Angling association members will tend to focus primarily on the maintenance of their fishing grounds, hunters on their hunting grounds, boaters on the marina where they moor their boat, and so on.

An examination of project size provides further insights (Table 3).

Table 3: Surface area, shoreline length and duration of restoration projects, with and without recreational users' operational competences

The sites where recreational users provided labour were smaller than those at which they had no involvement, in terms of both surface area (0.60 hectares compared to 4.53 hectares) and (restored) shoreline length (1,559 metres compared to 2,042 metres). The intervention duration was also shorter (3.25 days per year compared to 11.59)[4].

This tendency towards micro-localisation reflects not just the localisation of uses but also the recreational users' attitudes towards the plants. In particular, the users reported that they no longer sought eradication, which was considered unrealistic, but rather to simply "live with it" (Le Floch and Ginelli 2021). As one hunting association member put it: "At the start, we didn't any attention to it. It was over there, at the side. We weren't worried about it. But then we did become concerned when it reached the marina (…) So we just do our little bit to try and keep it under control. No, no, eradicate, no, anyway it's impossible in my opinion, for the Lagarosiphon major."

This micro-localisation of involvement also reveals coordination and conflict of use problems. These could be explained by the negative effects of too much "geographical proximity" between the stakeholders (Torre and Zuindeau 2009). As this angling association member said: "I don't really like this new canoeing plan. I mean, no one likes it cos everything people used to see on the shoreline when they went by, it's suddenly just gone. We won't be able to fish anymore. So it's gonna be war. There's gonna end up being a fight about it. Cos even with rowing on the lake now, the guys come up to within 10 metres, or even closer, it's just, if they get caught up in your lines. Same with the paddleboarders. And the windsurfers. Well, not the windsurfers, the sailing boats."

In this context, only the biological invasion professionals and the natural environment managers seemed to be able to forge relationships between the different initiatives, notably through their sociotechnical

networks. Three of the managers reported they were involved in more than 15 of the organisations included in the sample, three were involved in 7 to 8 organisations, and four were involved in 3 to 4 organisations. As one municipal technician stated: “the rivers association took over the territory of… of X, of all the streams, and they had a certain experience that we didn’t necessarily have. We work more and more often with them now and much better as well and that means we get to, well, to share techniques, ways of doing things and … and to work together.”

[2] All data extracts have been translated into English.

[3] These figures are primarily given for illustration purposes because the presence of ex aequo values do not allow the application of statistical test (Wilcoxson test).

[4] For the same reasons as above, these figures are given for illustration purposes.

Discussion

The organisations based on stakeholder cooperation seemed to offer new opportunities for the management of biological invasions. Their approaches varied across a spectrum that ranged from the “classic” top-down public intervention at one end to the fully decentralised system at the other, two solutions that still tend to dominate in the economic literature (van Dujin et al. 2021). To date, there has been little research conducted on this topic. However, a better understanding of the nature of these organisations would help to increase their scope (Graham et al. 2019). In this context, this study consolidates the findings of a number of previous studies and offers new insights. A coproduction analysis drawn from service economics (Gallouj and Weinstein 1997, Gadrey 2000, Perriet-Cornet and Aznar 2004) gives a better understanding of how the different factors (human, technical and environmental) combine in these organisations. By reducing the classic gap in economics between supply (the manager) and demand (the user), coproduction highlights new forms of interaction between the actors.

In relation to the classification proposed by Graham, Metcalf *et al.* (Graham et al. 2019), the most relevant category for the organisations analysed here is “organised coalitions”, which combine institutional and private actors. Cooperation was encouraged by the public authorities. The users did not own the resource that required management (Epanchin-Niell 2017). The priority was to federate as many actors as possible (Epanchin-Niell et al. 2010, van Dujin et al. 2021) rather than try to combat the “weakest link” within the organisation (Perrings et al. 2002).

The mixed methods approach used here, which was drawn from the social sciences, has seldom been applied in the Invasion Sciences (Epanchin-Niell et al. 2010, Niemiec et al. 2017). The qualitative analysis of the interviews identified the role of the relational and expert competences, which would otherwise have been difficult to determine (Pagès et al. 2019, Le Floch and Ginelli 2021), and provided an understanding

of the ways in which the managers established links with other organisations. The quantitative approach enabled a gain in generality beyond just the site-specific context.

A recurring characteristic of the organisations was their valorisation of the recreational users' operational and relational competences. These relational competences correspond to the social capital and networks notions, whose importance has been repeatedly highlighted in previous research (Graham 2013, Cole et al. 2016, Niemiec et al. 2016). The lack of expert and creative competences offered by the recreational users could be seen either as a limitation or, as I prefer to see it, as the first step in a dynamic coproduction process that could be developed further in the future (Filipe et al. 2017). The findings also reveal that this labour supply was valued for its quality and that the contributions of the different actors were not interchangeable. This shows that labour, an essential input in economic production analysis, was not a generic factor. Even in the case of these "basic" operations, it is essential to think in terms of competences. These findings support those of Ervin and Frisvold (Ervin and Frisvold 2016), who showed that subsidies have a determining influence on system sustainability. They also confirm the importance of environmental factors alongside technical and human factors in organisations. More precisely, they show that these environmental factors are multiple and that they relate to the settings in which the plants develop as well as the species themselves. In addition, the settings do not just have a physical influence, because institutional aspects (accessibility, responsibility, financing) can also condition the modes of organisation.

Finally, this study has revealed the specificity of organisations involving recreational users compared to those mobilising other categories of stakeholders (farmers, residents, etc.). There is already evidence in the literature of the influence of recreational uses on people's perceptions of the impacts of invasive species and their attitudes towards them (Shackleton et al. 2018) as well as on their willingness to give money to help combat invasions (Garcia-Llorente et al. 2008, Garcia-Llorente et al. 2011). This study has shown that recreational uses also influence the nature of the organisations in which recreational users will participate. This influence manifested here primarily in the location, size and frequency of the interventions. Furthermore, the recreational users seemed to prefer a micro-localisation of the operations, which was not entirely compatible with the movements of the invasive species. This reinforces the importance of managers in terms of facilitating and coordinating the interventions (Donaldson and Mudd 2010, Thomsen and Caplow 2017). The managers observed in this study often acted beyond their initial field of competences to set up new forms of cooperation. This confirms the need to think in terms of "flexible" boundaries (Barker 2008, Graham et al. 2019) and to make management tools place-specific (Nuñez and Pauchard 2010).

This study had a few limitations, however. First, despite a major data collection effort, the database on the organisations was relatively limited in size. The statistical tests nevertheless revealed the significance of the relationships identified within the sample. The method used here can therefore be easily replicated, and the indicators can be applied in other contexts (geographical, political, environmental) to increase generality. The relationships between the actors and the organisations that were identified by triangulating the interviews and the organisations database could be analysed in greater depth, in

particular using network analysis tools (Cole et al. 2016). Finally, the actors involved in the organisations examined here were probably more heterogeneous than our results suggest. Moreover, even the “free” recreational users, in other words those not affiliated to any association, had difficulty in embracing these initiatives. This finding just seems to confirm the complementarity of the approaches developed in this study and those that focus on revealing individual preferences rather than any conflict between them (Garcia-Llorente et al. 2011, Bougherara et al. 2022). This diversity perfectly reflects the rich insight that the human and social sciences can bring to the field of biological invasion control (Kueffer 2013, Simberloff et al. 2013, Vaz et al. 2017).

Declarations

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Tables

Table 1
Recreational users' operational competences offer according to setting

		Setting				
		Shorelines	Hydraulic networks	Marinas	Sailing zones	Total
Recreational users' operational competences offer	Without	0	0	1	3	4
	With	10	2	0	0	12

Table 2
Distribution of organisations according to origin of operational competences (recreational and non-recreational users)

		Non-recreational users		
		Without	With	Total
Recreational users	Without	0%	67%	67%
	With	22%	11%	33%
	Total	22%	78%	100%

Table 3
Surface area, shoreline length and duration of restoration operations with and without recreational users' operational competences

	Shoreline length treated (m)	Surface area treated (Ha)	Number of days per year
Without recreational users' operational competences	2,042	4.53	11.59
With recreational users' operational competences	1,559	0.60	3.25
Total	1,766	3.87	8.35

Figures

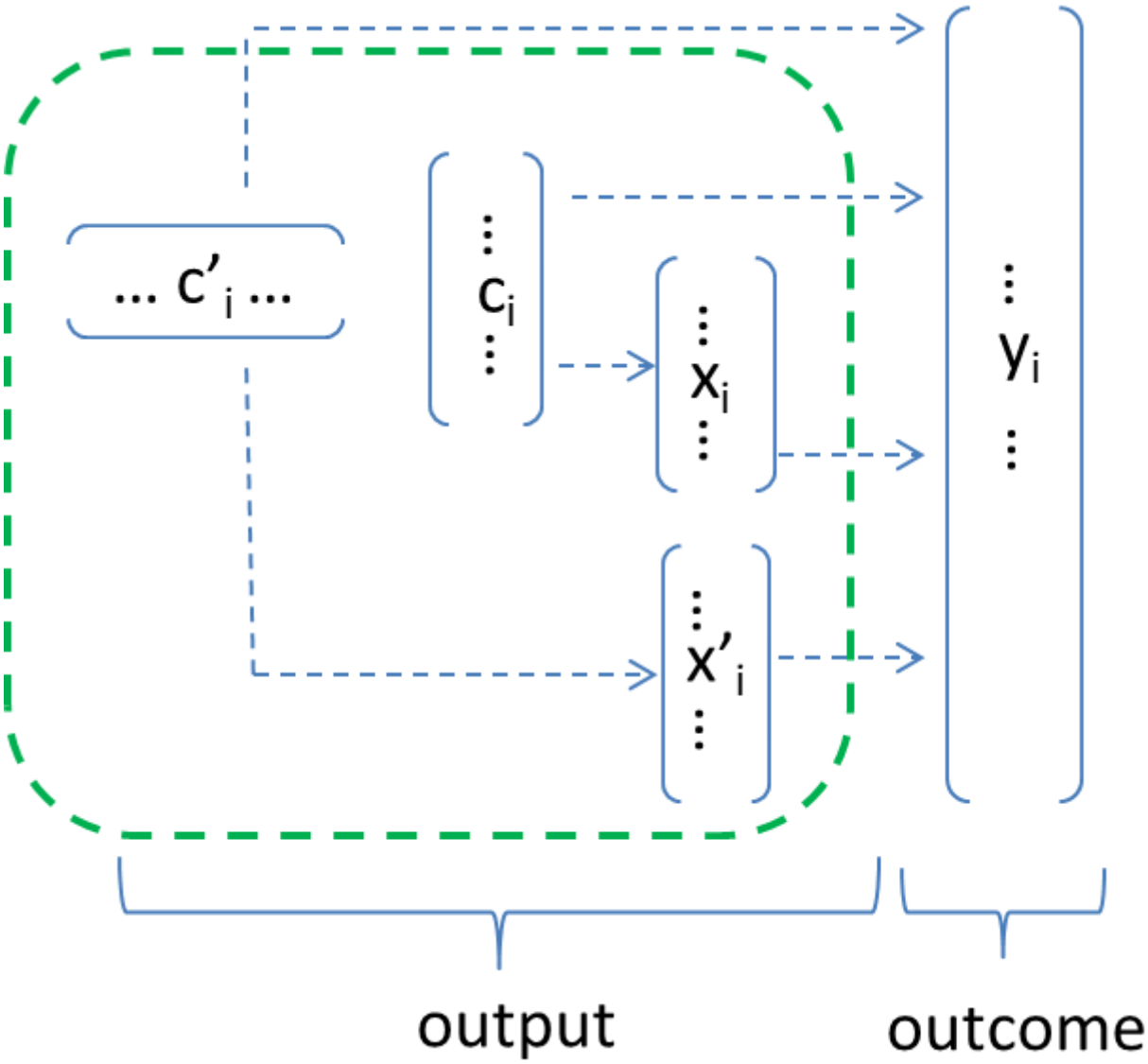

Figure 1

Economic representation of coproduction according to Gallouj and Weinstein (1997)

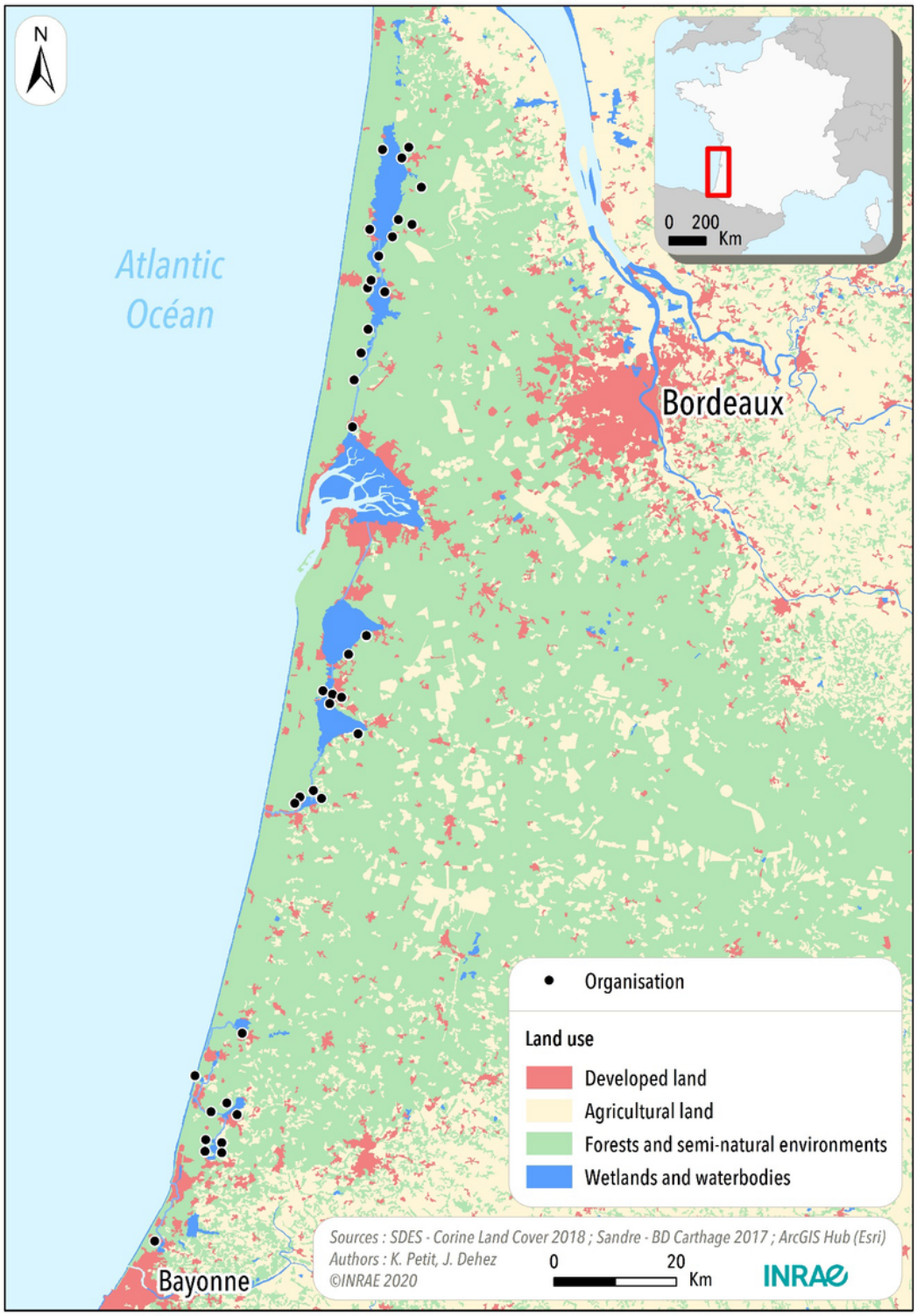

Figure 2

Geographical distribution of the 37 organisations

Supplementary Files

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- Appendix12.docx