Incorporation of Local Knowledge in the Identification of Ria de Aveiro Lagoon Ecosystem Services (Portugal)

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ABSTRACT

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Coastal lagoons, such as Ria de Aveiro, are of strategic importance as they play a crucial role in almost all biogeochemical processes that sustain the biosphere and provide a variety of services, which are essential to the human wellbeing. Due to their potential vulnerability, to the increased human-related activities and pressures, the management of these systems requires an integrated and ecosystem based approach with close engagement of civil society. It is in this context that this research aims to include the population knowledge in the identification of Ria de Aveiro ecosystem services. In the scope of the EU-FP7 LAGOONS project 9 Focus Groups with the coastal lagoon inhabitants have been developed, in order to combine different scientific disciplines with local knowledge and stakeholders' views. In these sessions the participants freely discussed the topic of 'Ria de Aveiro', and identified the types of uses and activities, discussed the current management model, and presented some recommendations for the future. This paper uses this privileged contact and proximity with local population to analyse the ecosystem services that participants indirectly identified. Relevant examples are the use of the lagoon for recreation, fishing or education-research activities. In terms of results, participants mainly identified provisioning and cultural services; however, even indirectly, they show some concerns regarding regulation and support services. Participants recognized the dependency of their uses and activities to a healthy ecosystem. The incorporation of their knowledge and concerns in the Ria de Aveiro management strategies is very important, since it has a pedagogical role and if people identify themselves with the decisions, they will accept them and enforce the compliance by the various users of Ria.

ADDITIONAL INDEX WORDS: *Estuaries, End-Users, Ecosystem Services, Focus Groups, Governance.*

INTRODUCTION

Researchers have identified coastal lagoons, such as Ria de Aveiro, as ecosystems of strategic importance as they play a crucial role in almost all biogeochemical processes that sustain the biosphere and provide a variety of services and functions that have greatly contributed to the mankind growth and development (MAOTDR, 2009). As already highlighted by several authors (e.g. Daily *et al.*, 1997; Emerton and Bos, 2004; MA, 2005; MAOTDR, 2009; Stuip *et al.*, 2002), coastal lagoons play, for instance, a fundamental role in the hydrological cycle by storing, regulating and recharging both surface and sub-surface water supplies, as well groundwater. By acting as reservoirs and "sponges" for holding water, coastal lagoons delay and even out peak flow releases (attenuating downstream flooding) as well as release water in the dry season to maintain flows. Coastal lagoons also absorb, filter, process and reduce the availability of nutrients, pollutants and wastes. They tend to have a high primary production, providing a rich source of nutrients for all forms of life, including fish, and are favoured breeding grounds and nurseries for both freshwater and marine species. Also, a wide range of products is harvested from coastal lagoons such as fish and other aquatic species, construction materials, fuel, wild foods and medicines, fodder and pasture. They play an important role in the global carbon cycle, acting as sinks for carbon and reducing its emission. Furthermore, coastal lagoons provide protection from natural hazards by acting as a protection strip on the coast, mitigating the vulnerability of coastal areas to rising sea levels and erosion.

However, these systems are among the most threatened in the world (MA, 2003) and the services they provide are becoming increasingly vulnerable (Agardy, 2010), experimenting biological, physical, chemical and social transformations, mostly forced by external pressures resulting from anthropogenic actions that can be exacerbated by climate change (IPCC, 2007). Moreover, as human population and consumption increase, drivers of ecosystem change intensify, and feedbacks among ecosystem services and human wellbeing become stronger and more complex (Carpenter *et al.*, 2009; MA, 2003).

Since that it is at local level that the changes and impacts on natural capital and ecosystem services may be more intensely experienced, it is necessary a decentralised and localised governance model (Müller, 2012). Given that local communities' wellbeing is strongly dependent on coastal lagoons' services,

alternative ways to add local knowledge to the governance model have to be addressed.

The future state of these social-ecological systems will depend on the ability to combine social, economic and ecological interests (Gooch, 2007), which requires an integrated and ecosystem based approach with close engagement of civil society.

It is in this context that we use the results of a deliberative and participatory study (Focus Groups), carried out with end-users of Ria de Aveiro, to analyse the ecosystem services that participants indirectly identified, and to understand their perception about their role in Ria's management.

This study has been carried out in scope of the international project LAGOONS (7th FWP - ENV.2011.2.1.1-1), which aims to develop science-based strategies and decision support frameworks for the integrated management of lagoons, based on an increased understanding of land-sea processes and the science-policy-stakeholder interface.

STUDY SITE: RIA DE AVEIRO COASTAL LAGOON

Ria de Aveiro is a shallow coastal lagoon located in the northwest coast of Portugal, integrating the Vouga river catchment area. It is a mesotidal system, 45 km long and 10 km wide, covering an area of 83 km^2 at high tide, and 66 km^2 at low tide (Dias and Lopes, 2006). It is characterized by narrow channels and inner bays, and by large areas of sand and mud flats, and salt marshes that become exposure during low tide (Figure 1).

Ria has 158 740 inhabitants (INE, 2011) in the adjoining parishes and plays a crucial role on the regional and national economy, contributing directly to more than 12% of the overall added value of the Baixo Vouga region (PLRA, 2011). It houses the Aveiro Harbour, industrial parks in the margins, fishing, aquaculture and tourism activities. In addition, Ria also supports traditional activities, such as salt-production, artisanal fishing, shellfish collecting, bait digging and recreational fishing. The sport activities in the lagoon (*e.g.* kitesurf, surf and sailing) are also very important for the local community, contributing to the local tourism growth. The high productivity of the lagoon also contributes to the local economy through the commercial exploration of species with high commercial value, *e.g.* bivalves, crustaceans and fish (e.g. Lillebø *et al.*, 2011).

From the ecological point of view, Ria de Aveiro coastal lagoon is a significant area in the national context, being the habitat of several species of flora and fauna that are supported by the dynamics of the lagoon. Ria de Aveiro ecosystem comprises a complex system of natural values and functions arising from the confluence between the coastal and inland waters and biodiversity, presenting a large number of habitats, which include: seagrasses beds, salt marshes including extended areas of reeds, intertidal mudflats, salt pans, rice fields, coastal dunes and agricultural areas (ICNB, 2006; PLRA/AMBIECO, 2011)(Figure 1). These wide ranges of habitats are used as nursery areas for many valuable species that include bivalves, crustaceans, fish and birds. Ria de Aveiro is classified as a special area of conservation under the EU directive on the conservation of wild birds (79/409/EEC). Under the Berne Convention it has several species classified as protected, strictly protected or as endangered. In its northern part, between S. Jacinto and Torreira, there is a nature reserve *'Reserva Natural das Dunas de S. Jacinto'*. Moreover, from the conservational point of view, this system is considered a high priority since it is a fundamental step in the migration of aquatic birds and an ideal place for winter shelter and nesting (ICNB, 2006).

However, the lagoon and surrounding areas are subject to a set of territorial management tools and other strategic plans, whose
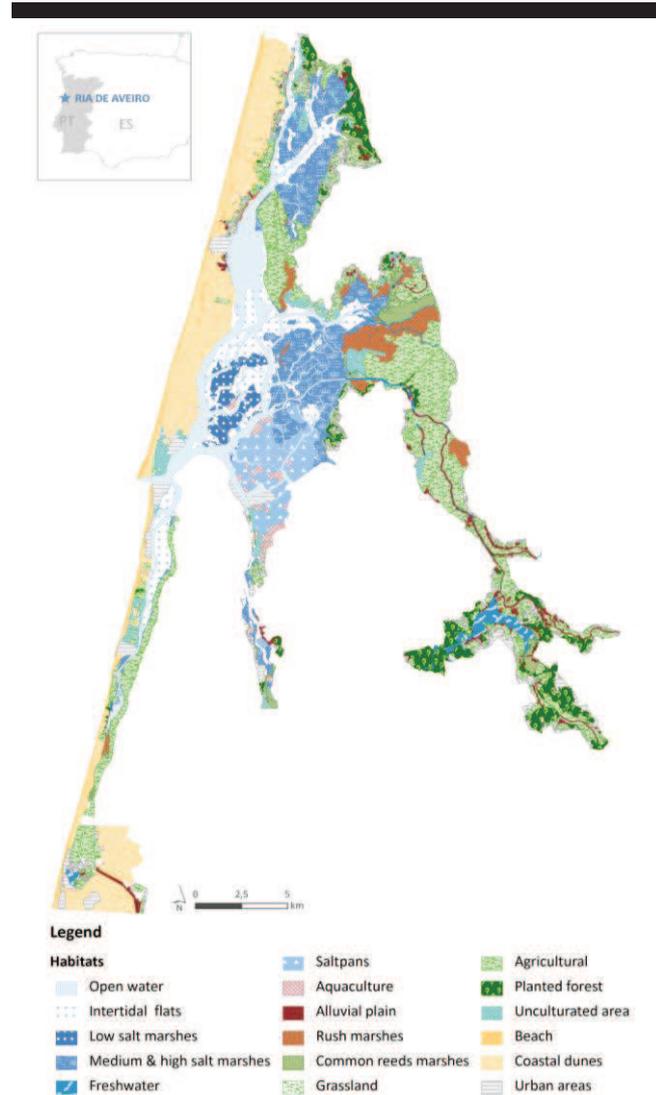
Figure 1. Ria de Aveiro's habitats (Source: data from PLRA/AMBIECO, 2011).

management and articulation is foreseen as complex, involving some constraints that require the coordination between several entities (Sousa *et al.*, 2011).

METHODS

A deliberative and participatory approach so-called Focus Groups was used as a first step for engaging local and regional end-users. Focus Groups can be used to obtain the experiences, opinions, wishes and concerns of a small group of users (Kitzinger and Barbour, 1999; Kress and Shoffner, 2007). This qualitative method can be used in a variety of contexts and in different stages of a research project as the main tool or in combination with other methods (Gooch, 2012). In the present work, the purpose of Focus Groups was to initiate the communication with the Ria end-users and to identify relevant issues, conflicts, concerns and existing responses to change.

A few open questions were structured to lead the discussion into the field of interest. These questions focus on the uses of the lagoon, most important aspects, changes on the lagoon, lagoon's management, tourism and recreation, development in/around the

lagoon and desired future wishes. The moderator was asked to leave the development of the discussion to the participants and only slightly control the discussion by keeping them on subject and helping them along when they get stuck (Gooch, 2012). The idea behind this is that participants can react and discuss freely around a general question and then, by the help of the script, are lead in more focused way to the key subject of the study (Gooch, 2012).

At the end of the session, the participants were asked to identify three locations of concern and three locations that they enjoy on the Ria de Aveiro lagoon map through the use of red and green stickers.

In order to have a better group dynamic, the groups should be small, between 8-10 participants, to encourage a close connection to the discussion and to provide a better opportunity to give voice to ones opinion (Gooch, 2012). A snowball approach or the identification of a contact person, were two proposed methods of participant selection. In the second one, a contact person is recruited as a participant and through that person new participants are then recruited. The snowball method is similar: a participant is recruited and is responsible for recruiting a new participant, which recruits another one and so on (Gooch, 2012).

Focus Groups in Ria de Aveiro

In the case study of Ria de Aveiro, 9 Focus Groups were conducted between April 2012 and January 2013, with a total of 74 participants (80% men and 20% women): 6 with local citizens of coastal parishes (Torreira, Murtosa, Vera Cruz, São Jacinto, Glória, and Gafanha da Encarnação), 1 with Gloria parish staff/council, 1 with students, technicians and researchers of University of Aveiro, and 1 with members of hunters and fishermen's association of Avanca Parish (Figure 2). The idea behind this was to capture the local knowledge, specificities and perceptions in the different coastal parishes, because it is noted that, in spite of a shared identity, local traditions, uses and activities vary according to the spatial distribution of habitats, species and physical characteristics of the lagoon. The participants invited to these Focus Groups were common citizens, inhabitants of coastal parishes, with different relations to Ria de Aveiro: some were closely related to the lagoon and use to gain their income directly from Ria resources, others were related through family members, traditions or just because live nearby the lagoon. On the other hand, it was intended to have the perception of students and researchers of the University that are from other regions and have a different connection with the lagoon. Additionally, because the recreational hunting (an important activity in the lagoon area) was poorly represented, an additional Focus Group was organized.

The Focus Groups in coastal parishes were created with help of contact persons (the mayor of each parish), which were recruited as participants and then invited new participants. It was clear that the aim of these sessions was to freely discuss the issue of Ria de Aveiro, and that participants did not need to have any scientific or technical knowledge. The same method was used in Avanca, but in this case the contact person was the president of hunters and fishermen's association. In the academic group, the snowball method was used: some students were invited and they recruited other ones.

In all sessions, the participants signed a consent form of free and informed participation and authorized the audio recording of the session, to support its analysis.

The number of participants and their background varied in the different Focus Groups:

- **FG1 – Glória Parish (I).** This was the first session and it had the particularity of having all members of the governing body
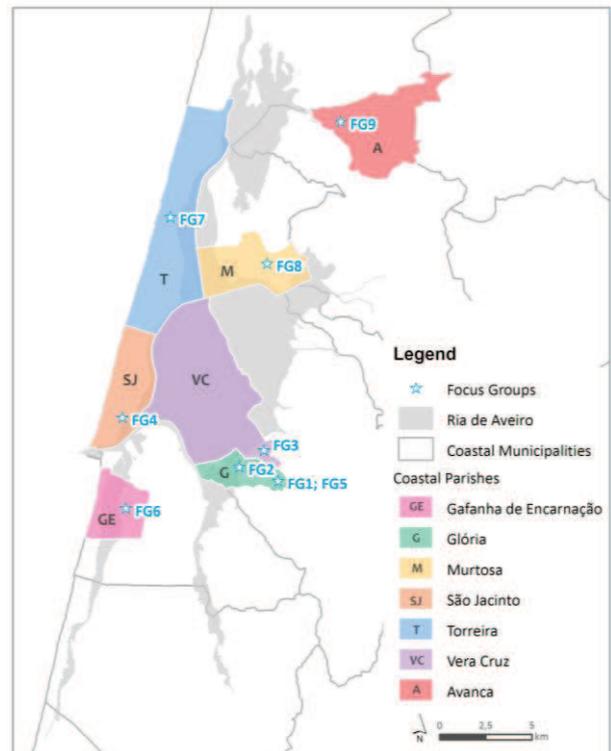
Figure 2. Distribution of the Focus Groups in Ria de Aveiro.

of the parish council. The four participants were found to be users of the lagoon for many years through recreational fishing and admires of the landscape.

- **FG2 – University of Aveiro.** The majority of the participants (7 in 8) were not born in Aveiro, but were studying or working at the University of Aveiro (from 3 to 12 years). Their use of the lagoon was mainly in the Aveiro city channels related with recreation, leisure, landscape appreciation and also research work.

- **FG3 – Vera Cruz Parish.** This session was attended by three amateur fishermen and one marketing student of University of Aveiro, who admires the landscape. It was marked by the dominant participation of one participant.

- **FG4 – São Jacinto Parish.** The majority of participants (6 in 7, being the other one the mayor of the parish council) belong to the local community of fishermen with significant knowledge of the lagoon.

- **FG5 – Glória Parish (II).** This session was the second one in the Glória parish, but with different participants (2 members of the parish council and 9 members of the community). Their use of the lagoon was diverse, e.g. exploitation of saltpans, harvesting of reeds and seagrasses, hunting and fishing, transport, nautical and sport activities. Furthermore, some participants demonstrate interest for the theoretical and scientific study of the lagoon.

- **FG6 – Gafanha da Encarnação Parish.** In this session there were eight participants with a long and direct contact with the lagoon. The professional activity of most participants was directly related with the lagoon, e.g. fishermen, shellfish exploitation, boat building and transport of tourists in the lagoon. Others used the lagoon for recreation, such as sport fishing and sailing.

- **FG7 – Torreira Parish.** The professional activity of all participants, except the mayor, was related with fishing, showing a high knowledge of the sector in the lagoon: a member of the fish producers cooperative, a member of a purifying company and four fishermen (one of them with licence to collect shellfish).
- **FG8 – Murtosa Parish.** This session had a large number of participants (15), with different relation to and levels of knowledge of the lagoon. Some use the lagoon for recreation and leisure, others for fishing, tourist transport and seagrasses harvesting.
- **FG9 – Hunters and Fishermen's Association of Avanca Parish.** This session was attended by 10 members of the association. Their use of the lagoon was mainly related with recreational hunting and fishing, but some of them were rice farmers and land owners.

RESULTS: ECOSYSTEM SERVICES PROVIDED BY RIA DE AVEIRO

Ria de Aveiro, like the generality of coastal lagoons, provides essential services of ecological, economic and social importance, especially for the local/regional community. During the Focus Groups, the participants mentioned several services provided by Ria de Aveiro such as the navigability of lagoon channels, allowing the transportation of people and goods and the communication through public transport (ferry and speedboats), touristic transport (traditional boat *'moliceiro'*), private vessels and traditional boats (such as *'bateiras'*, *'mercanteis'* and *'moliceiros'* formerly used to transport raw materials and now mostly used for tourism). The harvesting of raw materials such as seagrasses, reeds to be used as fertilizers in agriculture, sludge to enrich soils and sand was once a common activity that is currently done on a very small scale. The fishing and shellfish harvesting were mentioned as important activities for the local economy, being the income of several families. They reported the diversity of fish and shellfish of commercial value (such as lamprey, eel, bass, bream, sole, cuttlefish, crucian carp, flounder, crab, cockles, oysters and clams). The salt production was once an important economic activity however at present only a few saltpans are working, having been replaced by aquaculture that is an emerging economic activity in the region. During low tide some users harvest the solitary tube worm (*Diopatra neapolitana*, *'casulo'*) to use as bait for fishing. Hunting was also referred as an activity in the lagoon. In the lagoon there are several small ports for local fishermen, population and recreational users, and a commercial harbour that plays a crucial role in the regional economy and whose activity has a strong influence in the lagoon's system, namely on bathymetry, tides, currents and water velocity. There are several uses related with leisure, recreation and sport activities such as landscape appreciation, walking and biking on the banks, swimming, sailing, rowing, kayaking, windsurfing, kitesurfing, recreational fishing and others that contribute to the local economy and identity. In some areas of the lagoon, the land is used for agriculture and livestock, where the certified *'marinhoa'* breed (indigenous specie) is produced. According with some participants, rice and flax production was a common practice in the lagoon's islands, however is no longer the case.

The educational value associated to the traditional activities, such as salt production, and the local and scientific knowledge (through the existence of museums and guided tours) was stressed out, attracting visitors from schools and others. Also, the role of research in the study, monitoring and management of the lagoon was mentioned. Furthermore, some participants showed theoretical interest for the history of the lagoon and their

elements/components (e.g. traditional boats), stressing out the Ria's inspirational value from which resulted some books, such as *"A Ria de Aveiro – Um olhar resvés"*.

Several traditional products (including food and cosmetics) and handcraft were mentioned such as salt soap, salt foam, salt exfoliating, flavouring and aromatic salt, flower of salt, samphire, fish and shellfish.

The scenic value of Ria de Aveiro was constantly mentioned in the sessions by the participants, to which the traditional architecture (e.g. *'palheiros'*), boats, activities and biodiversity also contributes.

Also the local knowledge and the sense of place were emphasized, in part because of participants' nostalgia for the traditional activities that are vanishing, remaining almost only for tourism and educational purposes.

The religious values were mentioned in association to the uses of the lagoon and to the drawings in traditional boats (*'moliceiro'*). Some festivals were referred in association to the start and end of salt production, and to the moliceiro's summer regatta.

A set of these ecosystem services, such as gastronomy, traditional products and handcraft, traditional architecture, activities and boats, the semi-natural landscape and the conditions for navigation and recreation attracts tourism for this region, contributing to the economic growth.

Although most services identified are provisioning and cultural, the participants recognized the importance of vegetation, e.g. reeds and salt marshes for soil-sediment retention/erosion control in the banks. In addition, they refer the plant and animal biodiversity of the lagoon and the importance of Ria as habitat, nursery and nesting ground (e.g. seagrasses and saltmarshes) for birds, fish and shellfish species.

Table 1 summarizes the ecosystem services indirectly identified by participants according with the classification adopted by the Millennium Ecosystem Assessment (MA, 2005).

DISCUSSION

Participants showed to be aware of the ecosystem services provided by Ria de Aveiro. Although they identified more tangible services (provisioning and cultural services) than intangible (regulating and supporting services and biodiversity), they clearly recognized the social importance and the regional economic dependence of a healthy ecosystem. In order to maintain the lagoon's ability to provide ecosystem services, essential for the lagoon's uses and activities, participants identified the need to preserve/protect the ecosystem. Participants identified both emerging services (e.g. tourism and recreational activities such as kitesurf and windsurf) and declining services (e.g. navigability, salt production, harvesting of seagrasses and reeds, fish diversity, use of traditional boats, e.g. *'moliceiro'*), showing a clear concern with the future of some activities in Ria de Aveiro. It was interesting to see that some fishermen, for instance, recognize the importance of the sustainable use of lagoon's resources. They acknowledged the impact of their activities in the ecosystem because they experienced the impoverishment of the sediment bed and loss of species due to the use of non-authorized fishing gears. Due to this recognition, they changed their practices; however, according to them, the younger generations do not have this concern, and in some situations the dilemma of the commons (e.g. Jansse and Ostrom, 2006) still applies.

The majority of participants recognize several changes in the ecologic and socio-economic systems, driven by:
- hydrodynamic changes – as a result of dredging in the lagoon's mouth to improve the port activity; and

Table 1.   Ria de Aveiro ecosystem services identified in the Focus Groups and grouped according to MA (2005) approaches.

Provisioning Services	
Food supply	*fish, shellfish, salt*
Raw materials	*seagrasses, reeds, mud, sand, algae*
Transport and communication	*public transport (ferry and speedboats), touristic transport (e.g. traditional boat 'moliceiro'), private vessels and traditional boats (e.g. 'bateiras', 'mercanteis' and 'moliceiros')*
Port infrastructures	*commercial harbour and small fishermen ports*
Fishing	*fish and shellfish*
Aquaculture	*fish and shellfish*
Bait digging	*the solitary tube worm (Diopatra neapolitana, 'casulo')*
Salt production	
Agriculture and livestock	*'marinhoa' breed, rice and flax production*
Research	*R&D Projects (e.g. LIFE ESGIRA-Maria)*
Regulating Services	
Erosion control	*salt marshes*
Cultural Services	
Traditional products and handcraft	*salt soap, salt foam, salt exfoliating, flavouring and aromatic salt, flower of salt, samphire, fish and shellfish*
Traditional boats	*'bateiras', 'mercanteis', 'moliceiros'*
Traditional architecture	*'palheiros'*
Local festivals	*associated to the start and end of salt production, 'moliceiros' regatta*
Religious values	*religious drawings in traditional boats (e.g. 'moliceiros')*
Tourism	*gastronomy, traditional products and handcraft, traditional architecture, activities and boats, the semi-natural landscape and the conditions for navigation and recreation*
Recreation and leisure	*landscape appreciation, walking and biking on the banks, swimming, sailing, rowing, kayaking, windsurfing, kitesurfing, recreational fishing and hunting*
Education	*museums and guided tours*
Scenic value	*saltpans, traditional boats and architecture (e.g. 'palheiros'), biodiversity, water body*
Inspirational value	*from which resulted some books, such as 'A Ria de Aveiro – Um olhar resvés'*
Local knowledge	
Sense of place	*"I am a defender of Ria", "(...) is one of the most wonderful things in Portugal"*
Supporting Services	
Plant and animal diversity	*"species need each other"*
Habitat, nursery and nesting ground	*seagrasses, saltmarshes, "Ria functions as a maternity", "natural nursery"*

- overexploitation (fish and shellfish) – leading to habitat degradation (caused by e.g. shellfish collecting) and commercial fish species extinction (by e.g. capturing juveniles and/or capturing them before spawn).

It was noted that despite participants' different interests, e.g. tourism, recreation and fishing, they pointed out common concerns, such as loss of navigability, change in hydrodynamic regime (increasing of water velocity and tidal prism), loss of biodiversity (especially fish species), introduction of exotic invasive species, loss of habitat and nursery grounds, abandonment of traditional activities and loss of identity, use of non-authorized fishing gears and lack of surveillance, isolation of some communities and salt water intrusion in agricultural fields. Compiling all 9 Focus Groups, we can say that participants share common visions that focus on i) preserving the cultural values through the maintenance of traditional activities and dissemination of local knowledge; ii) preserving, protecting and restoring the ecosystem elements (habitats, species and hydrodynamic conditions); and iii) endorsing the economic development through the promotion of new activities (e.g. tourism, recreation and aquaculture) and creation of infrastructures.

As a mean to solve the identified problems and to meet the common vision, the participants suggested some actions, such as:
- adopting an integrated management of Ria de Aveiro, founded on a single structure and supported by users associations;
- addressing the interests of all users (not only major economic groups but also small users of the lagoon);

- improving the law enforcement by increasing surveillance;
- improving users awareness and knowledge, and encouraging them to protect the lagoon and supervise one another;
- monitoring water quality and biotoxins; and
- creating closed fishing seasons and nursery/breeding grounds for fish and shellfish.

CONCLUDING REMARKS

The use of Focus Groups methodology allowed us to better understand the community perceptions of Ria de Aveiro in terms of its ecological, economic and social dimensions.

Participants showed to have a great knowledge about the uses and activities, the historic evolution of social, economic and ecological aspects of the lagoon, and the performance of some management actions. Also, they reveal a strong sense of place and a clear feeling of ownership of the lagoon, which make us believe that a collaborative governance would be an asset to the management of Ria de Aveiro. By encouraging the cooperation of local community in the lagoon's management, it is expected to achieve the most appropriated responses to local needs and raise awareness.

In addition to the integration of local knowledge, the active involvement of the community in the processes and practices of the lagoon's management should take place. In this case, it would be crucial to build community's capacity to effectively contribute to the management of the lagoon.

Moreover, by raising awareness of end-users about the impact of their activities and uses on the lagoon's ecosystem, we expect them to enforce the compliance of the law and management measures.

The use of Focus Groups is the first step for researchers establish the first contact with the community and understand their concerns and expectations. This method will be used in association with other participatory and capacity building approaches in order to contribute to the definition of strategies and prioritization of actions.

ACKNOWLEDGEMENT

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