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How geographical factors and decision-makers' perceptions influence the prioritization of ecosystem services: Analysis in the Spanish rice field areas in RAMSAR Mediterranean wetlands

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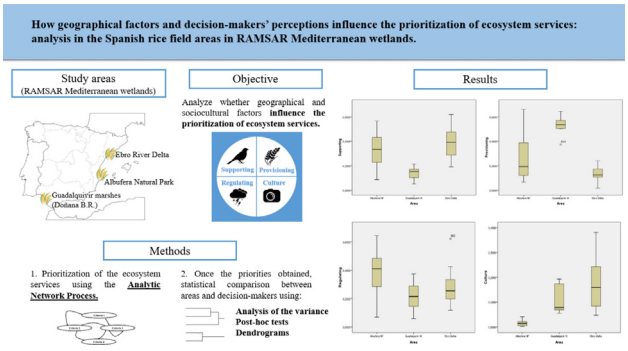
HIGHLIGHTS

- Ecosystem services provided by RAMSAR rice field areas are strongly interconnected.
- The Guadalquivir Marshes priorities statistically differ from the other two areas.
- Decision-makers' judgements are influenced by sociocultural factors.
- The methodology has been implemented from a global to a local scale.

GRAPHICAL ABSTRACT



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ABSTRACT

Mediterranean wetlands provide many ecosystem services to humans and other organisms. However, these services are being increasingly damaged. The prioritization of ecosystem services is essential to start a decision-making process focused on environmental policies, highlighting the necessity of equilibrium between sustainability and human well-being. This study analyzes the similarities and differences among the ecosystem services provided by the Spanish RAMSAR Mediterranean wetlands, where rice production is the main economic activity. These areas are the Ebro Delta, the Albufera Natural Park and the Guadalquivir Marshes (Doñana Biosphere Reserve). Despite being different areas, environmental and agricultural policies sometimes treat their characteristics without distinction since they are conceptually englobed in the same category. This analysis aims to study whether geographical and sociocultural factors could influence the prioritization of ecosystem services. The prioritization of the three study areas was conducted using the Analytic Network Process (ANP), a multi-criteria decision-making method which allows decision-makers to manage the ecosystem's complexity. The results are helpful for future policies and in understanding the complex network of interconnections among ecosystem services. Additionally, results show that there are statistically significant differences in priorities among the three study areas due to geographical and cultural reasons. Moreover, results have also shown that decision-makers judgements influenced the priorities depending on their background and personal or professional preferences. It emphasizes the necessity of implementing environmental policies from a theoretical and global scale to a participatory and local one, considering a broader range of stakeholders' perceptions to reflect the complexity of the ecosystem services network.

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1. Introduction

Ecosystem services (ESs) are the benefits people obtain directly or indirectly from ecosystems (MEA, 2005; Fu et al., 2013), although how and how much they benefit human beings and the environment differs according to stakeholders' perceptions and backgrounds (Cebrián-Piqueras et al., 2017). This definition emphasizes thus the relationships among biodiversity, ecosystems and society (Díaz et al., 2018), including an environmental, material, social, spiritual and moral approach (Agarwala et al., 2014; Sandifer et al., 2015; Sangha et al., 2015; Cruz-Garcia et al., 2017). Several studies recognize human contributions as most ESs are co-produced by a mixture of natural and social capital (Palomo et al., 2016). Conceptually, there has not been created any universally-accepted classification system for the study of ESs (Camacho and Ruiz, 2012). Nonetheless, the Millennium Ecosystem Assessment (MEA, 2005) is internationally recognized by the United Nations and was created in an agreement of scientists from more than 95 different countries (MEA, 2005). It is currently one of the most common classification stakeholders by many organizations, and public administrations use (Camacho and Ruiz, 2012). Despite existing more recent classifications like the Common International Classification of Ecosystem Services (CICES) (Haines-Young and Potschin, 2018) or the National Ecosystem Services Classification System (NESCS) Plus (U.S. EPA, 2015; Newcomer-Johnson et al., 2020), most Spanish public administrations in Spain continue using the MEA (2005) system.

Agroecosystems have both biophysical and socioeconomic dimensions (Vadrevu et al., 2008). According to MEA (2005), ESs are divided into four categories: provisioning (products obtained), regulating or regulation (benefits people obtain from the regulation of the services), cultural (non-material benefits) and supporting (basis of the other three groups). ESs varied with the land use types since farming lands provide good provisioning services, although they have weak supporting and regulating services. In contrast, unspoilt natural areas afford the inverse phenomenon (Jin et al., 2017). Moreover, grassland supplies good supporting services but poor regulating services such as carbon sequestration or water quality (Hasan et al., 2020). Regarding urbanized areas, there is also a demand and consumption of cultural services linked to ecological services (Li et al., 2020).

Wetlands are the most productive ecosystems for their role of sustaining a wide range of biodiversity and providing goods and services to society (Costanza et al., 2014; Song et al., 2021; Pal and Singha, 2022). The provisioning, regulation and cultural service provided by coastal wetlands play a significant role in human well-being improvement (MEA, 2005; Sun et al., 2018; Duku et al., 2022). Therefore, this link between nature and society has emphasized the necessity of researching in the field of sustainable science (Bennett et al., 2015; Fang et al., 2018). They provide a great diversity of ESs to humans and other living beings, although these areas are constantly being degraded and damaged (Aryal et al., 2021). The decline of ESs values directly reflects human effects on ecological degradation (Kindu et al., 2016), as any environmental change has the potential to alter the synchrony and asynchrony of ecosystem processes (Seybold et al., 2021). Some global changes are increasingly affecting the ESs damaging the natural assets and, consequently, human well-being too (Polce et al., 2016; Ruckelshaus et al., 2020). Therefore, the study of ESs has become a paradigm for ecosystem management and a primary helpful tool for decision-making from local to global scales (Daily et al., 2009; Ouyang et al., 2016; Burkhard and Maes, 2017; Costanza et al., 2017; Geijzendorffer et al., 2017; Falk et al., 2018). It means that the study and valuation of ESs have turned into a relevant tool to integrate environmental needs into public policies, sustaining their effect on human well-being (Salles, 2011; Guerry et al., 2015; van Oudenhoven et al., 2018).

The economic assessment and prioritization of ESs are thus a viable solution to help decision-makers (DMs) introduce environmental policies to preserve natural areas (Gao et al., 2019; Pisani et al., 2021; Sinclair et al., 2021; Walters et al., 2021) and technical support for regional social-economic development (Zhang et al., 2021). Moreover, it allows for a more rational design of public interventions to correct social or environment-related market failures (Aznar-Bellver and Estruch-Guitart, 2015). On the other hand, quantifying ESs is also critical for landscape management to achieve Sustainable Development Goals (Mouchet et al., 2014; Mach et al., 2015; Gong et al., 2022). Costanza et al. (2017) concluded that there is a need to broaden public discourse and participation in integrating ESs into mainstream economic policy.

Nevertheless, the perception of those benefits matters differently to different communities or even sectors depending on many factors, including individual and collective experiences (Felipe-Lucia et al., 2015; Fischer and Eastwood, 2016). The study of the influence of the geographical and sociocultural factors has motivated this study based on previous research. According to Cebrián-Piqueras et al. (2017), ecological characteristics can influence people's perception of the importance of each ES and which of those are the most crucial. Moreover, the perception of ESs are influenced by the ecosystem's properties and social factors (Burkhard et al., 2012; Castro-Martínez et al., 2013) depending on social, cultural and economic contexts (Turner et al., 2010; Martín-López et al., 2012; Hamann et al., 2016). Additionally, Quintas-Soriano et al. (2018) concluded in their study that whether a stakeholder was a scientific expert or donated to an environmental organization affected ESs perception. Nevertheless, "studies rarely address how the valuations are influenced by sociocultural contexts, humans' interests and stakeholders' preferences" (Cebrián-Piqueras et al., 2017). Therefore, applying the ESs concept and their prioritization at the local level has challenges and limitations but also opportunities, "especially in terms of implementing theory into the local-level activities" (Tusznio et al., 2020). Regarding local scales, Busch et al. (2012) held that "ESs are strictly linked to the spatial dimension of the defined area in which those services are provided". Global estimations can help highlight the magnitude of ESs but have no specific decision-making context (Costanza et al., 2014).

This study aims to compare the prioritization of the ESs provided by the three Spanish RAMSAR Mediterranean wetlands where rice production is the main economic activity. These natural areas are the Ebro Rivel Delta in Catalonia, the Albufera Natural Park in Valencia and the Guadalquivir Marshes in Andalusia, a zone within the Doñana Biosphere Reserve. Generally, environmental and agricultural policies address these areas identically or, at least, similarly. This study thus aims to implement the global-scale theoretical background of Mediterranean wetlands to local and concrete areas to evaluate whether the prioritization of ESs differs or not from one area to another. This study also allows examining the influence of the decision-makers on the prioritization of ESs depending on their background and preferences. The ESs provided by the three areas have been prioritized using the Analytic Network Process (ANP). Then, the results were compared with the ones previously obtained in the other two areas. The prioritization from the Albufera Natural Park (Jorge-García and Estruch-Guitart, 2020) and the Guadalquivir Marshes (Jorge-García and Estruch-Guitart, 2022) are already available from previous research.

2. Study area

The three Spanish RAMSAR Mediterranean wetlands studied are the Ebro Delta in Catalonia, the Albufera Natural Park in the Valencian Community and the Guadalquivir Marshes within the Doñana Biosphere Reserve in Andalusia. In the three areas, rice fields grown on flooded shallow land occupy a significant part of the surface. Additionally, their rice production is the main economic activity directly linked to the ecosystem. These three areas are considered some of the most important protected wetlands globally since they host a massive variety of species, especially birds passing annually through these wetlands on migratory flyways because of the strategic location between Europe and Africa (UNESCO, 2020). In this section, First, the characteristics of the Ebro Delta are explained in more detail. The other two ecosystems are briefly summarized below. Fig. 1 shows the location of the study areas.

2.1. The Ebro River Delta

The Ebro Delta is a RAMSAR coastal wetland of international importance located southwest of Catalonia (Spain). This area represents

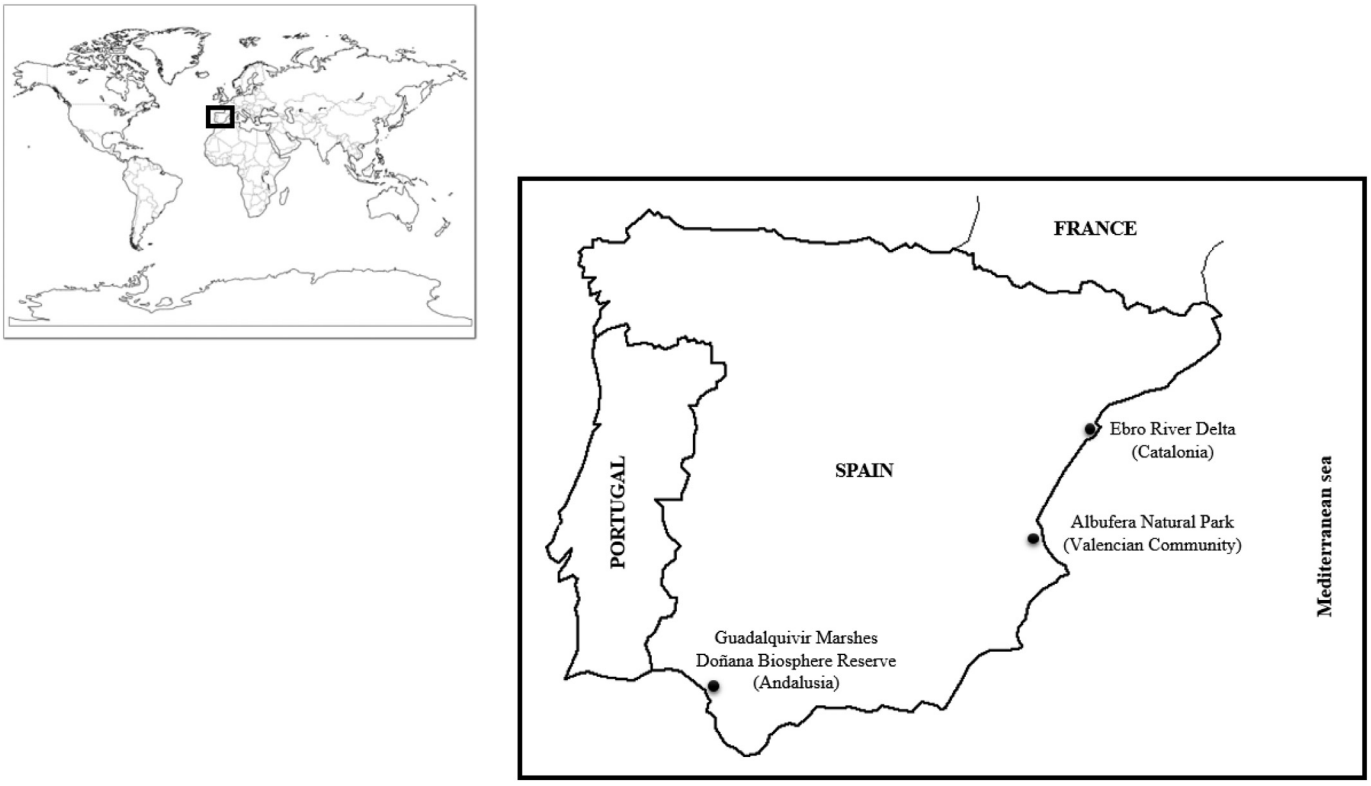

Fig. 1. Location of the study areas.

environments with a great diversity of habitats, flora and fauna in an interface between land (deltaic marshes) and sea (Rodríguez-Santalla and Navarro, 2021). The emerged area of the Ebro River Delta occupies 325 km2 (15 % of the whole Delta), one of the largest Mediterranean humid areas in Europe. Of its total terrestrial surface, 12,560 ha are part of the Natura 2000 Network (Site of Community Importance and Special Area of Conservations), and 7.736 ha are part of the Ebro Delta Natural Park. This humid area is home to many species of fauna and flora, especially aquatic birds, including the autochthonous. The Delta Ebro is an important stopover site for migrating birds in spring and autumn (Guerreiro Duarte Rivaes da Silva, 2018). According to the Plan for protecting the Coastal Edge of the Ebro Delta (MITECO, 2021), the Ebro Delta is home to about 360 species of birds out of the 600 declared in Europe. They use these habitats for nesting, wintering and as a resting area during their migrations. The Delta has different biotopes such as river banks, wetlands, marshes, dune systems, lagoons, coastal systems and bays apart from the rice fields.

Among the different economic activities, agriculture stands out as rice fields cover around 70 % of the total area (Rodríguez-Santalla and Navarro, 2021). According to 2019 statistics, rice fields occupied 19,888 ha and produced 129,710 t (19.23 % of the Spanish rice surface and 17.27 % of the Spanish rice production). The Ebro Delta's rice fields generated 47.95 million euros, signifying 3 % of the Catalan farming income (Statistical Institute of Catalonia). Furthermore, fishing and aquaculture are other relevant primary activities developed in the area, from the traditional fishing in the lagoons and bays to the most cutting-edge aquaculture of bivalve species. According to the Plan for protecting the Coastal Edge of the Ebro Delta (MITECO, 2021), the Mediterranean mussel is the predominant cultivated aquatic organism, followed by the Delta oyster. Moreover, it also highlights the traditional fishing in the lagoons, such as eel fishing using the 'pantena' ancient art and other techniques. Furthermore, although they are secondary, animal husbandry, orchard farming and hunting are other provisioning economic activities in the area (Kleinpenning, 2016). At the non-agricultural industrial level, a private company exploits the salt flats of La Trinidad within the Ebro Delta Natural Park producing between 70,000 and 80,000 tons per year on average (Kleinpenning, 2016). However, the economic activity that has grown the most during the last decade is the tertiary, especially ecotourism linked to biodiversity and the beauty of the landscape (MITECO, 2021).

2.2. The Albufera Natural Park and the Guadalquivir Marshes

The Albufera Natural Park is located about 7.5 km south of the Turia River mouth in the Valencian Community. It occupies an approximate surface area of 21,190 ha. Rice fields occupy a significant extension with 15,447 ha, and the sweet-water lagoon (the core area supporting the ecosystem) has 2394 ha (Soria, 2006). Approximately 110,000 tons of rice are produced annually. Marshland, dunes, and Mediterranean forest mainly occupy the remaining surface. Hunting and fishing are secondary provisioning activities. Moreover, this Natural Park keeps some ancestral activities, such as the Latin sailing exhibitions or the handmade traditional fishing arts, declared Protected Cultural Heritage. Additionally, the Albufera Natural Park was the primitive area for cultivating this crop in Spain. Valencian rice farmers took the crop to the other two producing areas studied.

On the other hand, the Guadalquivir Marshes are part of a more extensive and complex RAMSAR ecosystem, the Doñana Biosphere Reserve. The total area of the Reserve (269,158 ha) is divided into three zones: the National Park, the Natural Park and the transition zone. In contrast with the studies carried out in the other two areas, in the Guadalquivir marshes, only the rice fields area has been considered since the rice fields in the Doñana are specifically located together in a distinctive and homogeneous part of the Reserve. It occupies about 36,000 ha in the transition zone. It is the most extensive rice-producing area in Spain, with 350,000-ton production in 2016, representing 42.6 % of the national and 10 % of the European production, according to official statistics (Castillo-Manzano et al., 2021).

3. Materials & methods

Within the Multiple Criteria Decision Making (MCDM) methods, the group of Multiple Attribute Decision Making (MADM) methods are commonly used to solve discrete problems with a finite number of alternatives or criteria (Córdoba-Bueno, 2004). According to Ishizaka and Nemery (2013), pairwise comparison methods are instrumental when defining utility functions is impossible, as in this case. According to the literature review carried out by Khan and Ali (2020), the Analytic Hierarchy Process (AHP) (Saaty, 1986; Saaty, 1990) and the Analytic Network Process (ANP) (Saaty, 1986; Saaty, 2004; Saaty and Vargas, 2013) are the most frequent methods, counting both simple and integrated methods, in public sector decision-making. Concretely, "the highest number of publications have used AHP applications in every category" (Khan and Ali, 2020; Fountzoula and Aravossis, 2022). Nevertheless, AHP simplifies reality by not considering the relationships among elements (Zhu et al., 2010). Thus, this method is the most appropriate in situations where criteria are not interconnected as it is less time-consuming and less complex (Asadabadi et al., 2019). Nonetheless, "most complex real-world decision-making problems have numerous interdependent elements that can only be captured and processed utilizing the feedback and interaction capabilities of an ANP model" (Tjader et al., 2014; Saaty and Ozdemir, 2021).

ANP is a generalization of AHP, both methods proposed by Thomas Saaty. It is used in multi-criteria decision analysis. The resulting model is a network or graph, weighted and oriented, allowing an influence or reciprocal relationship between the elements (Saaty and Vargas, 2012; Schulze-González et al., 2021). According to Reig et al. (2010), ANP draws a network capable of incorporating feedback and interdependent relationships within and between clusters. Hence, ANP is more precise and convenient for ESs' economic valuation or prioritization.

In the field of ESs, some studies have shown that AHP is not the suitable multi-criteria method as it simplifies reality since it does not consider the relationships among the services of different groups (Jorge-García and Estruch-Guitart, 2020; Jorge-García and Estruch-Guitart, 2022). In this method, each ES is only compared among the others of the same group. For instance, a cultural service is only compared with the other cultural ones. On the contrary, ANP allows experts to integrate their judgements, based on their experience, by managing the complexity of the interrelationships among criteria (Saaty and Vargas, 2013). At the same time, it improves the accuracy and homogeneity of the results, as some studies carried out in other fields demonstrated (Baviera-Puig et al., 2014; Janeš et al., 2018; De Brito et al., 2018; Nimawat and Gidwani, 2021; Daneshparvar et al., 2022). Moreover, Lee and Lautenbach (2016) also concluded that understanding relationships between ESs helps minimize undesired trade-offs and enhance synergies. For all these reasons, the prioritization carried out in this study has been done using ANP as in the other two study areas. Next, the ANP constructed in this study, based on a five-stage model, is explained step-by-step as in the flowchart presented below in Fig. 2. The complete fieldwork was conducted in May, June and July 2022.

3.1. Choice of experts (decision-makers) participating in the pairwise comparisons

Inclusion of multiple stakeholder perspectives has become routine to enhance the effectiveness and acceptability of complex environmental management decisions (Schmoldt and Peterson, 2000; Broderick, 2005; Bryan et al., 2010). In ANP, the relative weight of criteria is determined by employing expert judgements, preferences and perceptions of a multidisciplinary team (Schulze-González et al., 2021). In this study, eleven decision-makers (DMs) have been chosen to complete the needed pairwise comparisons among the ESs individually. They are experts who show a broad vision of the area's social, ecological and economic reality since they are part of selected organizations that encompass an essential range of different points of view. The roles of the eleven DMs are listed below:

- DM1: Technician expert in artificial purification wetlands (green filters) in AGBAR
- DM2: Manager of an ecotourism company and member of the association of ecotourism companies of the Ebro Delta
- DM3: Technician in a local conservationist NGO: 'Picampall'
- DM4: Technician in a conservationist NGO: SEO-Bird Life
- DM5: Researcher in the Dept. of Climate Change in EURECAT (regional technological centre)
- DM6: Researcher specialised in environmental economy
- DM7: Researcher specialised in rice production IRTA – Amposta
- DM8: Researcher specialised in regulation services in rice field areas in IRTA – Amposta
- DM9: Researcher specialised in aquaculture in IRTA – Ràpita
- DM10: Researcher specialised in fishing in IRTA Ràpita
- DM11: Technical director in COPATE (Consortium of environmental policies of 'Terres de l'Ebre')

All eleven DMs have separately participated in completing the pairwise comparisons. However, four have also contributed to the selection of criteria (step 2), as explained.

3.2. Definition of clusters and elements (criteria): ESs provided by the Ebro Delta (study area)

Regarding the criteria, this study has not considered the complete list of MEA (2005) as some ESs do not exist or are not suitable enough in the Ebro Delta. It is recommendable that valuations should begin with a participatory identification of ESs (Boeraeve et al., 2018; Asah and Blahna, 2020). Consequently, four of the eleven experts and a local farmer have been interviewed to adjust the list. Concretely, the experts participating in this phase are two scientific researchers (DM7 and DM8), two technicians working for conservationist organizations (DM1 and DM4) and a local farmer member of 'Unió de Pagesos', the principal agrarian union in the rice fields of the Ebro Delta. The local farmer has only participated in this step. All five have studied the list of ESs supplied by the Catalonian regional government (GENCAT, 2016) based on MEA (2005). Then, they have gotten rid of the ESs, which do not currently exist and the area and the ones which are not relevant.

Additionally, two supporting ESs, 'Biodiversity' and 'Geodiversity', have been joined in a unique service as it has been assumed to be more visual for the subsequent valuation. Finally, as the 'Protection' service includes different subgroups, the name of the service has been adapted to include the only two protection services existing in the area hence called 'Protection of the coast and against salinity'. Accordingly, the model was finally built with twelve ESs aggregated in the four clusters or groups considered. Table 1 shows the list of ESs considered by the Catalonian regional government based on MEA (2005) and its adaptation to the Ebro Delta through the mentioned interviews.

3.3. Element's relationship or interfactorial dominance matrix

Each DM has constructed its own zero-one interfactorial dominance matrix to determine the influences among ESs. The coefficients of this matrix Ci, Cj take the value 1 or 0 depending on whether the element Ci influences element Cj. If an existent influence is not considered relevant enough by the DMs, its coefficient has also taken the value of 0. Each DM has analyzed 144 potential influences as twelve elements form the network. The question all DMs have answered has been: "*Do you think that criterion Ci has any influence on Cj?*". The questionnaire was conducted in May and June 2022.

At this point, in the Albufera Natural Park, the ten DMs produced similar matrices (Jorge-García and Estruch-Guitart, 2020). Therefore, a unique Element's Relationship matrix could be agreed. The same happened in the Guadalquivir Marshes among the nine DMs (Jorge-García and Estruch-Guitart, 2022). On the contrary, each DM has its Element's Relationship matrix in the Ebro River Delta since consensus was not viable due to their different judgements (more than 25 % of the influences analyzed had no consensus; that is, at least one DM had a different opinion to the others). Table 2 shows the number of DMs who have considered each influence in the Ebro Delta.

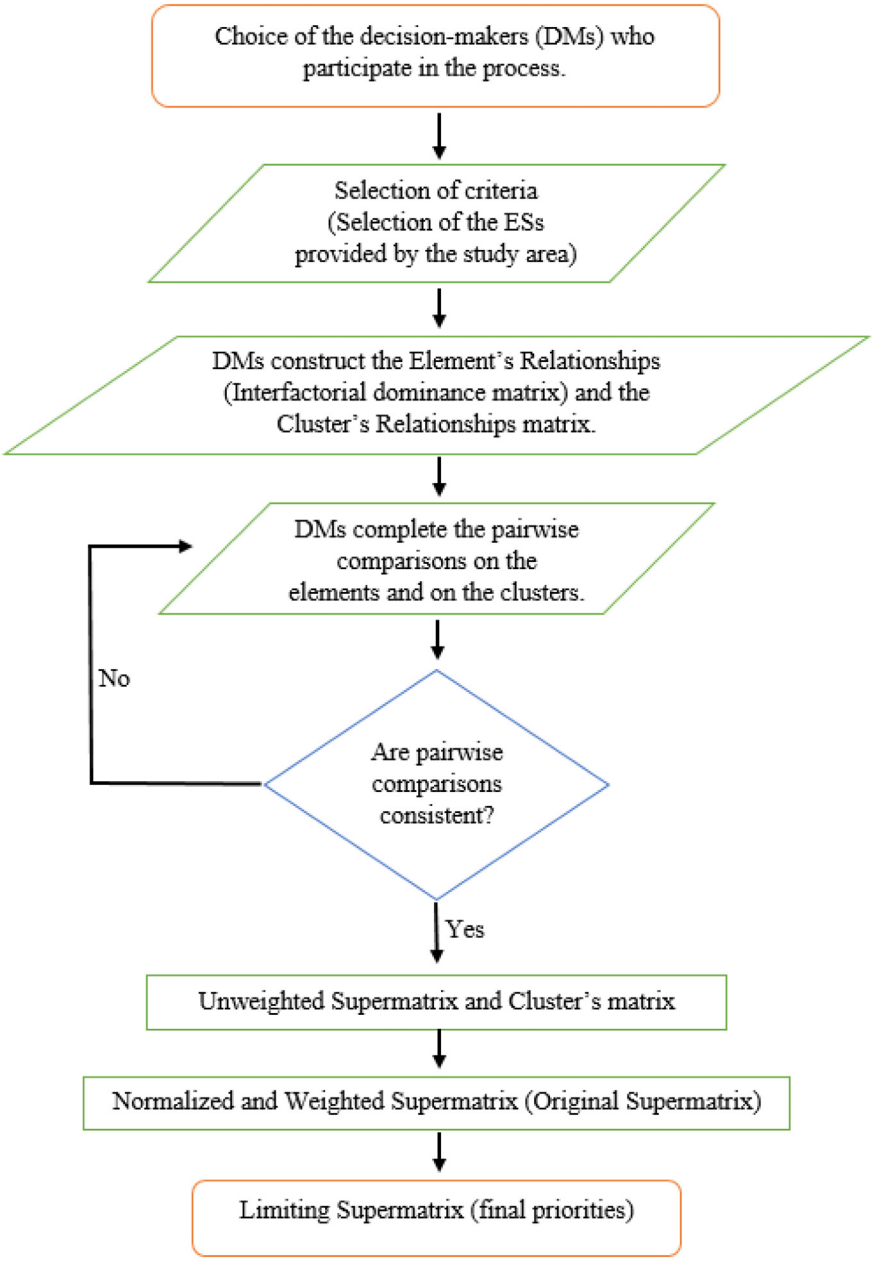

Fig. 2. Flowchart representing the methodology followed in this study.

The Element's Relationship matrices corresponding to the Albufera Natural Park and the Guadalquivir Marshes are shown in the Supplementary materials.

3.4. Cluster's Relationship matrix

Each DM has constructed its own zero-one Cluster's Relationship matrix to determine the influences among the four clusters (supporting, provisioning, regulating and cultural services). The coefficients of this matrix also take the value 1 or 0, depending on whether each cluster influences the others. Each DM has analyzed 16 potential influences as four clusters form the network. The question all DMs have answered has been: "*Do you think that cluster 1 has any influence on cluster 2?*". In this step, all DMs have agreed that the four clusters are all completely interrelated.

At the end of steps 3 and 4, all the criteria and cluster relationships have been analyzed. Each DM has obtained its own Element's Relationship and Cluster's Relationship matrices. Afterwards, DMs carried out the following steps individually.

3.5. Pairwise comparisons on the elements and on the clusters

Each DM has received a personalized questionnaire based on their Element's Relationship matrix model. DMs use pairwise comparison matrices to compare the influence of the elements belonging to each cluster on any element. They only complete the pairwise comparisons of those relationships scored 1 on the Element's Relationship matrix, obtaining a priority vector for each influence. These vectors substitute the values scored a 1 in the Element's Relationship matrix obtaining the Unweighted Supermatrix. The priority vectors give the importance of each element (ES) over the cluster it belongs. The matrix is unweighted since columns do not sum 1 yet.

Afterwards, DMs carried out the same process on the clusters. The priority vectors obtained substitute the relationships scored a 1 on the Cluster's Relationship matrix obtaining the Cluster's Weighted Matrix.

DMs use the 1-to-9 Saaty's Fundamental scale, shown in Table 3, to rate their judgements and preferences. The question all DMs have answered in this step has been: "*Given a certain ecosystem service and two criteria to*

Table 1
General list of ESs and its adaptation to the Ebro Delta.

Group of ES	General ESs list (GENCAT, 2016; based on MEA, 2005)	ESs provided by the Ebro Delta (selected criteria)
Supporting	Biodiversity	C11: Biodiversity and geodiversity
	Geodiversity	
	Ecological connectivity and complementarity	C12: Ecological connectivity and complementarity
	Soil formation and maintenance	
	Paleobiology	
	Primary production	C13: Primary production
Provisioning	Provision of food resources	C21: Provision of food resources[a]
	Natural medicines	
	Provision of raw materials	
	Water resources	
	Energy resources	
	Genetic heritage	
Regulating	Protection (some subgroups)	C31: Protection of the coast and against salinity
	Improved water quality	C32: Improved water quality
	Climate change mitigation and carbon sequestration	C33: Climate change mitigation and carbon sequestration
	Improved soil fertility	
	Pollination and biological control	C34: Pollination and biological control
Cultural	Landscape enjoyment	C41: Landscape enjoyment
	Knowledge, activities of environmental awareness, leisure and ecotourism	C42: Knowledge, activities of environmental awareness, leisure and ecotourism
	Historical and cultural heritage	C43: Historical and cultural heritage
	Spiritual and religious enjoyment	
	Identity and sense of belonging	C44: Identity and sense of belonging

[a] The provision of food includes agriculture, hunting, fishing, aquaculture and the salt industry. This industry also includes salt commercialized for non-agro-food purposes.

compare, which one, A or B, has the greatest importance or influence on it and to what extent (according to Saaty's 1–9 scale)?". The same questions have been answered for the clusters.

Here, there is a concrete example of a question: *Given the ecosystem service C11 - Biodiversity and geodiversity, in your opinion, which criterion, 'C32 – Improved water quality' or 'C34 – Pollination and biological control', has the greatest importance or influence on it and to what extent (according to Saaty's 1–9 scale)?*

The questionnaire consisted of between 194 and 281 pairwise comparisons in this step. This number differs from one DM to another since the model is personalized, as explained in the previous paragraph. Overall, each DM has responded to between 338 and 425 questions counting steps 3, 4 and 5.

Table 2
Number of DMs who have considered each influence as relevant in the Ebro Delta.

	C11	C12	C13	C21	C31	C32	C33	C34	C41	C42	C43	C44
C11		11	11	10	10	10	11	10	11	11	4	10
C12	11		11	9	8	9	8	9	9	10	2	8
C13	11	11		10	8	10	10	10	9	10	3	7
C21	11	11	10		9	11	9	9	11	11	7	11
C31	11	9	9	10		10	5	8	11	11	3	8
C32	11	10	11	11	6		7	9	10	10	4	8
C33	11	9	9	9	4	7		6	6	6	3	4
C34	9	8	9	9	11	8	6		6	6	4	4
C41	8	7	6	8	5	3	2	2		11	7	9
C42	9	7	6	11	8	11	6	5	10		9	9
C43	3	1	0	6	3	1	1	1	10	11		10
C44	8	4	4	11	9	8	2	3	10	10	8	

Criteria (Ecosystem services): C11 (Biodiversity and geodiversity); C12 (Ecological connectivity and complementarity); C13 (Primary production); C21 (Provision of food resources); C31 (Protection of the coast and against salinity); C32 (Improved water quality); C33 (Climate change mitigation and carbon sequestration); C34 (Pollination and biological control); C41 (Landscape enjoyment); C42 (Knowledge, activities of environmental awareness, leisure and ecotourism); C43 (Historical and cultural heritage) and C44 (Identity and sense of belonging).

Table 3
Saaty's fundamental scale.

Intensity of the importance of one ES over another	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2, 4, 6 and 8	Comparison between the above values

As for the consistency of the pairwise comparisons, if the number of criteria goes beyond three, an inconsistency arises as "humans are not capable of keeping consistent pairwise judgments when the number of components increases" (Saaty, 2004; Raharjo and Endah, 2006; Saaty and Vargas, 2013; Tavana et al., 2017; Piengang et al., 2019; Asadabadi et al., 2019; Saaty and Ozdemir, 2021). According to that, each matrix is associated with a consistency ratio (CR). Inconsistencies have been accepted below 9 % for matrices of rank $n = 4$ and below 5 % for rank $n = 3$. Experts must repeat a pairwise comparison matrix when it surpasses the CR established.

Once all the questionnaires were carried out and all data collected, the Super Decisions V3.2 software (www.superdecisions.com) separately built the model of each DM and calculated the corresponding priorities. The following steps have been directly conducted using this software.

3.6. Normalized and Weighted Supermatrix (Original Supermatrix)

Each Unweighted Supermatrix is weighted by the clusters priorities using the corresponding Cluster's Weighted Matrix (Weighted Supermatrix). Subsequently, they are normalized so that it becomes column stochastic, that is, each column sums to 1, achieving the Original Supermatrix (one per DM).

3.7. Limiting Supermatrix

The Limiting Supermatrix (one per DM) is the absolute priority of criteria. It is calculated by raising each Original Supermatrix to limit powers until the weights converge and remain stable, that is, until the same value is repeated in each row and the supermatrix no longer changes.

Once the results are obtained, a dendrogram diagram has been elaborated to analyze the similarities and differences among the eleven judgements obtained for the Ebro Delta. Afterwards, these results were compared with the ones obtained in the previous studies conducted in the Albufera Natural Park in Valencia and the Guadalquivir Marshes within the Doñana Biosphere Reserve in Andalusia. An Analysis of Variance (ANOVA) and a post-hoc test have been carried out to study the statistically significant differences among the prioritization of the ESs in the three study areas. The judgements elaborated from all the DMs have also been clustered using a dendrogram diagram. All statistical tests and diagrams have been carried out using the IBM SPSS Statistics 27.0 software.

4. Results and discussion

4.1. Prioritization of the ESs provided by the Ebro Delta

Considering the priorities calculated from the pairwise comparisons carried out by the eleven DMs in the Ebro River Delta, Table 4 shows the weight of all the ESs and groups.

As can be observed, 55 % of DMs have considered that supporting services are the most relevant ESs in the Ebro Delta, whereas 27 % of DMs have ranked the regulating and 18 % the cultural services as the most relevant ones. The two DMs rated the provisioning services the most

Table 4
Prioritization of the ESs provided by the Ebro Delta.

Ecosystem services (ESs)	Decision-makers (DMs)											$\bar{x}$	Standard Deviation
	DM1	DM2	DM3	DM4	DM5	DM6	DM7	DM8	DM9	DM10	DM11		
C11	0.1709	0.0815	0.3126	0.1895	0.2021	0.2282	0.1480	0.2001	0.1321	0.1002	0.1544	0.1983	0.0638
C12	0.1459	0.0321	0.1423	0.2438	0.0551	0.1658	0.0939	0.1453	0.1054	0.0674	0.0933	0.1242	0.0595
C13	0.0745	0.0774	0.1419	0.1853	0.0500	0.1453	0.0252	0.0681	0.1089	0.0619	0.1458	0.1038	0.0500
Supporting (C11 + C12 + C13)	0.3913	0.1911	0.5968	0.6186	0.3071	0.5393	0.2671	0.4135	0.3464	0.2295	0.3935	0.4264	0.1439
C21	0.1085	0.1048	0.2010	0.1188	0.0177	0.1466	0.2350	0.1335	0.0751	0.2398	0.1236	0.1398	0.0669
Provisioning (C21)	0.1085	0.1048	0.2010	0.1188	0.0177	0.1466	0.2350	0.1335	0.0751	0.2398	0.1236	0.1398	0.0669
C31	0.1240	0.1772	0.0476	0.0430	0.0681	0.0426	0.1215	0.1041	0.0575	0.0854	0.0901	0.0954	0.0420
C32	0.2173	0.1862	0.0215	0.1164	0.0235	0.0893	0.0391	0.0748	0.1434	0.0297	0.0572	0.0826	0.0676
C33	0.0426	0.1859	0.0219	0.0357	0.0901	0.0445	0.0576	0.0549	0.0352	0.0261	0.0220	0.0546	0.0474
C34	0.0413	0.0720	0.0263	0.0200	0.1119	0.0047	0.0361	0.0604	0.1381	0.0322	0.0712	0.0497	0.0405
Regulating (C31 + C32 + C33 + C34)	0.4252	0.6214	0.1172	0.2151	0.2937	0.1811	0.2543	0.2941	0.3742	0.1733	0.2406	0.2823	0.1414
C41	0.0206	0.0327	0.0292	0.0287	0.0359	0.0463	0.0130	0.0645	0.0823	0.0431	0.0522	0.0440	0.0200
C42	0.0292	0.0276	0.0188	0.0092	0.0432	0.0263	0.0922	0.0536	0.0644	0.0865	0.0759	0.0473	0.0285
C43	0.0134	0.0080	0.0201	0.0002	0.1435	0.0042	0.0585	0.0126	0.0370	0.0078	0.0587	0.0166	0.0420
C44	0.0117	0.0145	0.0169	0.0094	0.1589	0.0563	0.0799	0.0281	0.0205	0.2200	0.0554	0.0437	0.0687
Culture (C41 + C42 + C43 + C44)	0.0750	0.0828	0.0850	0.0475	0.3815	0.1331	0.2436	0.1588	0.2042	0.3574	0.2422	0.1516	0.1141

Criteria (Ecosystem services): C11 (Biodiversity and geodiversity); C12 (Ecological connectivity and complementarity); C13 (Primary production); C21 (Provision of food resources); C31 (Protection of the coast and against salinity); C32 (Improved water quality); C33 (Climate change mitigation and carbon sequestration); C34 (Pollination and biological control); C41 (Landscape enjoyment); C42 (Knowledge, activities of environmental awareness, leisure and ecotourism); C43 (Historical and cultural heritage) and C44 (Identity and sense of belonging).
Decision-makers: DM1 AGBAR (green filters); DM2 Ecotourism company; DM3 NGO 'Picampall'; DM4: NGO 'SEO-Bird Life'; DM5 EURECAT (regional technological centre); DM6 Researcher in the environmental economy; DM7: Researcher (rice production) IRTA – Amposta; DM8 Researcher (regulating ES) in IRTA – Amposta; DM9: Researcher (aquaculture) in IRTA – Ràpita; DM10 Researcher (fishing) in IRTA - Ràpita; DM11 COPATE (Consortium of environmental policies of 'Terres de l'Ebre').

are DM7 and DM10, the two researchers who directly work on agriculture and fishing productions, respectively. On average, supporting services hold a 42.64 % global value of the area. In comparison, the provisioning service only embraces 13.98 % of its value, even though the rice fields occupy a significant part of the Ebro Delta. However, the central part of the cultural values comes from agriculture and fishing as these are traditional activities strongly linked to some services such as Identity or cultural heritage.

Focusing the attention on the complete ESs list, three appear at the top of the list. On the one hand, 45 % of DMs have rated 'C11 – Biodiversity and Geodiversity' as the most relevant ES in the area. Moreover, ten of eleven DMs have concluded that this service is among the three most important. On the other hand, 18 % of DMs have considered that 'C21 – Provision of food resources is the most relevant ES; for 55 % of DMs, it is among the three most crucial ones. Finally, two of eleven DMs have rated 'C32 – Improved water quality' as the most central ES. On the contrary, the cultural services are, on average, the least rated ES as only two of eleven DMs have considered any of them among the three most vital services in the area.

According to the results, and although two concrete ESs are leading the list, DMs have some differences when prioritizing them. Fig. 3 shows a dendrogram which clarifies the distance among the eleven DMs' judgements.

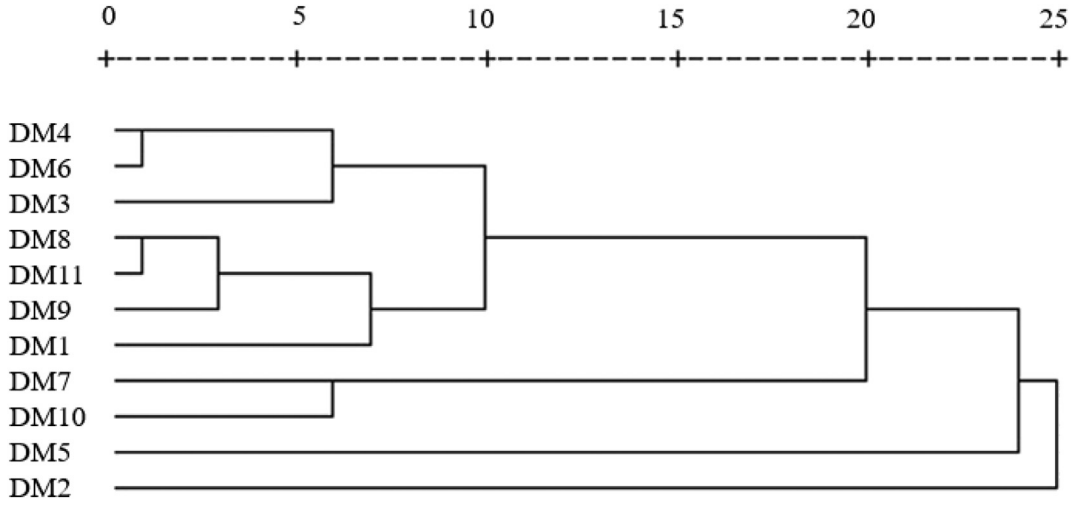

Fig. 3. DMs' dendrogram using Average Linkage (between groups)
Decision-makers: DM1 AGBAR (green filters); DM2 Ecotourism company; DM3 NGO 'Picampall'; DM4: NGO 'SEO-Bird Life'; DM5 EURECAT (regional technological centre); DM6 Researcher in the environmental economy; DM7: Researcher (rice production) IRTA – Amposta; DM8 Researcher (regulating ES) in IRTA – Amposta; DM9: Researcher (aquaculture) in IRTA – Ràpita; DM10 Researcher (fishing) in IRTA - Ràpita; DM11 COPATE (Consortium of environmental policies of 'Terres de l'Ebre').

Table 5
Relevant ESs studied in the three areas.

	Albufera Natural Park	Guadalquivir Marshes	Ebro River Delta
Supporting	Nutrient recycling	Habitat for species	Biodiversity and geodiversity
	Primary production	Biodiversity	Primary production
			Ecological connectivity and complementarity
Provisioning	Food provisioning	Food provisioning	Food provisioning
	Freshwater supply	Freshwater supply	
	Genetic sources		
Regulating	Climate regulation	Local climate and air quality	Climate change mitigation and C sequestration
	Air quality regulation		
	Water-water sanitary	Waste-water sanity	Improved water quality (waste-water sanity)
		Erosion prevention and maintenance of soil fertility	Protection of the coast and salinity
		Biological control of pests and diseases and pollination effect	Pollination and biological control
Culture	Cultural value		Historical and cultural heritage
	Tourism and recreation	Tourism, recreation and mental and physical health	
	Educational value	Knowledge, science and education	Knowledge, education, leisure and ecotourism
	Aesthetics and inspiration	Aesthetics and inspiration	Landscape enjoyment
	Identity value		
	Social relationships	Identity, spiritual experience and sense of place	Identity and sense of belonging

Table 6
Prioritization of the four groups of ESs by the three areas.

Area	DMs	Supporting	Provisioning	Regulating	Culture
Albufera Natural Park (Jorge-García and Estruch-Guitart, 2020)	AL1	0.22810	0.66180	0.07030	0.03980
	AL2	0.43190	0.12110	0.44390	0.00310
	AL3	0.08640	0.38810	0.48430	0.04110
	AL4	0.52710	0.08950	0.37820	0.00520
	AL5	0.56640	0.22290	0.19840	0.01220
	AL6	0.29690	0.35210	0.33470	0.01630
	AL7	0.42190	0.06690	0.50940	0.00180
	AL8	0.36930	0.16260	0.45070	0.01740
	AL9	0.20830	0.14100	0.64320	0.00750
	AL10	0.23230	0.46080	0.28500	0.02190
	$\overline{X}$	0.33686	0.26668	0.37981	0.01663
Guadalquivir Marshes (Jorge-García and Estruch-Guitart, 2022)	GU1	0.15280	0.50370	0.28840	0.05520
	GU2	0.08910	0.61130	0.12610	0.17340
	GU3	0.05220	0.53830	0.34080	0.06870
	GU4	0.17180	0.37490	0.37480	0.07850
	GU5	0.17830	0.53500	0.19230	0.09440
	GU6	0.21410	0.50050	0.21410	0.07130
	GU7	0.10290	0.64530	0.05880	0.19300
	GU8	0.10930	0.57100	0.14470	0.17490
	GU9	0.15400	0.51780	0.27030	0.05790
	$\overline{X}$	0.13610	0.53310	0.22340	0.10750
Ebro Delta	EB1	0.39131	0.10845	0.42520	0.07504
	EB2	0.19106	0.10476	0.62137	0.08281
	EB3	0.59676	0.20095	0.11724	0.08504
	EB4	0.61865	0.11878	0.21508	0.04749
	EB5	0.30713	0.01768	0.29367	0.38152
	EB6	0.53927	0.14655	0.18112	0.13306
	EB7	0.26711	0.23499	0.25429	0.24361
	EB8	0.41351	0.13351	0.29414	0.15885
	EB9	0.34644	0.07510	0.37425	0.20421
	EB10	0.22946	0.23981	0.17334	0.35739
	EB11	0.39355	0.12358	0.24064	0.24224
	$\overline{X}$	0.42635	0.13977	0.28232	0.15156

Decision-makers in the Albufera Natural Park: AL1 Appellation of Origin 'Arròs de València'; AL2 Professor at the Polytechnic University of Valencia in the Department of Agroforestry Ecosystems; AL3 Professor at the Polytechnic University of Valencia in the Department of Vegetal Production); AL4 Technician in PAVAGUA (green filters); AL5 Technician in the Assut Foundation; AL6 Technician in the Farmer's Union 'La Unió'; AL7 Technician in the conservationist NGO 'SEO-Bird Life'; AL8 Technician in the Fishermen Community; AL9 Technician in the conservationist NGO 'Acció EcologistaAgró'; AL10 Technician in the Farmer's Union 'AVA-ASAJA'.
Decision-makers in the Guadalquivir marshes: GU1 Freelance agrarian technician; GU2 Local politician with agricultural competency; GU3 Technician working for a cooperative; GU4 Technician of a Community of irrigation; GU5 Technician working for a red swamp crayfish industry; GU6 Technician working for the Federation of rice growers of Seville; GU7 Environmentalist and member of the NGO, SEO-Bird Life; GU8 Agrarian Union member in UPA; GU9 Professor at the University of Seville.
Decision-makers in the Ebro Delta: EB1 AGBAR (green filters); EB2 Ecotourism company; EB3 NGO 'Picampall'; EB4: NGO 'SEO-Bird Life'; EB5 EURECAT (regional technological centre); EB6 Researcher in the environmental economy; EB7: Researcher (rice production) IRTA – Amposta; EB8 Researcher (regulating ES) in IRTA – Amposta; EB9: Researcher (aquaculture) in IRTA – Ràpita; EB10 Researcher (fishing) in IRTA - Ràpita; EB11 COPATE (Consortium of environmental policies of 'Terres de l'Ebre').

It is noticeable that there is a group of three experts, 'DM4 – NGO SEO-Bird Life', 'DM6 - Researcher in the environmental economy' and 'DM3 – NGO Picampall', whose results are close. These three DMs highlighted the importance of the Ebro Delta's supporting services, especially the 'C11 – Biodiversity and Geodiversity', which can be explained as they are part of conservationist organizations which work or research in the protection of the environment in the study area.

Another group is formed by 'DM7 - Researcher (rice production) IRTA – Amposta' and 'DM10 - Researcher (fishing) in IRTA Ràpita'. Their priorities have been the provisioning services directly linked with their field of research as they specialize in agriculture and fishing productions, respectively. On the other hand, 'DM8 - Researcher (regulating ES) in IRTA – Amposta', 'DM11 - COPATE', DM9: Researcher (aquaculture) in IRTA – Ràpita' and 'DM1 – AGBAR' have formed another group with an intermediate vision between supporting and provisioning services but also focusing their attention on the regulating processes. Finally, 'DM5 – EURECAT' and 'DM2 – Ecotourism company' are the experts who have rated the ESs differently, especially regarding the cultural services. Concretely, the result obtained by 'DM2 – Ecotourism company' also coincides with her personal and professional background giving a judgement which better emphasizes the cultural services as part of them. As a result, all the judgements are, to a greater or lesser extent, influenced by DMs' backgrounds, knowledge and perceptions.

4.2. Similarities and differences among the rice fields located in Spanish Mediterranean wetlands

Firstly, Table 5 shows the relevant identified ESs which have been prioritized in each study area.

As observable, some ESs appear in the three ecosystems as they are characteristic of rice field areas in wetlands, such as food or waste-water production, since rice fields traditionally grow on flooded shallows. Regarding cultural services, the three regions provide similar immaterial benefits (cultural heritage, sense of place or identity, knowledge, aesthetics, etc.). However, DMs have combined them somewhat differently depending on their criterion. Something similar happens with the regulating services except for the Albufera Natural Park, where DMs have identified less relevant ESs.

As for the provisioning services, the freshwater supply has not been considered in the Ebro River Delta since there; this resource comes from the upper area of the river, which exceeds the geographical limit studied. The importance of genetic sources in the Albufera Natural Park is explained since most of the rice varieties cultivated in Spain nowadays come from this area. Finally, the supporting services somewhat differ from one area to another depending on the DMs judgements.

On the other hand, Table 6 shows the weight of each of the four groups of ESs per DM and on average in the three study areas. The number of experts somewhat differs from one area to another.

As observable, some differences exist between the three study areas and even among DMs. Therefore, it is necessary to investigate whether they are statistically significant enough. Table 7 shows the ANOVA and the Tukey post-hoc test carried out among the three study areas. The mean difference has been considered significant at level 0.05. According to the analysis, the differences between the three study areas are statistically significant except for the regulating services. Moreover, apart from the ANOVA, it is also necessary to analyze the reason for these differences through a boxplot (boxplots shown in Fig. 4 and their descriptive statistics in Table 8), which graphically illustrates the differences among the four groups of ESs provided by the three study areas.

As a homogenous zone, the Guadalquivir marshes concentrate most provisioning and anthrophonic economic activities, especially rice production and the red swamp crayfish industry. On the contrary, the other two studies have considered the whole natural area, including the rice fields and different natural areas (dunes, Mediterranean forest and others), highlighting the complexity and heterogeneity of the ecosystems.

Table 7
ANOVA and Tukey post-hoc test among the three study areas.

(A) one-way ANOVA test

		Sum of squares	Degrees of freedom	Mean square	F	Significance*
Supporting	Inter-groups	0.345	2	0.172	10.638	**0.0000**
	Intra- groups	0.438	27	0.016		
	Total	0.783	29			
Provisioning	Inter- groups	0.793	2	0.397	24.957	**0.0000**
	Intra- groups	0.429	27	0.016		
	Total	1.222	29			
Regulating	Inter- groups	0.118	2	0.059	2.981	0.0680
	Intra- groups	0.533	27	0.02		
	Total	0.65	29			
Culture	Inter- groups	0.145	2	0.072	12.434	**0.0000**
	Intra- groups	0.157	27	0.006		
	Total	0.302	29			

(B) Tukey post-hoc test

Dependent variable	(I) Area	(J) Area	Mean Difference (I-J)	Std. Error	Significance*
Supporting	Albufera NP	Guadalquivir M	0.2008	0.0585	**0.0050**
		Ebro Delta	−0.0535	0.0556	0.6060
	Guadalquivir M	Albufera NP	−0.2008	0.0585	**0.0050**
		Ebro Delta	−0.2543	0.0572	**0.0000**
	Ebro Delta	Albufera NP	0.0535	0.0556	0.6060
		Guadalquivir M	0.2543	0.0572	**0.0000**
Provioning	Albufera NP	Guadalquivir M	−0.2664	0.0579	**0.0000**
		Ebro Delta	0.1299	0.0551	0.0650
	Guadalquivir M	Albufera NP	0.2664	0.0579	**0.0000**
		Ebro Delta	0.3963	0.0567	**0.0000**
	Ebro Delta	Albufera NP	−0.1299	0.0551	0.0650
		Guadalquivir M	−0.3963	0.0567	**0.0000**
Regulating	Albufera NP	Guadalquivir M	0.1564	0.0645	0.0560
		Ebro Delta	0.0898	0.0614	0.3240
	Guadalquivir M	Albufera NP	−0.1564	0.0645	0.0560
		Ebro Delta	−0.0667	0.0631	0.5490
	Ebro Delta	Albufera NP	−0.0898	0.0614	0.3240
		Guadalquivir M	0.0667	0.0631	0.5490
Culture	Albufera NP	Guadalquivir M	−0.0908	0.0351	**0.0390**
		Ebro Delta	−0.1662	0.0333	**0.0000**
	Guadalquivir M	Albufera NP	0.0908	0.0351	**0.0390**
		Ebro Delta	−0.0754	0.0343	0.0900
	Ebro Delta	Albufera NP	0.1662	0.0333	**0.0000**
		Guadalquivir M	0.0754	0.0343	0.0900

* The bold and underline means that the mean difference is significant at level 0.05.

The relative importance of the supporting and provisioning services among the three areas explicitly differs between the Guadalquivir Marshes and the other two study areas, as the slight differences between the Albufera Natural Park and the Ebro Delta are not significant enough. These differences could lie in the portion studied. As previously explained, the study in the Guadalquivir marshes only considers a pretty homogenous and specific zone. It concentrates the majority of provisioning and anthrophonic economic activities, especially rice production and the red swamp crayfish industry. On the contrary, the other two studies have considered the whole natural area, including the rice fields and different natural areas (dunes, Mediterranean forest and others). Conservationist experts from the Guadalquivir Marshes agreed that the homogeneity of the rice fields decreases the area's biodiversity (supporting services).

Thus, a greater or lesser homogeneity could make the importance of these services differ. The provision of food is higher in the Guadalquivir Marshes since the study only considers the rice fields area and surrounding and the benefits provided by the supporting services are not as relevant as in the core zone of the Doñana National Park.

On the other hand, the differences in the cultural services cannot be explained in the same way. The results obtained in the Albufera Natural Park have differed from the other two areas. Concretely, their value is

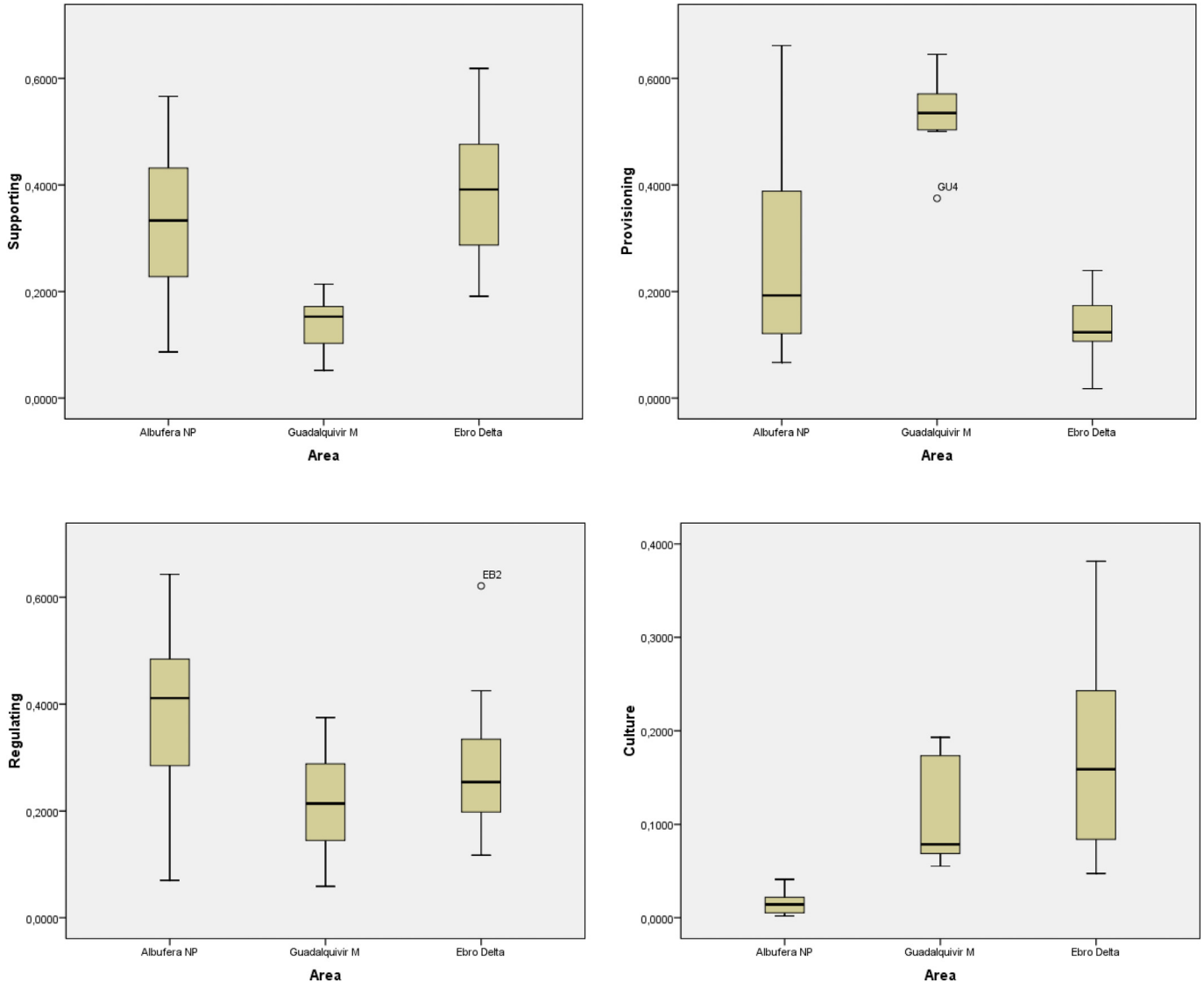

Fig. 4. Boxplot with the four ESs' groups in the three areas.
(*) The small circles (GU4 in provisioning services and EB2 in regulating services) are outliers.

Table 8
Descriptive statistics of the priorities obtained in the three areas.

Group of ESs	Area	N	Mean	Std. Deviation	Std. Error	95 % Confidence Interval for Mean	
						Lower Bound	Upper Bound
Supporting	Albufera NP	10	0.3369	0.1527	0.0483	0.2276	0.4461
	Guadalquivir M	9	0.1361	0.0510	0.0170	0.0969	0.1753
	Ebro Delta	11	0.3904	0.1439	0.0434	0.2937	0.4871
	Total	30	0.2963	0.1643	0.0300	0.2349	0.3576
Provisioning	Albufera NP	10	0.2667	0.1935	0.0612	0.1283	0.4051
	Guadalquivir M	9	0.5331	0.0769	0.0256	0.4739	0.5922
	Ebro Delta	11	0.1368	0.0669	0.0202	0.0918	0.1817
	Total	30	0.2990	0.2053	0.0375	0.2223	0.3756
Regulating	Albufera NP	10	0.3798	0.1653	0.0523	0.2616	0.4981
	Guadalquivir M	9	0.2234	0.1042	0.0347	0.1432	0.3035
	Ebro Delta	11	0.2900	0.1414	0.0426	0.1950	0.3850
	Total	30	0.3000	0.1498	0.0273	0.2440	0.3559
Culture	Albufera NP	10	0.0166	0.0141	0.0045	0.0065	0.0267
	Guadalquivir M	9	0.1075	0.0561	0.0187	0.0643	0.1506
	Ebro Delta	11	0.1828	0.1141	0.0344	0.1062	0.2595
	Total	30	0.1048	0.1020	0.0186	0.0667	0.1429

significantly lower than that of the Guadalquivir Marshes and the Ebro Delta. Considering the different interviews with the DMs, the reason could lie in a rurality factor. The Albufera Natural Park is located in the metropolitan area of Valencia, the third most populated city in Spain and surrounded by about one million inhabitants.

In contrast, the other two ecosystems are located in rural regions where a significant part of the population directly or indirectly works on activities related to the local agriculture or environment. The loss of contact with rural areas and their traditions reduces thus the value or social perception of the local inhabitants. This fact can easily alter the perception of cultural services such as Identity or cultural heritage.

Apart from the areas, another fact to consider is the diverse judgements of DMs. A complete dendrogram (shown in Fig. 5) has been done to observe the proximity among the thirty DMs participating in the three studies. After attending the resulting dendrogram, all the DMs were aggregated into three clusters to distribute them equitably. As it is detected, it is not only the area or its part considered differing in the prioritization but also the DMs' perception, experience and background.

Afterwards, a post-hoc test (shown in Table 9) has been conducted with the three resulting clusters using the Bonferroni method.

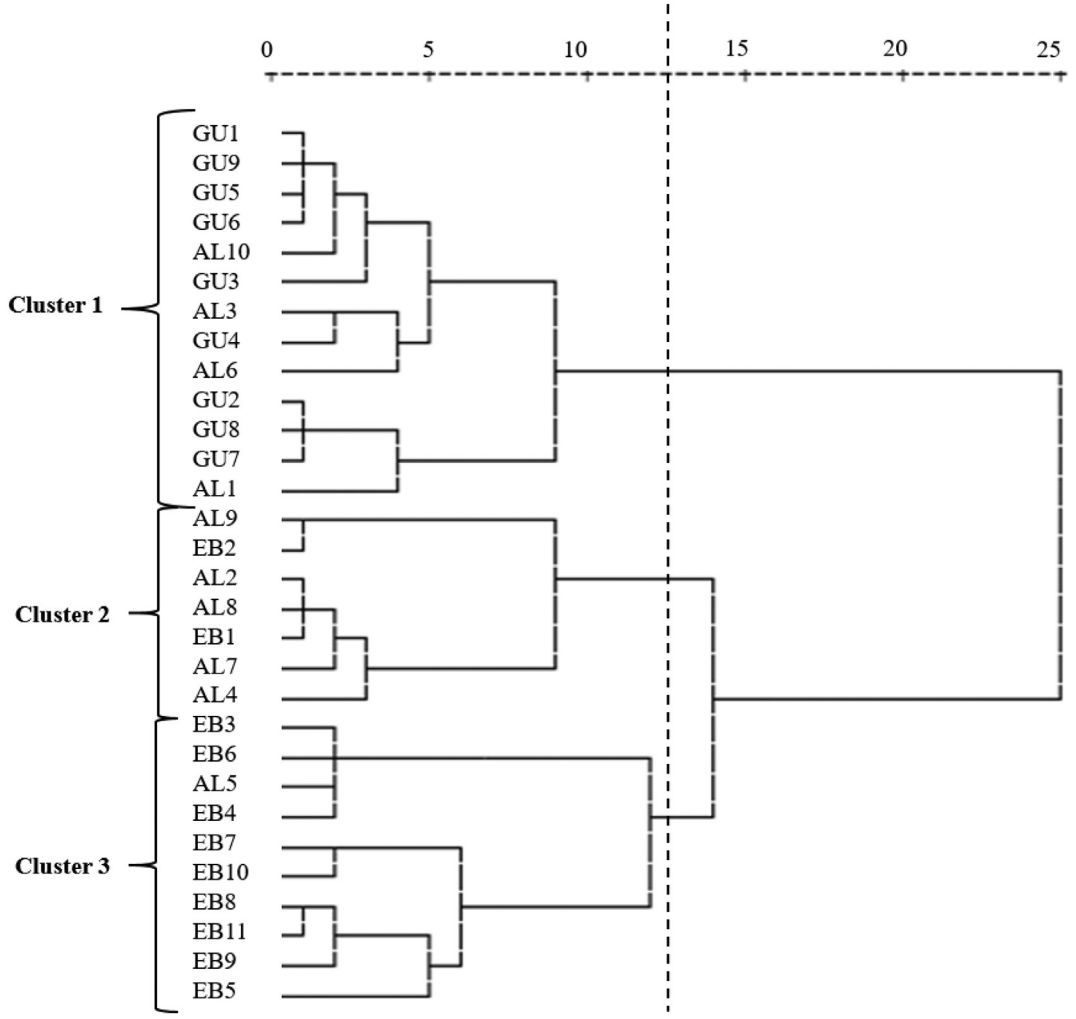

Fig. 5. Dendrogram with all DMs

Decision-makers in the Albufera Natural Park: AL1 Appellation of Origin 'Arròs de València'; AL2 Professor at the Polytechnic University of Valencia in the Department of Agroforestry Ecosystems; AL3 Professor at the Polytechnic University of Valencia in the Department of Vegetal Production); AL4 Technician in PAVAGUA (green filters); AL5 Technician in the Assut Foundation; AL6 Technician in the Farmer's Union 'La Unió'; AL7 Technician in the conservationist NGO 'SEO-Bird Life'; AL8 Technician in the Fishermen Community; AL9 Technician in the conservationist NGO 'Acció EcologistaAgró'; AL10 Technician in the Farmer's Union 'AVA-ASAJA'.

Decision-makers in the Guadalquivir marshes: GU1 Freelance agrarian technician; GU2 Local politician with agricultural competency; GU3 Technician working for a cooperative; GU4 Technician of a Community of irrigation; GU5 Technician working for a red swamp crayfish industry; GU6 Technician working for the Federation of rice growers of Seville; GU7 Environmentalist and member of the NGO, SEO-Bird Life; GU8 Agrarian Union member in UPA; GU9 Professor at the University of Seville.

Decision-makers in the Ebro Delta: EB1 AGBAR (green filters); EB2 Ecotourism company; EB3 NGO 'Picampall'; EB4: NGO 'SEO-Bird Life'; EB5 EURECAT (regional technological centre); EB6 Researcher in the environmental economy; EB7: Researcher (rice production) IRTA – Amposta; EB8 Researcher (regulating ES) in IRTA – Amposta; EB9: Researcher (aquaculture) in IRTA – Ràpita; EB10 Researcher (fishing) in IRTA - Ràpita; EB11 COPATE (Consortium of environmental policies of 'Terres de l'Ebre').

All the DMs from the first cluster come from the Guadalquivir marshes, except for four experts from the Albufera Natural Park. The DMs from this cluster have given the most importance to provisioning services to the detriment of supporting services. As mentioned before, in the Guadalquivir marshes, this preference could be mainly based on the homogeneity of the portion of the area studied.

The second cluster, on the contrary, has emphasized the supporting services over the other three groups. It is formed by the majority of DMs from the Albufera Natural Park and the two DMs from the Ebro Delta. In contrast, the third cluster is formed by all the DMs from the Ebro Delta. EB1 and EB2 are the exceptions, as they are in the second group. Only AL5, one DM from another area, is included. This cluster is closer to the second group than the first one as their vision of provisioning, and supporting services is similar, emphasizing the first group. However, this third cluster has minimized the regulating service's importance and better rated the cultural ones.

Accordingly, the study area is the main factor that explains the differences between all the judgements. However, there are also some significant differences between Albufera Natural Park and the Ebro Delta regarding cultural services. On the other hand, the effect of the DM's perception and background could be also influencing the results since some DMs' judgements are closer to others from different areas than those in their area.

The case of the DMs from the Albufera Natural Park stands out over the other areas. Despite the Guadalquivir's and the Albufera's ESs being statistically different except for the regulating services, four DMs' judgements are closer to the Guadalquivir Marshes' priorities than the rest of the DMs of their area. It coincides that the four DMs on the first cluster are the ones who work or research rice production (the two Farmer's Unions, the Appellation of Origin and the university professor researching Vegetal Production), whereas the others are more conservationists.

Table 9
Post-hoc test conducted with the three clusters using Bonferroni method.

Group of Ess	(I) Cluster	(J) Cluster	Mean Difference (I-J)	Standard Error	Significance*
Supporting	1	2	−0.2039	0.0521	**0.0020**
		3	−0.2687	0.0468	**0.0000**
	2	1	0.2039	0.0521	**0.0020**
		3	−0.0649	0.0548	0.7410
	3	1	0.2687	0.0468	**0.0000**
		2	0.0649	0.0548	0.7410
Provisioning	1	2	0.3989	0.0374	**0.0000**
		3	0.361	0.0335	**0.0000**
	2	1	−0.3989	0.0374	**0.0000**
		3	−0.0379	0.0393	1.0000
	3	1	−0.361	0.0335	**0.0000**
		2	0.0379	0.0393	1.0000
Regulating	1	2	−0.251	0.0493	**0.0000**
		3	0.0108	0.0443	1.0000
	2	1	0.251	0.0493	**0.0000**
		3	0.2618	0.0518	**0.0000**
	3	1	−0.0108	0.0443	1.0000
		2	−0.2618	0.0518	**0.0000**
Culture	1	2	0.056	0.0391	0.4890
		3	−0.103	0.0351	**0.0200**
	2	1	−0.056	0.0391	0.4890
		3	−0.159	0.0411	**0.0020**
	3	1	0.103	0.0351	**0.0200**
		2	0.159	0.0411	**0.0020**

* The bold and underline mean that the mean difference is significant at level 0.05.

An ANOVA between these two DMs' categories (productivist and conservationist DMs) has been conducted. This test, shown in Table 10, aims to analyze whether the differences in their judgements are statistically significant.

According to the ANOVA, the differences between the four productivity DMs and the conservationist ones are statistically significant for the supporting, regulating and cultural ESs. The primary difference has come from the provisioning services. The four experts who work or research rice production have best ranked the services they directly work with compared to the other six DMs. Therefore, DMs' perceptions and professional backgrounds could interfere with the results obtained in the Albufera Natural Park, although future research must be done to corroborate this possible explanation.

This fact emphasizes the importance of considering various DMs with different backgrounds capturing every potential existing diversity. Moreover, it also underlines the necessity of using sophisticated multi-criteria methods such as ANP or a fuzzy and hybrid version to grasp the reality of the ecosystem complexity better.

Table 10
ANOVA between the productivist and the conservationist DMs from the Albufera Natural Park.

		Sum of Squares	Degrees of freedom	Mean Square	F	Significance*
Supporting	Inter-groups	0.106	1	0.106	8127	**0.021**
	Intra-groups	0.104	8	0.013		
	Total	0.210	9			
Provisioning	Inter-groups	0.264	1	0.264	29,008	**0.001**
	Intra-groups	0.073	8	0.009		
	Total	0.337	9			
Regulating	Inter-groups	0.050	1	0.050	2020	0.193
	Intra-groups	0.196	8	0.025		
	Total	0.246	9			
Culture	Inter-groups	0.001	1	0.001	14,204	**0.005**
	Intra-groups	0.001	8	0.000		
	Total	0.002	9			

* The bold and underline mean that the mean difference is significant at level 0.05.

5. Conclusions

The three Mediterranean wetlands studied are complex areas where most ESs are strongly interconnected. The Analytic Network Process (ANP) has allowed prioritizing the ESs of each of the three ecosystems in all their complexity. This multi-criteria method has well captured the judgements of the decision-makers who have participated in the process. This study has highlighted the differences between the three areas due to possible geographical and sociocultural factors and between decision-makers.

Regarding the Ebro Delta, the supporting services have resulted in the most relevant ESs to most DMs, especially those who are part of conservationist organizations. Concretely, the biodiversity and geodiversity of the Ebro Delta shelters are perceived as the most effective service in the area. The provision of food is the second most-rated service in the Ebro River Delta. Regarding Albufera Natural Park, regulating services have become the most relevant, followed by supporting services. As for the Guadalquivir Marshes, the provisioning services is the best-ranked group. Generally, provisioning and supporting services have become crucial in the whole network as they mainly support all the other services. The prioritization also differs when the ESs are individually analyzed, as some only exist or are relevant in one area. This fact also highlights the importance of implementing these studies and methodologies from a global to a local scale.

On the other hand, the priorities obtained from the Guadalquivir Marshes statistically differ from the Albufera Natural Park and the Ebro Delta except for the regulating services. Concretely, provisioning services have been rated more intensely over the total value in the Guadalquivir Marshes, and the supporting ones reversed compared to the other two ecosystems. There are also statistically significant differences between the Albufera Natural Park's cultural services in relation to the other two areas. The choice of the study area could have changed the results depending on its heterogeneity since the portion studied in the Guadalquivir Marshes is geographically more homogeneous. Accordingly, the DMs' judgements in the Guadalquivir Marshes are more similar. On the contrary, there are no significant differences between the supporting and provisioning services of the Ebro Delta and the Albufera Natural Park.

Finally, all DMs have tended to rank supporting and provisioning services among the most crucial ones in the Ebro Delta. In the Guadalquivir Marshes, all agreed to best-ranking the provisioning services, as mentioned before. Nonetheless, in the Albufera Natural Park, the conservationist organizations and the researchers specializing in the environment have better rated the supporting services. On the contrary, the researchers who specialised in rice or fishing production have highlighted the importance of the provisioning services. These differences have been proven to be statistically significant. Therefore, decision-makers perceptions or professional backgrounds could have influenced the results obtained in the Albufera Natural Park, although future research must be done to corroborate this possible explanation. Nonetheless, these differences are somewhat minor compared to the geographical factor. Accordingly, the prioritization or valuation of the ESs has to implement participatory actions and methodologies to consider a broader range of perceptions and points of view linked to the area. It also allows the study of the ESs from a more practical and local perspective.

CRediT authorship contribution statement

David Jorge-García: Conceptualization, Methodology, Data curation, Writing- Original draft preparation, Visualization, Investigation, Software, Writing, Reviewing and Editing.

Vicente Estruch-Guitart: Conceptualization, Methodology, Supervision, Reviewing and Editing.

Pablo Aragonés-Beltrán: Software, Validation, Reviewing.

Data availability

The data that has been used is confidential.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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