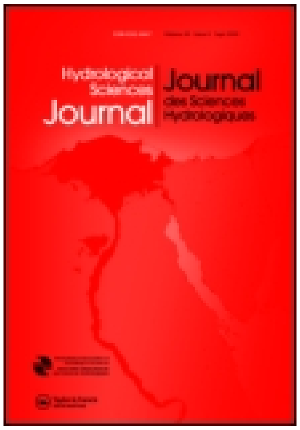

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Ecosystem services of inland wetlands from the perspective of the EU Water Framework Directive implementation in Spain

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Abstract Inland wetlands are numerous in Spain and have been classified in a broad range of categories. At present, the most relevant classification is that applied by River Basin Authorities for the identification of water bodies, according to the EU Water Framework Directive. This typology recognises up to 27 different types of inland lake in Spain. The aims of this paper are to review current knowledge about the evaluation of the ecosystem services provided by inland wetlands, and to present a discussion about two cases that have been subject to economic evaluation. The results obtained highlight the fact that little work has been done in Spain on this topic, thus opening up new lines of research. In particular, a significant amount of work is required to identify and characterize specific ecosystem services provided by wetlands in Mediterranean conditions, which in turn will do a great deal to highlight the importance of their conservation.

Key words inland wetlands; types of lake; EU Water Framework Directive; functions; services; economic valuation of wetlands; Spain

Services des écosystèmes des zones humides intérieures dans la perspective de la mise en oeuvre en Espagne de la directive cadre sur l’eau de l’Union Européenne

Résumé Les zones humides intérieures sont nombreuses en Espagne et ont été classées selon un large éventail de catégories. A l’heure actuelle, la classification la plus pertinente est celle appliquée par les autorités de bassin de rivières pour l’identification des masses d’eau, conformément à la Directive Cadre sur l’Eau de l’Union Européenne. Cette typologie reconnaît jusqu’à 27 types différents de lacs intérieurs en Espagne. Les objectifs de cette étude sont d’examiner les connaissances actuelles sur l’évaluation des services écosystémiques fournis par les zones humides intérieures, et de présenter une discussion sur deux cas qui ont été soumis à une évaluation économique. Les résultats obtenus mettent en évidence le fait que peu de travaux ont été réalisés en Espagne sur ce sujet, ouvrant ainsi de nouvelles lignes de recherche. En particulier beaucoup de travail est nécessaire pour identifier et caractériser les services écosystémiques fournis par les zones humides spécifiques dans les conditions méditerranéennes, qui à leur tour vont participer à mettre en évidence l’importance de leur conservation.

Mots clefs zones humides continentales; types de lac; Directive Cadre sur l’eau UE; fonctions; services; évaluation économique des zones humides; Espagne

INTRODUCTION

The purpose of this paper is to review current knowledge about the evaluation of wetland ecosystem services in Spain, excluding coastal areas. To achieve this, we discuss the classification and description of specific services; describe the status of wetlands in Spain according to the available technical information, and present the typology of lakes established by the Hydrologic Planning Instruction, HPI (Ordinance ARM/2656/2008, of 10 September), the official guideline for the development of river basin management under the EU Water Framework Directive (WFD) (EC 2000).

In Spain, literature on wetland ecosystem services is scarce, although there are some relevant

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literature reviews (e.g. Junta de Andalucía 2002). However, it is well known that wetlands provide multiple services that are an asset for society. These services should be identified and measured, so that wetlands are managed and preserved in accordance with the functional conditions that are specific to them (something that many authors describe as their *ecological integrity*).

Although the WFD does not define the concept of wetland, it refers to the protection of "terrestrial ecosystems and wetlands directly depending on aquatic ecosystems" (Art.1). In parallel, the Habitats Directive (HD) (Directive 92/43/EEC) seeks to identify and define the ecological requirements of the habitats of Community interest that are in these ecosystems. Both directives closely overlap in the management of the environment in general and wetlands in particular. The need to make an inventory of wetlands for the purposes of both Directives is generating many problems, and the Spanish National Wetlands Inventory is not yet complete.

Why is it important to identify the services that Spanish wetlands provide? There are two main reasons for developing this approach: on the one hand, Spain has the largest diversity of wetland ecosystems in Europe, making it possible to derive a wide range of goods and services that traditionally have not been taken into account (MMA 2000). On the other hand, some of the ecological functions of wetlands, and some of the biotic and abiotic components of wetland ecosystems, produce goods that may have no economic value, but give benefits that are essential to society (Junta de Andalucía 2002).

BASIC CONCEPTS

Here, the basic concepts that are central to the study are described, and the objectives set out. For the purpose of this paper, Spanish inland wetlands refer to those epi-continental, aquatic, lentic or still pools of water, retained, or not constituting coastal ecosystems (Camacho *et al.* 2009). This includes lakes, ponds, wetlands and other water bodies with a variable surface to volume ratio.

The Spanish HPI uses a very broad concept for *lake* that covers both traditional lakes (large and deep) and wetlands of different types. This includes: retained-water, aquatic ecosystems with a surface area greater than 0.08 km^2 and a maximum depth greater than 3 m; those with an area exceeding 0.5 km^2 regardless of depth; and those that do not meet the above criteria but have special ecological significance for the Administration, considering wetlands of international importance included in the Ramsar List (of the 68 wetlands in the Spanish Ramsar List as of February 2011, 60% are inland wetlands).

Functions, goods and services of wetlands

For this study, we use the definitions included in the Spanish Strategic Plan for Wetlands (MMA 2000) and in the Andalusian Wetland Plan (Junta de Andalucía 2002). According to these sources, processes and interactions generate a series of wetland values and benefits that are basically of three types: functionality, products and attributes. The term *wetland function* defines the benefits that wetlands provide, either directly or indirectly, through the interactions of biotic and abiotic components (groundwater recharge, nutrient retention, flood protection, etc.).

According to different authors (Junta de Andalucía 2002), the concept of *good* may or may not be equivalent to *service*. *Good* and *service* concepts may be different if one takes into account that "*some of the ecological functions of wetlands generate services (waste assimilation, soil fertility, water purification, flood control, erosion control, aesthetic and emotional pleasure), while some elements of their structure are involved in biotic and abiotic production of goods (species of commercial interest, hunting, fishing, livestock, agricultural supplies water, minerals, etc.)*."

Ecosystem services are defined by some authors (Bolund and Hunhammar 1999, MMA 2000, Junta de Andalucía 2002, Millennium Ecosystem Assessment, 2005, Brauman *et al.* 2007, Barbier, 2009), as the benefits that people obtain from ecosystems. Other authors (e.g. Gordon *et al.* 2010) define them as the social benefits of ecological processes. Both definitions include provisioning services, such as food and water; regulating services, such as regulation of floods, droughts, land degradation and disease; support services, such as soil formation and nutrient cycling; cultural services; and recreational, spiritual, religious and other nonmaterial benefits.

It is important to mention two additional and related concepts to the three explained above. These are *attributes* and *products*, which are confusing and, in some cases, ambiguous terms. The term *attributes* refers to those components of a wetland that have value in themselves, or give rise to other uses (e.g. biodiversity, cultural heritage). The term *products* refers to those components directly exploitable by

Table 1 Classification of values for wetlands (Barbier *et al*. 1997).

Use values			Non-use values
Direct use value	Indirect use value	Option and quasi-option value	Existence value
Fish	Nutrient retention	Potential future uses	Biodiversity
Agriculture	Flood control	Future value of information	Culture, heritage
Fuel wood	Storm protection		Bequest values
Recreation	Groundwater recharge		
Wildlife harvesting	External ecosystem support		
Peat/energy	Micro-climatic stabilisation		

humans, and from which they can derive an economic benefit (e.g. fisheries, game species).

In the economic context, it is also important to pay attention to another differentiation between the *value* of wetlands and their economic valuation, as they are not equivalent. The term *value* includes, to a certain extent, the concepts of products and goods. For example, some authors, such as Barbier *et al.* (1997), have provided a classification of wetland values (see Table 1). The wetland assessment procedures available in the literature are varied (Barbier *et al.* 1997, Emerton and Bos 2004, De Groot *et al.* 2007).

There are several goods that can be generated by any functional type of wetland, not only in Spain but worldwide. This is the case, for example, of the reserves of genetic information. Moreover, they act as carbon sinks or can have some intangible values related to religious issues (MEA 2005), as occurs with El Rocío in the Doñana National Park wetland in Spain. In some cases, certain functions do not warrant obtaining particular goods and services. This is the case of goods (e.g. medicinal plants) which are attributes of particular sites. A service of this kind is the aesthetic and emotional pleasure that certain wetlands provide (Junta de Andalucía 2002).

Economic valuation of wetlands

Economic valuation of wetlands usually does not take into account many of these values. In fact, valuations are usually restricted to the quantification of a specific value or service, generally one or several *products* generated by the wetland. This occurs in two case studies discussed in the final section of this paper: in one of them a number of wetland products are evaluated (e.g. hunting, fishing, timber, recreation), while in the other just recreational use is assessed (this is the case of a National Park, whose legal condition as a protected ecosystem limits use and exploitation possibilities).

It is very interesting to produce economic valuation studies of the benefits provided by wetlands, because most planning decisions are based on economic criteria. The techniques of economic evaluation of wetlands are diverse.

De Groot *et al.* (2007) provide guidelines for conducting economic assessments of wetland services. According to these authors, the evaluation process includes the following steps: (1) inventory of functions, (2) identification of services, and (3) assessment of services.

STATE OF THE ART OF WETLANDS IN SPAIN

In Spain, there is scarce information about some of the most important and internationally known wetlands (e.g. Doñana, Ebro Delta, Daimiel). Information on the remaining wetlands is virtually nonexistent.

According to the information available (DGOH 1991, 1995), some authors suggest the existence of between 1200 and 1600 wetlands in Spain (Montes 1995, Bernués 2009). However, depending on the types and minimum sizes considered, as well as the delineation methods used, total numbers can be much higher, ranging between 2500 and 3600 (DGB 2006). In any case, figures for total estimates should be considered with caution.

According to this information, 92.50% of Spanish wetlands are inland wetlands (Fig. 1) and 7.50% are coastal (MMA 2000). In contrast, in terms of area, inland wetlands cover 13.60% of the total wetland surface, as many of the coastal wetlands have a large area. Specifically, only six coastal wetlands occupy 86% of the total wetland surface in Spain (MMA 2000). In summary, the Spanish wetlands are characterized by an abundance of inland

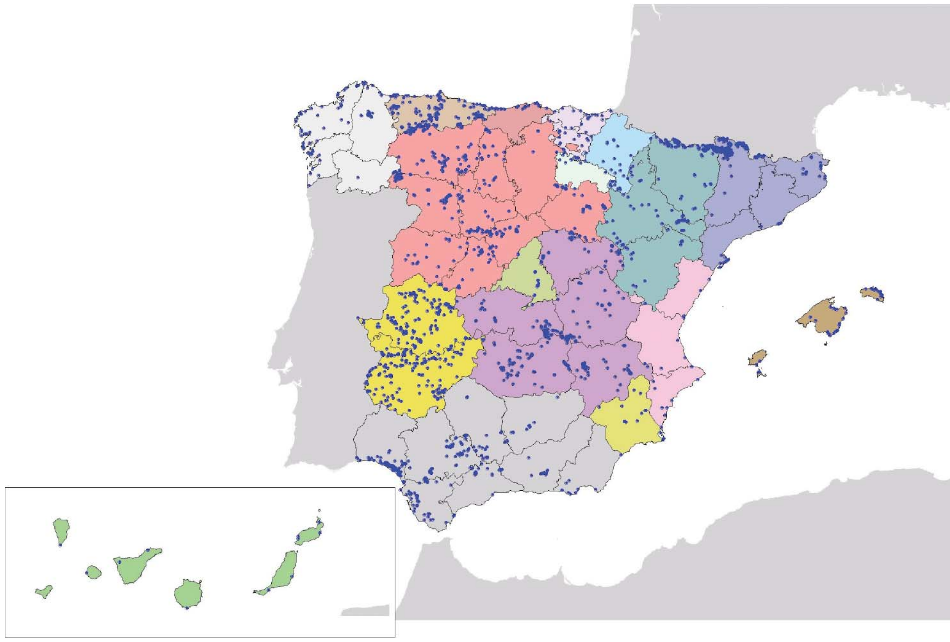

Fig. 1 Wetland distribution in Spain according to the Spanish Inventory of Wetlands, currently being developed (DGB 2006).

water bodies of small size, accompanied by a small number of large coastal wetlands. According to MMA (2000), 55% of Spanish inland wetlands are considered to have an acceptable conservation status, while 36% are altered and 9% are considered significantly degraded.

Some authors (e.g. Casado and Montes 1995) indicate that at least 60% of the original wetland surface has been lost in the last 200 years, with wetland loss concentrated in the last 50 years (MMA 2000). The drainage of wetlands for agriculture is clearly the main cause (Bernués 2009). The total loss of different types of wetlands is shown in Table 2 (MMA 2000).

IMPLEMENTATION OF THE WFD FOR LAKES AND WETLANDS IN SPAIN

The implementation of the WFD in Spain has been a long and complex process. The new river basin management plans that should have been approved in December of 2009 are not yet completed. The implementation started with the transposition of the WFD into Spanish law through Law 62/2003 of Administrative and Fiscal measures, of 30 December 2003. The Water Planning Regulation (Royal Decree 907/2007 of 6 July), which establishes the guidelines for the development of the basin management plans, was approved in 2007, followed by the approval in 2008 of the HPI.

Table 2 Evolution of lakes and wetlands surface according to MMA (2000).

Type	Original surface (ha)	Current surface (ha)	% Current surf./ original surf.
Inland wetlands	40 600	16 421	40.4
Mountain wetlands*	2 314	2 386	103.1
Karstic wetlands	874	784	89.7
Inland wetlands	14 802	4 805	32.5
Saline wetlands	6 743	5 212	77.3
Floodplain wetlands	15 867	3 234	20.4
Coastal wetlands	239 628	97 679	40.8
Total	280 228	114 100	

* Increase caused by dams built for hydroelectric purposes.

The HPI distinguishes between 27 different types of inland lake (see Table 3): nine medium and high mountain lake types, six that are linked to karst processes, and 12 types of lake and wetland in sedimentary basins.

In Spain, Water Authorities are responsible for identifying specific wetlands that may correspond to each type, a process that is not yet completed. At present, only three of the 17 Autonomous Regions in Spain have included their wetlands in this inventory that, so far, contains only 189 sites. However, this work is well advanced for new inclusions (Ministry of Environment of Spain, personal communication, February 2011).

Table 3 Modified list of variables which define the ratio of each type of inland lake in the HPI (2008).

Types of lake	Altitude (m)	Origin	Regime of contribution	Hydroperiod	Size (ha)	Depth (m)	Conductivity (μS/cm)	Alkalinity (meq/L)	Examples
1	>1500	Glacier	Epigenic	Permanent	<50	>10	<500	<0.2	Sierra de Gredos
2	>1500	Glacier or Glacier-Karst	Mixed	Permanent	<50	>10	<500	>0.2	Pyrenees
3	>1500	Glacier	Epigenic	Permanent	<50	<10	<500	<0.2	Central System
4	>1500	Glacier or Glacier-Karst	Mixed	Permanent	<50	<10	<500	>0.2	Pyrenees
5	>1500	Glacier	Epigenic	Temporal	<50	<3	<500	>0.2	Sierra de Urbión
6	900–1500	Glacier	Epigenic	Permanent	>50	>10	<500	<0.2	Sanabria Lake
7	1000–1500	Glacier or Glacier-Karst	Mixed	Permanent	<50	>10	<500	>0.2	Enol Lake (Picos de Europa)
8	1000–1500	Glacier or Glacier-Karst	Mixed	Permanent	<50	<10	<500	>0.2	Ercina Lake (Picos de Europa)
9	>2000	Glacier	Epigenic	Permanent	<50	>3	<500	<1	La Caldera Lake (Sierra Nevada)
10	15–1500	Calcareous karst	Hypogenic	Permanent	<50	>3	<3 000	>1	Grande Lake in El Tobar (Serranía de Cuenca)
11	5–1500	Calcareous karst-source	Hypogenic	Permanent	<50	<3	500–3 000	>1	Fuentona de Muriel (Soria)
12	15–1500	Calcareous karst-travertine closure	Mixed	Permanent	Any	>3	<3 000	>1	Ruidera Lakes (Albacete and Ciudad Real)
13	15–1500	Calcareous karst	Hypogenic	Temporal	<50	>3	<3 000	>1	Espolla Clot Lake
14	15–1500	Gypsum-karst	Hypogenic/ mixed	Permanent	>50	>3	500–3 000	>1	Banyoles Lake (Girona)
15	15–1500	Gypsum-karst	Hypogenic/ mixed	Permanent	<50	>3	500–50 000	>1	Montcortés Lake
16	15–1500	Diverse genetic processes	Mixed	Permanent	Any	<5	<500	Any	Honda Lake (Guadalajara)
17	15–1500	Diverse genetic processes	Mixed	Temporal	Any	<3	<500	Any	Puebla de Beleña wetland complex
18	15–1500	Diverse genetic processes	Mixed	Permanent	Any	<3	500–3 000	>1	Taray Lake (Cuenca)
19	15–1500	Diverse genetic processes	Mixed	Temporal	Any	<3	500–3 000	>1	Boada lagoon (Duero basin)
20	15–1500	Diverse genetic processes	Mixed	Permanent	Any	<3	3 000–50 000	>1	Grande de Villafranca (Toledo)
21	15–1500	Diverse genetic processes	Mixed	Temporal	Any	<3	3 000–50 000	>1	Laguardia (Ebro basin)
22	15–1500	Diverse genetic processes	Mixed	Permanent	Any	<6	>50 000	>1	Chiprana Lake (Ebro basin)
23	15–1500	Diverse genetic processes	Mixed	Temporal	Any	<3	>50 000	>1	Gallocanta Lake (Ebro basin)
24	5–1500	Fluvial. Type flood plain.	Mixed	Any	Any	<3	<3 000	>1	Arkaute Betoñom
25	5–1500	Fluvial. Type flood plain.	Mixed	Any	Any	<3	3 000–50 000	>1	Tablas de Daimiel (Guadiana basin)
26	5–1500	Fluvial. Type abandoned meander	Mixed	Any	Any	<10	500–3 000	>1	Alfranca (Ebro basin)
27	15–1500	Associated to alkalinised peat bog	Hypogenic	Permanent	<50	<3	3 000–50 000	>1	Padul (Sierra Nevada)

Key: [dark grey] High and medium mountain wetlands [light grey] Karstic wetlands [white] Sedimentary basin wetlands

FUNCTIONS, GOODS AND SERVICES PROVIDED BY VARIOUS TYPES OF INLAND WETLAND IN SPAIN

We have described the various types of inland wetland that exist in Spain. That diversity means there is a multiplicity of functions, which give rise to a multiplicity of goods and services. Although most Spanish wetlands are of small size, it would be appropriate to consider them as the *kidneys* of the landscape (Mitsch and Gosslink 1993) with regard to their role in the regulation of key ecological processes operating either regionally or globally. They also have important physical features (hydrological, chemical, biological and ecological), as well as considerable socio-economic tangible and intangible values (Montes 1995).

A list of the functions, goods and services that can be potentially provided by Andalusian wetlands is discussed in the Andalusian wetland plan (Junta de Andalucía 2002). According to the authors of the plan, this inventory could be largely extrapolated to the entire Spanish territory, as the wetland types present in Andalusia are representative of those in the rest of the country.

Table 4 identifies the primary functions performed by the four large groups of wetlands recognized in Spain by the HPI (high and medium mountains, karst and interior basin sedimentation), as well as the goods and services that they potentially provide. It is worth noting that such functions, goods and services may be different depending on their type and scale, both spatial (local, regional or national) and temporal (analysing the benefits they provide in the short or long term). This paper uses a national level and short-term approach.

ECONOMIC VALUATION OF SPANISH WETLANDS

General framework

Economic valuation of wetland ecosystems is not widespread in Spain. In fact, this work was only started in the late 1990s, and has only been applied to five cases (Table 5), three of which correspond to coastal wetlands (Albufera of Valencia, Doñana National Park and Delta del Ebro), and two to inland wetlands (wetlands of Navarra and National Park of Las Tablas de Daimiel); the latter two are addressed herein.

Wetlands of Navarre

A wide typology of wetlands is scattered throughout the Autonomous Region of Navarre. Almost all wetlands in Navarre have been affected by a high degree of human intervention: in many cases agriculture and livestock activities have led to a change in their boundaries through, for example, the construction of dams, the planting of crops in their margins, hunting and fishing activities. Today, tourism and recreational activities should be added as additional pressures on these ecosystems.

The Navarre Wetland Inventory, established by Provincial Decree 4/1997 of 13 January, includes 23 sites. According to Elorrieta and Castellano (2003), these 23 wetlands can be grouped as follows:

Natural areas of Atlantic rhythm associated with limestones These are located in the massive limestone Urbasa-Andia, Sierra de Lóquiz and Aralar.

Table 4 Some correlation between types, functions, goods and services of Spanish wetlands (modified from Junta de Andalucía 2002).

Major types of wetland	Functions	Goods	Services
High mountain wetlands	Recharge of aquifers Delay of run off	Drinking and irrigation water Landscape contrast	Microclimate control
Medium mountain wetlands	Discharge of aquifers Recharge of aquifers Delay of run off Production/Recycling of organic matter	Drinking and irrigation water Building materials Landscape contrast	Flood control Water storage Nutrient cycles
Karstic wetlands	Discharge of aquifers Delay of run off	Animal husbandry Water and/or irrigation	Nutrients cycles Water storage
Sedimentary basin wetlands	Discharge of aquifers Recharge of aquifers Delay of run off Production/Recycling of organic matter	Animal husbandry Irrigation and watering Building materials Brine and salt Green tourism	Flood control Water storage Nutrient cycles Sediment retention

Table 5 Summary of the Spanish wetlands where economic valuation studies have been conducted.

Type of wetland	Wetland name	Applied method	Valuation objective	Source
Inland	Wetlands of Navarre	Validated set of methods that make reference value market	Direct-use goods (hunting and fishing) and non-use goods or environmental (wood, grass, wind and carbon)	Elorrieta and Castellano (2003)
	Tablas de Daimiel National Park	Contingent valuation	Recreational	Júdez *et al.* (2003)
Coastal	Albufera de Valencia	Contingent valuation	Recreational	Del Saz and Suárez (1998)
	Delta del Ebro		Economic viability of organic agriculture	EC (2007)
	Doñana National Park	Contingent valuation (WTP)	Esthetical and spiritual values Educational values Scientific values Religious values Indirect use value	Martín-López (2007), Martín-López *et al.* (2007)
		Restoration Costs Method	Control of Alien Invasive Species Grazing	
		Conservation Costs Method	Control of Alien Invasive Species Grazing	
		Travel Costs Method	Religious values	
		Research Costs	Scientific values	
		Market Analysis	Crops, cattle, fish, coastal resources, beekeeping and forest resources	

WTP: willingness to pay.

They appear on karstic limestone substrates, but with capacity to hold water due to the appearance of clay sediments. They are usually small and have little habitat diversity. These wetlands correspond to types 10 or 13 of Table 3, depending on their hydro-period, i.e. the duration and frequency of flooding.

Natural areas of endorheic Mediterranean pace and steppe origin These wetlands are located in the Ribera de Navarra in usually flat, open areas surrounded by crops. They are formed by the accumulation of surface water in depressions or groundwater discharge. They have a marked seasonal character, and large inputs of salt due to washing of the soil around them. Sometimes these surfaces desiccate during summer, and these salts precipitate on the surface. One example to be highlighted is the Pitillas Lake (216 ha). These wetlands correspond to types 22 or 23 of Table 3.

Artificial wetlands (reservoirs) The most important of these is Las Cañas (100 ha). Artificial wetlands are not included in the 27 inland lake types considered by the HPI.

Artificial wetlands (ponds) These are widely distributed in the southern half of Navarre and are mainly used for irrigation and watering livestock. Generally, they are small in size, host migratory bird populations, and provide watering to wildlife during extreme drought events. The most important example is the Agua Salada pond (17 ha). This wetland would belong to Type 19 of Table 3.

An economic valuation of Navarre wetlands has been conducted by Elorrieta and Castellano (2003). We refer to a valuation of the direct-use goods, and non-use or environmental goods and services, as commented by Barbier (2007). The methodology used by Elorrieta and Castellano for the economic assessment, is related to a set of validated methods that refer to the market value of the productive elements of wetlands (wood, hunting, grazing, fishing); the rate of occupancy in the case of wind; the travel cost method to estimate the recreational value; the cost of replanting to assess the absorption of CO_2; and contingent valuation methods to determine the non-use and landscape value.

Instead of estimating the market value of wetlands, Elorrieta and Castellano (2003) considered the value that society gives them as generators of private goods, that is, those goods that are considered to be subject to consumption rivalry, must be competed for because of their limited access and, in fact, society considers that they must be under the right to private property. Thus, for example, they valued hunting and fishing, considered as a private property good, and timber, grass and wind. The carbon was calculated through the vegetation as a fixer of atmospheric carbon. The use of recreational areas was estimated through the travel cost method. To calculate the value of the landscape, Elorrieta and Castellano (2003) estimated the per capita willingness to pay of the population of Navarra for the recreational structure that is actually used (€80 per person over 14 years old, per year). A similar calculation was performed, supposing that all Navarrans would behave like those that do not often enjoy the outdoors (€67.58 per person per year). The difference (€12.42 per person per year) is the willingness to pay for the use of the landscape of Navarre.

In order to estimate the value of non-use, or the environmental value, Elorrieta and Castellano (2003) conducted a contingent valuation study. Residents in Navarre were asked about their willingness to pay for three issues: (a) to maintain biodiversity; (b) to increase forest area; and (c) to maintain the current road network in the state. To do this, a survey of 1122 people was conducted, using a selected sample proportional to the structure of population in the Autonomous Region of Navarre. The overall results obtained for each of the aspects evaluated, are shown in Table 6.

Elorrieta and Castellano (2003) claim that this only represents a minimum, since all the figures are an underestimation of the actual value, taking into account that, among the ecosystem services, only the value of CO_2 fixation by wood has been considered, whereas many other important services, such as retention of nutrients or sediments, have been obviated. La-Roca (2003) criticised the limitations of such work. Nevertheless, the wetlands in Navarre are, after

Table 6 Annual income of each type of assets (Elorrieta and Castellano 2003).

Type of good	Annual income (€)
Wood	9 920 000
Pastures	6 700 000
Hunting	6 520 000
Fishing	3 770 000
Wind	910 000
Entertainment	5 870 000
Landscape	5 355 820
Carbon	10 290 000
No use or environmental	29 300 000
Total economic value	78 635 820

river groves (not included in the economic appraisal), the ecosystems with the highest total economic value.

Tablas de Daimiel National Park

The Tablas de Daimiel National Park is located in the region of La Mancha in the centre of the Iberian Peninsula, and it can be included in Type 25: inland in sedimentary basin, floodplain type, with high or very high mineralization. Originally, it was one of the most important wetlands in Spain, despite its small size (1928 ha), as demonstrated, among other protection data, by its declaration as a National Park in 1973, its inclusion in the Ramsar List of wetlands of international importance (in 1982), its designation as a Special Protection Area for Birds (in 1987, under European Directive 79/409/EEC, currently amended by Directive 2009/147/EC), and its designation as a Site of Community Importance (in 1997, under the HD).

The Tablas de Daimiel was the natural overflow area of several groundwater bodies (West Mancha I and II aquifers, and the western part of Rus-Valdelobos aquifer). However, since the late 1970s, the Daimiel Tablas have been affected by severe degradation caused by a sharp and rapid decline in groundwater levels, as a result of intensive exploitation of groundwater for irrigation. The result is that the hydrological functioning of the system has been profoundly altered, so that from the early 1980s, this aquatic ecosystem stopped working as an area of natural groundwater discharge. Patterns of wetland flooding, which were originally stable, have become unstable, with a long period of desiccation that greatly modified the flora and fauna of the National Park. At present, this wetland depends on artificial inputs of water (such as water transfers from the Tagus-Segura aqueduct, and pumping), and exhibits physical and chemical characteristics that differ greatly from its natural state.

The degradation of the conservation status of this important Spanish wetland has caused deep international concern, resulting in the opening of infringement proceedings by the European Commission against Spain for its breach of the Birds and Habitat Directives.

Júdez *et al.* (2003) have studied the economic valuation of the Tablas de Daimiel wetland ecosystem, using the contingent valuation method for recreational uses. This has provided data on the public's willingness to pay through a simple dichotomous choice survey, conducted through direct interviews. This format implies that the interviewer asks the respondent if s/he is willing to pay a certain price, chosen at random from a predefined set, for the good they want to evaluate. The answers *yes* or *no* allow for an estimation of the probability distribution of the willingness to pay. From this distribution it is possible to estimate a measure of the welfare provided by the good or service being studied.

The total number of surveys conducted by the authors was 433: 200 in the spring of 1996, and 233 in the summer of the same year. Respondents were interviewed after their visit to the park, stating whether or not they were willing to pay a certain amount by answering the following question: "Following your recent visit, would you be willing to pay *x* euros as an entrance fee to the Tablas de Daimiel National Park?" The price was randomly drawn from the following options: €0.60, 1.20, 1.80, 2.40, 3.60, 6.01 and 12.02. Additionally, the survey included some other classic items such as the socio-economic characterization of the respondents, their reasons for visiting the park and views on certain aspects of the visit.

An estimated value of €5.67 per visit was obtained. Since the annual average of visitors to the Park for the period 1992–1996 was 86 270 people, the annual average value of the recreational use was estimated to be €489 224. Taking the area of the National Park as 1928 ha, the estimated value of a hectare for recreational use is €253.75 per year, with a range that varies between €279.31 and 228.10 ha^{-1} $year^{-1}$.

This value of €5.67 per visit per year is comparable to those estimated in other studies conducted in Spain on the recreational value of natural areas. However, according to some authors (Brower *et al.* 1997), the value of the different functions of wetlands in the USA is higher (almost double) than that obtained in Europe.

It must be borne in mind that the application of other methods of economic valuation of wetlands to estimate the recreational use of Las Tablas de Daimiel, may lead to different results. However, this does not mean that the recreational value obtained by the method of contingent valuation and dichotomous choice format is incorrect.

CONCLUDING REMARKS

Conceptual confusion

When the concepts of *functions*, *goods* and *services*, are integrated, the relationships between them and their conceptualization are unclear. It is important to mention two additional related concepts: *attributes* and *products*, which are confusing and in some cases, ambiguous terms. Therefore, it is necessary, to correctly define them and the differences between them. The results of this study based on inland wetlands show that functioning relationships, goods and services are distinct not only between the different types of wetlands, but also with regard to the spatio-temporal conditions of each wetland.

Economic valuation of wetlands

Today, research in Spain on economic valuation of wetlands is very limited, partial and carried out with different methodologies, making it impossible to establish comparisons that are always useful in decision-making processes.

Types of lake

Lake types established by the 2008 HPI provide information associated with the lithology, morphology and characteristics of the water filling the basin of the wetland (alkalinity and conductivity). That is, it only applies once one knows the functioning of wetlands (particularly as regards the source of water: either predominantly surface water or groundwater, or even mixed inputs). There is still much work to be done in the hydrological study of the functioning of Spanish wetlands that will lay the groundwork for identifying the processes, functions, goods and services that they provide to society.

Services of wetlands

Biotic and abiotic interactions are affected by changes in the quality and quantity of water that constitutes the backbone of the dynamics of the wetland. This means changes in the biotic (decrease in the richness and diversity of species, etc.) and abiotic (water contaminants, hydrological and morphological conditions) characteristics of the wetland.

The common philosophy underlying the WFD and HD makes it useful to develop a systematic classification of types of lake in the WFD, and types of habitat related to the wetlands HD in the National Wetlands Inventory, and correlate these results with the functions, goods and services that these ecosystems provide.

It would be desirable to systematize what must be evaluated economically in order to provide useful information for management and for future comparative studies.

Some wetlands respond today to a typology that differs greatly from their natural or original characterization. For example, the Tablas de Daimiel used to be a groundwater-dependent wetland, and has become a raft of aquifer recharge, which requires artificial strategies (transfer of water from other basin, water pumps from the aquifer itself) to maintain the ecosystem, albeit in a poor state of preservation. Thus, it will not recover its original function until the aquifer that was the natural supplier of water is also recovered.

At present, it is essential for Spain to lay the foundations of knowledge of wetland functions, which will subsequently provide the basis for rational management of their goods and services. The latter are products of the ecological integrity of a wetland. This identification of functions, goods and services must be addressed not only to the wetlands that will be considered as lake-like water bodies in the future river basin management plans, but also for all the wetlands that are included in the National Wetlands Inventory.

Finally, it is interesting to point out an additional issue that has not been tackled in this paper, but that will be very important to carry out in the future: the mapping of the services provided by wetlands. Thus priorities for conservation and management could be established in order to increase social awareness of the value of wetlands and to improve the integrated management. Indeed, these are fields of major socio-economic and environmental importance. However, given the limitations on the knowledge of Spanish wetlands, one cannot currently provide a mapping of these features.

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