Communicating research on the economic valuation of coastal and marine ecosystem services

1. Introduction

Economic valuation (EV) can provide policy makers, environmental managers and planners with information about the social benefits and costs associated with alternative coastal and marine policies. It can help to assess and highlight the trade-offs and synergies inherent in ecosystem-based management, thus increasing the social efficiency of decision-making processes. A key question is thus why such valuation is not more widely used in actual decision-making.

As this paper shows, valuation researchers have applied their methods to an increasingly wide variety of coastal and marine ecosystems. However, the growing number of valuation studies has not been accompanied by an increase in the use of EV in the actual management of such ecosystems. As stated by Ruckelhaus et al. [1], "the pace at which the theory of ecosystem services (ES) valuation is being incorporated into real decisions has been painstakingly slow, with disapprovingly few success stories". Laurans et al. [2] argue that, despite valuation being able to demonstrate to policy makers the benefits derived from sustainable resource management, it has been used "in an *informative* way rather than in a *decisive* or *technical* perspective".

This situation raises an interesting question for valuation researchers: *Is EV responding to the needs of policy makers?* This question becomes even more relevant in a framework where environmental policies increasingly call for a balancing of the benefits and costs of regulations, and for regulatory impact assessments [3–6]. In a recent paper, Hanley et al. [7] wonder if EV of marine and coastal ecosystems is "currently fit for purpose", given the demands of European environmental legislation. The authors conclude that evidence that non-market values are used in policy formation is mixed, which can be explained by the "lack of scientific knowledge of key linkages in the valuation framework, a lack of relevant economic valuation studies, methodological problems in applying certain valuation methods to marine issues", and the "unfamiliarity of most people with marine ecosystems and their components".

Hanley et al. [7] mainly focus on the limitations of EV and the analysis of the extent to which the current scientific evidence base allows valuation to be conducted. However, they also call for further interaction between political and social scientists on the basis there is a need "to communicate ES research more effectively and to improve understanding of the *realities* of policy makers to economists and marine and coastal scientists". The motivation for the present paper is to guide policy makers interested in using EV in coastal and marine policy formation and management. To achieve this aim, it presents a systemic survey of the current evidence base on the values for coastal and marine resources, placing emphasis on the analysis of both the policy implications of current studies as well as the main research needs stated by those undertaking the valuation studies. It then discusses the scope for these kinds of studies to get used in policy implementation and environmental management, as well as the main barriers to a more widespread and in-depth use of EV in coastal and marine ecosystem management.

The paper extends the analysis by Hanley et al. [7], emphasizing the multiple roles which EV can play. We highlight the need for more primary and high quality valuation studies to increase the scale and quality of benefit transfer; and advocates for examination of the potential of EV to complement more participatory and deliberative decision-making approaches. The paper thus attempts to start a discussion about the most profitable directions for further research work. We also stress the importance of collaboration among social, natural and political sciences in increasing the use of EV methods in ecosystem management.

The structure of the paper is as follows. Section 2 describes the methodology used to provide a comprehensive overview of the knowledge base regarding the valuation of coastal and marine ecosystem services. Section 3 presents the main conclusions from the analysis of the current evidence base and examines the scope for EV to play in the better management of coastal and marine ecosystems, while

section 4 discusses the main barriers to a more influential use of the method. A "Concluding Remarks" section ends the paper.

2. Methodology

The increasing demand for non-market economic values in policy decisions has led to an increase in the use of valuation estimate databases that may be used in value transfer exercises [7]. Our systemic survey of the current evidence base on the values for coastal and marine ecosystem services (ES) has been undertaken through an extensive literature review, the main source for which has been the National Ocean Economics Program/Middlebury Institute of International Studies at Monterey (NOEP) database.[1] The criteria selected to obtain the list of NOEP papers have been the following: i) to guarantee the quality of the publications, only peer-reviewed papers have been considered, so technical reports, book chapters and working papers have not been taken into account, ii) published between 2000 and 2015, iii) conducted in any country or region in the world, iv) using any valuation methodology), v) being original or undertaking meta-analyses, vi) estimating any type of value (i.e. use values, non-use values or both), vii) valuing any type of relevant natural capital asset, and viii) focusing on any type of use or activity in relevant ecosystems.

From the resulting list of papers, two types of journals where these have been published can be identified. The first type refers to journals interested in publishing work related to specific natural resource and environmental issues, for which further development of valuation methods and their novel applications to new data sets is of major concern. Articles published between 2000 and 2015 in 10 journals which are considered relevant within this type have also been reviewed and added to the list if they focus on valuing coastal and marine ES. The second type corresponds to 22 journals interested in publishing work around both ecological and management issues in coastal and marine settings. In total, 196 papers whose primary objective is the valuation of goods and services provided by coastal and marine ecosystems have been analysed, which can be viewed as representative of the valuation work that has been undertaken so far during the 21st century in marine and coastal settings.[2]

2.1 Responding to policy makers' needs: paper classification by ecosystem type

The papers have been analysed according to their study object; the ES being valued, which has/have also been classified according to the Millenium Ecosystem Assessment (2005)'s category/ies to which it/they belong to (i.e. provisioning, regulating, cultural and supporting services); the types of values being estimated; and their main outcomes and policy implications. Additionally, the most important research needs as well as major challenges stated by the authors have been examined. To better contribute to the analysis of the role of economic valuation (EV) in coastal and marine ecosystem decision-making, the papers have been classified relating to different ecosystem types resulting from the consideration of different management frameworks. These frameworks have been determined according to both the major management concerns among valuation researchers identified in the literature; and the classification of aquatic ecosystems made by the Water Framework Directive (WFD, 2000/60/EC) which establishes integrated river basin management as the best strategy to achieve good status of water.

The review of the valuation literature has allowed the identification of eight management areas to which valuation research has made a potential contribution: wetland management, beach management, coastal area management, freshwater resource management, coastal water management, coral reef management, marine protected area (MPA) policy design, and strategies to protect the deep sea/open ocean waters. The WFD establishes a framework for the protection of inland surface, transitional, coastal and ground water, where inland waters (standing or flowing), which include rivers, streams, canals, lakes and reservoirs are freshwater ecosystems; coastal waters are marine ecosystems; and transitional waters, which include estuaries and deltas, involve a mix of freshwater and marine ecosystems.

[1] http://www.oceaneconomics.org/nonmarket (accessed from September 7th to September 21st, 2015).
[2] See Torres and Hanley [107] for further details about the reviewed journals.

Accordingly, and to classify the papers, eight management areas have been identified and hence eight *broad ecosystem types* have been considered, as shown in Table 1. The table also depicts the *specific ecosystems* whose services are object of valuation within each ecosystem type, and the management area which the papers within each type could contribute to:

[Table 1 here]

As it will be noted, the marine ecosystem types are not mutually exclusive. Indeed, marine protected areas (MPA) are established to protect marine environments which involve some of the three remaining ecosystem types, namely protection of coral reefs, deep sea organisms or coastal waters being habitat of iconic species. Besides, cold-water corals (CWC) are deep-sea organisms and, unlike coastal coral reefs, their services cannot be enjoyed directly by most of people.

Accordingly, some assumptions have been made for paper classification within each marine ecosystem category. First, the studies focusing on MPA valuation have been categorized as "MPA studies" regardless of the ecosystem type the MPA aims to protect due to the specific policy implications derived from MPA management.[3] Second, papers concerned with coral reef conservation which do not make any reference to the creation of an MPA as a conservation tool have been categorized as "coral reef studies". While it is true that many MPA papers focus on protected coral reef areas, not all papers valuing coral reef services centre on the creation of MPAs for their protection. In fact, EV of coral reef services can serve to demonstrate the benefits of their sustainable management regardless of the management tool [2]. Besides, MPAs involve marine environments possessing features of uniqueness and national importance which are not exclusive of coral reefs. Third, the Coral reefs category only includes studies around *coastal* coral reefs, thus excluding those estimating the value of CWC protection, which have been categorized as either "Deep sea papers" or "MPA studies" if protection is achieved through an MPA. Fourth, "Deep sea papers" exclude those focusing on MPAs aimed at ensuring long-term deep sea service provision, which have been classified within the MPA category.

A ninth ecosystem type called "Coastal and marine ecosystems" has also been considered to include papers which either value services provided by more than one of the broad ecosystem types (excluding MPA studies) or do not make any reference to any specific ecosystem category and just refer to "marine and coastal ecosystems".

3. EV of coastal and marine ecosystem services: an overview from a management perspective

The literature review shows that, excluding the papers classified within the ninth ecosystem type (10), the number of papers focusing on the valuation of coastal ecosystem services (ES) is higher than that dealing with marine ES valuation (100>86), as shown in Table 2. Coastal ecosystems include more ecosystems providing services which people are more familiar with, compared to marine ecosystems some of which providing services which are very unfamiliar to individuals (e.g. deep sea). Table 2 shows that the management of coastal ecosystems such as beaches and wetlands has captured the same attention among researchers as the management of marine ecosystems such as coastal waters and MPAs.

[Table 2 here]

Over the last 16 years, valuation researchers have been particularly interested in contributing to the management of wetlands, beaches, coastal waters and MPAs. However, half of the MPA studies focus on protection of coral reefs due to their unique features, this suggesting coral reef protection through establishment of either MPAs or other conservation tools has also attracted the attention of researchers.

[3] This implies, for instance, that papers examining the values for an MPA in coastal waters were jointly analysed with papers estimating the value of either CWC or coastal coral reef protection through an MPA.

In the context of coastal ecosystems, interest in undertaking valuation studies to contribute to the management of beaches and other coastal habitats has been especially high in the last years [9–11]. This publication pattern has also been found for papers valuing services provided by inland and transitional waters, as almost half of them have been published during the last five years [12–14]. It is expected that the number of studies focusing on this type of ecosystem will increase in the next years if economic valuation and environmental cost-benefit analysis are going to play a role in integrated river basin management.

The interest in valuing services provided by marine ecosystems has also been growing over the last 16 years. The majority of papers focusing on services offered by coastal waters, coral reefs and MPAs have been published during the last decade [6,15–19]. This is especially true when it comes to valuation papers around deep-sea services, which have emerged in very recent years likely, due to the lack of familiarity of most of people with these services, the relative lack of scientific evidence linking ecosystem function to ES provision, and hence the difficulty of their valuation [20,21].[4]

3.1 Coastal and marine ecosystem services and values

Researchers have mainly focused on valuing cultural services provided by coastal and marine ecosystems with special emphasis on their recreational opportunities.[5] This is especially true for papers focusing on beaches and other coastal areas, inland and transitional waters, coastal waters, coral reefs and MPAs [13,22–26]. Exceptions are the papers focusing on wetlands, mostly centred on valuing their regulating functions and the provisioning services of mangroves; and the deep sea, mainly valuing its biodiversity and provisioning services for the fishing sector [20,21,27].

Studies show the high recreational benefits associated with coastal and marine ecosystems as well as the positive correlation between these benefits and the environmental quality can provide an economic justification for implementing conservation strategies [28]. This is of especial relevance in nature-based tourism destinations where the recreational opportunities offered by these ecosystems are at the core of their tourism product [29,30]. More importantly, a high number of studies show the economic justification for protection can be sounder if the non-use values recreationists usually attach to the cultural services are also considered. Indeed, non-use values are compatible with recreational values as evidenced by a majority of papers around wetland, coastal waters and MPA valuation, which use biodiversity/habitat attributes to describe the recreational activities they focus on, indicating that the value for recreational services involves a mix of use and non-use values [6,9,10,16,17,31]. Likewise, many inland and transitional water studies show the importance of eliciting passive use values relating to the historical and cultural importance of rivers [12]. Many papers find that non-users show a high, positive willingness-to-pay (WTP) for the conservation of coastal and marine ecosystems. Studies focusing on the protection of deep sea services through MPAs are some examples indicating that the inclusion of option and non-use values in policy assessments is essential for sustainable ecosystem management [5,32,33].

3.2 Scope for EV to be used in coastal and marine ecosystem management

Many management settings can greatly benefit from the information contained in WTP estimates. This section discusses some of the main ones identified in the literature, which Table 3 relates to the management areas reported in Table 1:

a) Assessment of wetland mitigation strategies

[4] See Torres and Hanley [8] for a description of the full bibliography and a classification of papers by journal and ecosystem type.

[5] Note that, according to MEA (2005)'s classification of ecosystem services, cultural services are viewed as non-material benefits relating to cultural and amenity services such as cultural identity, cultural heritage, spiritual services, inspirational services, aesthetic services, recreation and tourism.

Wetland values can contribute to assess wetland mitigation strategies (preservation of existing wetlands, restoration of degraded ones, or construction of new wetlands) and can inform the debate of whether wetlands should be preserved or not compared to alternative uses. It is argued that, if biodiversity protection is a policy priority, public awareness raising campaigns can be useful [34]. Indeed, public support for such strategies is essential as it is people who pay for such strategies through higher taxes. Decision makers should consider local demographics when determining appropriate projects due to its role in the type of mitigation preferred. An spatial ecosystem service (ES) valuation framework can also assist policy makers in the private and public sectors to identify areas being critical in the ES delivery [27].

b) Design of erosion prevention and coastal conservation programs

Beach values are useful information for policy makers interested in preserving beaches from erosion as they can provide economic justification for erosion management programs [35,36], and allow the examination of the economic efficiency of alternative beach nourishment projects [37]. In addition, economic valuation (EV) of coastal habitats other than beaches and wetlands can contribute to territorial, urban and environmental planning in areas where the tourist industry faces great structural problems [38]; design maritime and fishing heritage conservation plans [11]; and evaluate marine energy development projects [24].

c) Natural resource damage assessment

Economic values of coral reefs can be used to impose charges for damage to such resources [39], while values of coastal waters can help to design oil prevention and response programs as well as to determine the level of compensatory resources [40]. In a context of environmental damages caused by large international oil spills, consideration of non-use values is essential [41]. Valuation studies focusing on hypothetical beach closures can also help to determine compensatory restoration equivalents [42,43].

d) Fisheries management

Studies analysing recreational fishing and how it is affected by harvest enable the assessment of the potential effects of changes in harvest regulations [44] through, for instance, providing information about the welfare costs of imposing bag limits or closing fishing sites [45]. Positive values for fishing licenses can stimulate fisheries management activities oriented to improve fishing quality through habitat restoration, better enforcement, expanded research and education, and protection [46]. Results from recreational fishing studies can also be used to meet the needs of environmental and regulatory impact analyses [47].

In recent years, deep sea papers have also highlighted the EV contribution to commercial fisheries management by both providing economic justification for a better governance of ocean waters [5] and helping to assess fishery regulations [20].

e) Design of biodiversity preservation strategies

Values of coastal areas can contribute to conservation of biodiversity patterns and processes and hence to coastal conservation planning [48], while values of coastal waters can contribute not only to protecting endangered species [49] but also to conservation science "by offering alternatives whereby the value of biodiversity and public preferences can be accounted for in policy planning; identifying the main beneficiaries of conservation; and providing evidence of the social demand for biodiversity protection, reinforcing, thereby, scientific support for conservation" [50].

Deep sea studies show that conservation of deep sea organisms is valuable to people despite the fact that marine industries such as oil/gas and fisheries can be adversely affected by the establishment of protected areas [21]. Likewise, MPA values evidence support for preservation of unique ecosystems and inform negotiations about designation of MPA networks to better manage ocean waters [51].

f) Design of financing mechanisms

Environmental valuation in inland and transitional waters can contribute to the design of taxes aimed at either funding the costs of cleaning up toxic sites or preventing the spread of aquatic invasive species [52,53], while beach values can help to establish fee/tax mechanisms helping to finance beach nourishment projects [54,55]. Beach valuation is especially relevant for nature-based tourism destinations attracting a high number of visitors as it can also help to examine the appropriateness of charging them to contribute to fund coastal and marine ecosystem policies [56]. MPA papers also highlight the EV role in designing self-financing mechanisms through the proper user fee or tourist tax pursuing effective management of MPAs to ensure their sustainability [57,58].

g) Implementation of EU legislation

EV can also play a role in the implementation of European legislation which increasingly calls for a balancing of benefits and costs of regulations, and for regulatory impact assessments. Values of inland and transitional waters can contribute to the design of integrated river basin management plans required by the Water Framework Directive (WFD, 2000/60/EC). They can provide policy-makers with information about the benefits of achieving 'good ecological status' for the waters of the member states, thus giving guidance on the social desirability of alternative options and the potential disproportionality of some of them [31,59]. Wetland values can also contribute to design policies built on the principles of the WFD as "wetlands are considered as part of a cost-effective programme of measures in integrated river basin management plans to improve water quality" [60]. In addition, beach values can provide useful information for policy makers interested in further improving water quality to meet the standards required by the Bathing Waters Directive (2006/7/EC), or in deciding to de-designate sites where costs of meeting these higher standards greatly exceed benefits [3,61]. Values of coastal and marine ecosystems can also contribute to the implementation of the Marine Strategy Framework Directive (MSFD, 2008/56/EC) and the Marine Spatial Planning Directive (2014/89/EU) [62].

h) EV role in developing country settings

In many low income economies, coastal and marine resources provide important livelihood benefits to local communities. Valuation studies showing changes in the distribution of income from coastal and marine ES, "especially the share accruing to poor communities", can show how sustainable management of coastal and marine ecosystems can contribute to reducing poverty [63]. They can also show the importance of cultural services compared to other direct and indirect use ES, suggesting actions involving "short-term sacrifices" to improve ecological conditions may be more acceptable to the local community than previous research suggests. Bequest values can help to ensure long-term ecological and socio-cultural sustainability as well as improve livelihoods through encouraging resource stewardship [64]. Wetland studies discuss how the involvement of *all* the stakeholders is essential to ensure ecosystem sustainability [65].

Economic values can also help to design compensation mechanisms such as Payment for Ecosystem Services (PES) to offset the opportunity costs of conservation incurred by different types of users. PES schemes can lead local communities to better contribute to a more sustainable use of their resources at the same time as addressing poverty issues, as shown by wetland, beach, coral reefs and MPA studies [9,22,66–68]. Coral reefs and MPA papers also highlight the EV role in designing tools to finance coastal and marine policies in regions with funding problems [22,69].

EV can also give guidance on whether local communities should continue with damaging extractive resource uses or, in contrast, should pursue their protection through different practices such as MPA designs [70] or the implementation of nature-based tourism strategies allowing local people to capture greater benefits from managing their wetlands [71]. EV can also help to increase public awareness of the value of local resources, thus ensuring their sustainability, as shown by wetland studies [65].

[Table 3 here]

4. Barriers to a more effective use of EV in coastal and marine ecosystem management

Both in developing and developed country settings, EV information can facilitate the "transition to an ecosystem-based management by providing both an economic justification and a decision-making framework for prioritizing management actions" [72]. However, the use of EV methods in actual policy formation is still scarce. The analysis of the publication data base reveals what future work is required to increase the influence of EV on decision-making, and hence improve its contribution to the better management of coastal and marine resources. This section discusses the main areas for further research identified in the literature, which are related in Table 4 to the management areas used in Table 1.

a) Need for estimating non-use values

Beach and coral reefs valuation studies highlight the importance of estimating non-use values for ecosystems mainly demanded for their recreational benefits [3,73] as it can reduce the risk that protection strategies are not socially profitable and hence not considered by policy makers [74]. In addition, wetland studies point out that estimating *only* non-use values of wetlands can better contribute to biodiversity preservation [75]. Likewise, eliciting non-use values of inland and transitional waters is viewed as a necessary task to manage water resources sustainably over the long-term, especially in a context of water-scarce basins [76]. In this framework, passive use values linked to the historical and cultural importance of rivers are considered especially relevant, due to their potential impacts on welfare and subsequent decision making [12].

b) Need for more benefits transfer work

Studies around wetlands [27,60,75,77], inland and transitional waters [59], coastal waters [78], coral reefs [79] and MPAs [80] highlight the importance of strengthening cooperation across valuation researchers allowing for the development of more primary and high-quality valuation studies. Indeed, it can raise the possibilities of using benefit transfer (BT) approaches and hence better respond to the growing political demand of ecosystem services (ES) values. To date, very few studies have undertaken meta-analyses and applied BT approaches, the majority in a wetland valuation context. Such studies state a larger sample of available site-specific studies would increase the accuracy and applicability of meta-analysis results and improve the reliability of the welfare estimates [78,79]. They also suggest valuation meta-analyses should include comprehensive socio-economic information [81] and spatially-defined context variables to better represent value determinants [27]. The existence of a standard protocol to report valuation results would improve meta-analysis performance and consequently the accuracy of transferred values [79], which is of high relevance when the lack of uniformity across studies represents one of the major problems to apply BT [82]. Researchers should move their attention into these issues as BT can overcome problems of too little time and/or too little budget to perform original studies, which is of particular interest in the context of tight time schedules imposed by the Water Framework Directive (WFD, 2000/60/EC) on member states to develop integrated river basin management plans [59,83].

Several studies remind us of the need for *international* collaboration and research due to the transboundary nature of the marine environments [15]. This would not only promote the conduct of valuation studies to cover all European marine areas but also benefit meta-analyses through provision of more precise and comparable descriptions of the valuation scenarios [78]. In contexts of oil spills affecting many countries, international cooperation could serve as "an incentive for an institutional innovation in the EU governance based on the design of a supranational common environmental policy aimed at enabling environmental damage claims" [41].

c) Need for inter-disciplinary cooperation with natural scientists

Under almost all the ecosystem categories employed in the analysis reported herein, studies highlight the importance of strengthening collaboration between economists and natural scientists. Indeed, this is critical to pursue the integrated natural and social science approach necessary to promote sustainable ecosystem management, but also to increase the acceptance among the scientific community of the EV role in decision-making. In this sense, the reviewed papers evidence the importance of ecological knowledge to improve the measurement of economic values, as it can help economists to refine their methods (eg in the selection of attributes intended to measure ecosystem condition in a choice experiment) to reflect the ecological reality of valuation scenarios [84].

Wetland studies show that scientific data can help economists to model the specific threats faced by the ecosystem [27] and increase ecological understanding of the co-provision or trade-offs of multiple, inter-dependent ES [60]. Likewise, scientific data on environmental changes can help to assess the impacts of alternative catchment management strategies, as shown by inland and transitional waters studies [85]. Papers valuing coastal areas state that ecological knowledge can provide information about biophysical factors which are essential to identify areas of protection in efficient coastal land conservation planning [48], while coastal water valuation discusses how information on fish stocks and catch rates from biophysical models can be used in random utility maximization (RUM) models and how biophysical models can use fish extraction information from RUM models [45]. Studies valuing coastal waters can also benefit from scientific data clarifying issues regarding the relationship between marine biodiversity and ecosystem functions as it can increase understanding about the welfare implications of biodiversity loss [86]. Ecological knowledge can also increase public awareness regarding the benefits of deep-sea protection [5,21] and improve understanding about ES generation by biophysical functions and processes for a better MPA design [87].

Studies around wetlands [88,89], coastal waters [49,86] and MPAs [6,90] also point to the importance of cooperating with natural scientists to obtain information about environmental uncertainties and potential irreversibilities. As the way people process and interpret uncertainty and irreversibility risk can affect ecosystem values, such information is crucial to avoid biased estimates. Recently, uncertainty issues have also captured the attention of authors focusing on beach valuation [91].

d) Need for inter-disciplinary cooperation with political scientists

Exploring the potential of EV to complement rather than substitute more participatory approaches to coastal and marine ecosystem governance can increase the validity of EV and hence its influence on decision-making. The importance of addressing local stakeholders' concerns has been emphasized by papers around valuation of MPAs [6], beaches [92,93] and coral reefs [17,79]. In an MPA management context, Brown et al. (2001) makes it clear when stating that a more holistic approach enhancing stakeholder involvement in decision-making is more appropriate to manage "multiple use, complex systems […] where many different users are in conflict and where linkages and feedbacks between different aspects of the ecosystem and economy exist". Despite environmental cost-benefit analysis (ECBA) highlighting the nature of the benefits and costs accruing to different groups, it has been challenged in terms of concerns around rights, fairness and the need for stakeholder engagement and deliberation [95,96]. Public participation in ecosystem decision-making processes, viewed as crucial to ensure broad support for the implementation of management strategies [94,97–99], is beyond the EV scope. Also, despite ECBA providing a valuable framework for interpreting biophysical findings of environmental impact assessments in economic welfare terms [89], its single-criterion approach falls short when significant environmental and social impacts cannot be assigned monetary values [92,93]. Thus, although valuation can raise awareness regarding ecosystem conservation, "methodologies will have to be further developed, with multidisciplinary inputs, if they are to provide valuable inputs in local and technical decision-making" [2].

e) Need for recognition of developing country issues

In contexts where respondents have a low income level or many local communities might be unfamiliar with paying for access to ecosystem services, modifying the design of valuation methods to better suit the context of community relationships and kinship is an interesting area for further research, as suggested by studies estimating Aboriginal preferences for inland and transitional waters [100]. Some MPA papers draw a similar conclusion when suggesting the use of a willingness-to-work approach as an elicitation method and recommend further exploration of the opportunity cost of time and understanding of the labour market for its effective use [101]. The need for massive advocacy and education campaigns to increase public awareness and understanding of the ecosystem importance has also been argued by coral reefs studies [102] to increase the values and "promote responsible stewardship" of ecosystems.

The displacement costs incurred by local communities potentially derived from coastal and marine protection have led some MPA studies to advocate for further research on Payment for Ecosystem Services (PES) to draw stronger conclusions about their long-term feasibility. Ensuring the feasibility of PES schemes not only rely on a positive WTP for an environmental quality improvement and an acceptance of compensation by locals but also on the governmental participation due to the open access nature of the resource base [68]. MPA studies have also suggested future work on the feasibility of self-financing mechanisms such as Hotel Managed Marine Reserves, viewed as interesting tools in regions facing important funding problems [69].

[Table 4 here]

5. Concluding remarks

Better communication of ecosystem service (ES) valuation research can help to respond to the needs of policy makers interested in applying economic valuation (EV) in coastal and marine management, thus contributing to making the most of its potential to improve policy formation and environmental management. This paper has provided a comprehensive overview of the knowledge base regarding the economic values for coastal and marine ecosystems, based on the published literature in economics and interdisciplinary journals over the period 2000-2015. It has focussed on two aspects which are thought to be essential for an effective communication and hence for increasing the contribution of EV to the management of coastal and marine resources.

Firstly, the paper has communicated *what has been done* in EV of coastal and marine ES over the last 16 year,s placing emphasis on the analysis of the policy implications of the existing studies. The role EV can play in different management settings has been shown to facilitate the transition to an ecosystem-based management both in developed and developing countries. However, it is worth noting that the present analysis has focused on mean and aggregate estimated values, and has omitted close consideration of value distribution issues. This might miss out three important aspects which may be of high relevance in policy analysis. First, the identification of who gets the benefits relative to who faces the costs (negative consequences) of the environmental change: if a local community bears most of the costs of excluding fishing from a new MPA but benefits are enjoyed mainly by visitors is a policy relevant issue. Second, the spatial distribution of benefits from an environmental change. The issue of whether there are spatial hot spots of WTP for an improvement in coastal or marine ecosystems, or whether the benefits are relatively evenly distributed over space is also an issue of increasing interest [103]. Third, the distribution of benefits (e.g. by household income or wealth) across socio-economic groups is also an issue of growing concern [104].

Secondly, the paper has communicated *what is needed* in valuation research to increase the influence of EV on actual decision-making and hence help to ensure ecosystem sustainability. Estimation of non-use values and cooperation among social, natural and political scientists concerned with management of coastal and marine resources has been argued to be crucial. Importantly, the paper has emphasized cooperation should involve not only inter-disciplinary work but also *intra*-disciplinary collaboration across valuation researchers. The lack of correspondence between the growing number of studies

focusing on valuing coastal and marine ES and their scarce use in actual management deserves reflection within the discipline. While collaboration with other research fields is essential to improve economic valuation work and increase its acceptance by the scientific and policy communities, valuation practitioners should wonder if they are sufficiently cooperating with other researchers in the field to make their work more policy relevant. Inadequate cooperation between valuation researchers can help to explain the low influence of EV on actual management as, among others, it restricts the possibilities of using benefit transfer approaches and hence makes it difficult to respond to the needs of policy makers which increasingly demand consistent and reliable ES values. Recognition of developing country issues also suggests some areas for further research if EV has to play a role in protecting coastal and marine ecosystems in low income settings. Here, the authors would also like to point out that eliciting views from an international sample of the marine and coastal policy community members on what they perceive as the main barriers to a more effective use of EV would be an interesting future exercise.

The literature review has also revealed that important challenges still remain for the environmental valuation methods. First, this is particularly so in the context of understanding and conserving marine biodiversity [50]. There is still poor public understanding about the welfare implications of biodiversity loss, which is unsurprising given the limited scientific knowledge about the ecological consequences of marginal or severe biodiversity loss, and problems in perceiving changes in marine biodiversity [86]. The lack of information, experience and knowledge regarding the benefits of deep-sea protection constitutes the second biggest challenge [21]. The unfamiliarity of most people with the deep-sea environment represents a bigger challenge of assigning economic values to deep-sea services and biodiversity than the lack of scientific certainty about the baseline and future trends [6,32]. Indeed, "the lack of knowledge rather than the lack of interest" seems to explain "the near absence of wider societal values associated with deep-sea protection" [5]. Network research and outreach and education campaigns can help to overcome these two challenges as they can play a role in creating a larger WTP, thus enhancing the influence of valuation on policy assessments [86,102]. They can also contribute, together with a major participation of governments, to overcoming the major challenges faced by valuation in developing country settings: the lack of data and expert opinion, the lack of funding and the lack of trust in institutions [48,57,70,105,106].

Thus, cooperation across the different actors involved in the management of coastal and marine ecosystems is essential to overcome the major EV challenges. After all, beyond enhancing the use and influence of EV in the complex process of coastal and marine ecosystem management, cooperation should be driven by the need to give a voice to all stakeholders, to make coastal and marine governance more democratic and widely-accepted.

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