Alternative Approach and toolkits for Economic Valuation of Ecosystem Services of Wetlands: An Application to Farlington Marshes, UK

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SUMMARY

Wetlands offer a wide variety of ecosystem goods and services, such as fisheries, agriculture, tourism and regulatory functions that benefit human society. Despite this relevance, there is no generally accepted methodology for the economic valuation of ecosystem goods and services of wetlands. The existing methodologies for the valuation of ecosystem goods and services rely on revealed preference approach (willingness to pay and travel cost) due to lack market prices for most of the services. They do not provide actual value of ecosystem goods and services, because it is inferred from users' opinion and willingness rather than the actual benefit or services derived from the ecosystem. In addition, they lack simple resources and tools in order to make them user-friendly for surveyors and researchers assessing ecosystem services value. This paper attempts to develop an alternative holistic approach for the valuation of ecosystem good and services. The methodology includes fieldwork, case study and assessment of actual market values for each ecosystem goods and services, and application of opportunity cost where market values could not be ascertained. The results provide a realistic and evidence-based value to inform sustainable exploitation and management of wetlands. The paper concludes by advocating for the acceptance of this evidence-based valuation methodology for the economic valuation of ecosystem goods and service.

1. INTRODUCTION

Wetlands are defined by the Ramsar Convention as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres", including as well "riparian and coastal zones adjacent to wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands" (Ramsar Convention Secretariat 2013). The Ramsar classification comprises 42 types of wetlands grouped into three categories that are Inland wetlands, Marine/coastal wetlands and Human-made wetlands (Ramsar Convention Secretariat 2013).

Wetlands are valuable ecosystems that offer a very important range of EGS, including economic and ecosystem benefits such as water supply and water quality regulation (e.g. filtration pollutants and cycling of nutrients); ecosystem and landscape modelling features (e.g. protection against storms and floods, specific vegetation with relevant ecological functions, etc.); fisheries (around two thirds of the world's fisheries depends directly or indirectly on the good performance of the wetlands); agriculture services such as grazing areas or the availability of water for crop maintenance; provisioning of energy by peat and plant matter; biodiversity and wildlife resources; transport; and recreation and tourism opportunities (Ramsar Convention Secretariat 2013). They also play an important role in terms of the cultural heritage of humanity, as they are "linked to religious and cosmological beliefs, constitute a source of aesthetic inspiration, provide wildlife sanctuaries, and form the basis of important local traditions" (Barbier et al. 1997; Russi et al. 2013).

In the UK, 693 coastal wetlands are estimated to cover 274,613 hectares of the territory and they offered services projected to be valued between £510 and £786 million per year, with an average contribution per year per hectare estimated to be £1,856 (Morris and Camino 2011). The provisioning of ecosystem services is supplied at various spatial and temporal scales, which has a strong impact on the value different stakeholders attach to the services (Hein et al. 2006). EGS is also bound to the fate of the ecological processes of wetlands, as shown in the function-benefit interactions scheme presented by Defra (2007) (Figure 1). Therefore, it is very important to care about and keep track of the uses of wetlands, in order to prevent potential harm, abuse or negligent activities are taking place. Such destructive activities might compromise the whole performance of the habitats with strong socio-economic and ecological consequences. The assessment of the EGS of wetlands is an important area already covered by several studies (Barbier et al. 1997; Hein et al. 2006; Ghermandi et al. 2010; Morris and Camino 2011; Barbier et al. 2013; Liquete et al. 2013). Nevertheless, more efforts are required to increase our knowledge of wetlands and this includes carrying out the valuation of unknown areas and the development holistic easy-to-use tools and frameworks to aid, improve and encourage actual/alternative EGS valuation (Brett et al. 2015).

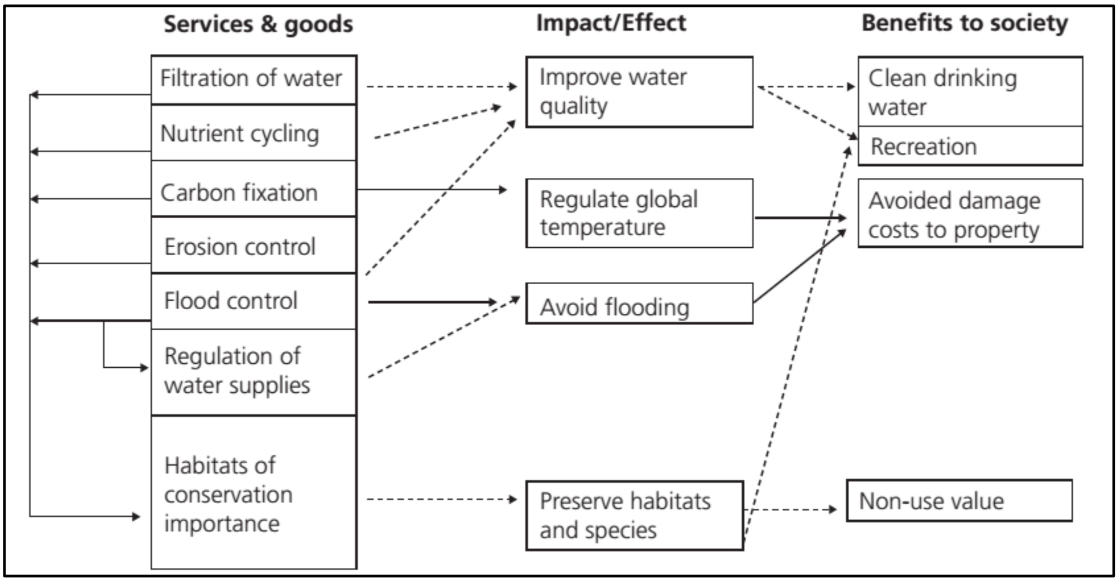


Figure 1. Wetland function-benefit interactions scheme (Defra 2007)

The ecosystem goods and services (EGS) could be defined as the range of benefits delivered by nature, that is directly or indirectly harnessed by humankind (De Groot et al. 2002). This includes actual tangible goods such as alimentary and mineral resources and “intangible” benefits such as environmental-regulative functions and cultural influence and affection.

The economic extrapolations of the EGS are useful for the estimation of the economic value of the natural resources and processes. There are several ways to make these extrapolations. These include direct methods based on commercial indicators (e.g. market values, industrial productivity rates and users’ consumption rate), and indirect methods based on revealed preference - hypothetical-qualitative considerations and indicators (e.g. contingent valuation, polls and quizzes, affection, willingness to pay and willingness to protect the resource) (Ledoux and Turner 2002). Thanks to these methods we have a better comprehension of the economic implications of different environmental features and processes that serve as a protection shield against extreme climatic events such as storms and flooding (Pert et al. 2012; Barbier et al. 2013; Camacho-Valdez et al. 2013). They also facilitate our ability to estimate how valuable these environmental features are for the regular operation of major economic activities such as fisheries, hunting, tourism and mining (Remoundou et al. 2009; Perni et al. 2011; Camacho-Valdez et al. 2013).

In addition to these, it is important to note that despite the intrinsic ecological value of the ecosystems, the economic assessment derived from the EGS valuation is an important resource to inform management policies and responsibilities, as it provides additional information that is useful for decision making as well as raising of awareness in certain social sectors (Bockstael et al. 1995; Hueting et al.1998; De Groot et al. 2002; Ahmed & Gotoh 2006; Fisher et al. 2009).

However, there is no commonly agreed to standardise approach for the accounting and extrapolations for economic value EGS (Boyd & Banzhaf 2007). In fact, different schemes with diverse approaches are rife. Some of them focusing on economic aspects (Barbier et al. 1997; Ledoux & Turner 2002), others on ecological-functional features (De Groot et al. 2002; Remoundou et al. 2009; Potts et al. 2014). There are others with mixed characteristics (Bockstael et al. 1995; Barbier et al. 1997; Hueting et al. 1998; De Groot et al. 2002; Liquete et al. 2013; Potts et al. 2014). All these approaches do not provide the actual value of EGS of wetlands because they are mostly based upon users’ willingness to pay or protect, which tend to be influenced by users purchasing power rather than a more objective value of the EGS.

Some authors and relevant institutions have suggested the need for unified approaches and frameworks in order to improve uncertainties in the valuation, management and research in EGS (Kubiszewski *et al.* 2017; Hammel & Bryant 2017. UK DEFRA report by Christie et al. (2011) proposed a holistic framework to conduct an EGS assessment. The United States Environmental Protection Agency website also provides resources such as the Causal Analysis/Diagnosis Decision Information System (CADDIS) (USA's EPA 2012), and Landers and Nahlik (2013) offered the Final Ecosystem Goods and Services Classification System (FEGS-CS). Nevertheless, all these approaches might be lacking certain qualities or just need a better divulgation as they are not based on the actual values of specific EGS. Therefore, more efforts are still necessary to create more holistic and user-friendly approach to facilitate the assessment and valuation of EGS. Nonetheless, the fight to reduce the impacts of climate change and associated global agreement on carbon cost to polluters, the improved awareness of the importance to protect wetlands, and the detailed classification and usage of ecosystem goods and services have moved society closer to the marketization of more non-market goods and services of wetlands. These have made it possible to develop an alternative valuation approach, which is holistic and facilitate the estimation of the actual value of EGS. This paper attempt to provide a more holistic approach, which provides a valuation of EGS based upon actual estimated values of goods and services from a particular wetland.

2 MATERIAL AND METHODS

2.1 The case study area

Farlington Marshes is a wetland located in Portsmouth, on the south coast of England (Figure 2). The wetland is a coastal grazing marsh that may be categorised as a "Marine intertidal marsh" according to the RAMSAR classification scheme (RAMSAR 2010, p80). The territory was originally reclaimed from the sea in the late 18th century, when a clay and timber wall was built across the mudflats, linking the natural islands that were previously occupying part of the Langstone Harbour (Hampshire & Isle of Wight Wildlife Trust (HIWWT) (n.d). Currently it is a 1,117,348 m^2 wetland (~276.11 acres) enclosed by a concrete barrier with a floodgate inlet controlling the amount of seawater allowed into the main lagoon, and features different traits such as two lagoons, reed bed patches, grazing meadows, several ponds, a network of channel and streams, comprising both fresh and brackish water bodies.

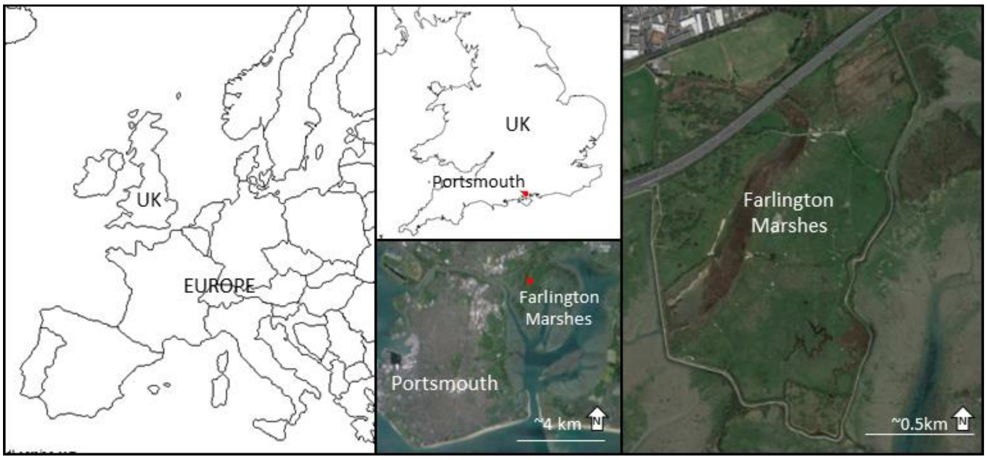


Figure 2. Location of Farlington Marshes (Coordinates 50°49'58.13" N, 1°01'36.26"E)

The EGS offered by this wetland in general terms, come by means of recreational areas for local people and internationally important habitats for winter migrant waders such as Brent geese and black-tailed godwits, coastal grazing marsh habitat (a very rare habitat in this region), hay meadows (grasslands), and the network of channels and waterways. It is covered by various national conservation designations. It is part of the Special Protection Area (SPA) of "Chichester and Langstone Harbours" and the Special Area of Conservation (SAC) of the "Solent and Isle of Wight Lagoons", part of the Ramsar site "Chichester and Langstone Harbours", part of the Site of Special Scientific Interest (SSSI) of "Langstone Harbour", and a Local Natural Reserve (LNR) by itself, called Farlington Marshes" (HIWWT n.d). These designations are assigned because of its special features, such as the salt marsh, fresh marsh, lagoon, reed beds, grassland, scrub and habitat for migratory birds.

Management and the cost of maintaining the site are met by HIWWT, a charity organisation, which relies on membership and donations from the public. They also receive money from Natural England. In addition, there are committed volunteer team that work on the site. Together with the reserve officers, they carry out the majority of the practical conservation work to maintain the habitats in the reserve.

In terms of scientific coverage, there is limited literature available online about this site. Approximately, 101 online articles mentioned the name “Farlington Marshes”, but only one addresses the shoreline management challenge of Farlington Marshes directly as a case study (Esteves et al. 2012). Most of the official information can be found through the HIWWT website, local news and direct contact with the managers. For this reason, this paper which, addresses the topic of EGS assessment of Farlington Marshes, could be identified as the first economic valuation of EGS to provide useful information for the local managers and policymakers.

2.2. Alternative Ecosystem Services Valuation Approach

The Alternative Ecosystem Services Valuation Approach (AESVA), is a holistic method for the assessment of the economic value of EGS of wetlands. The approach is two-prong. The first part presents details of the tools that have been developed for field survey, characterisation and valuation of EGS, together with an explanation of the application of the tools. The second part presents the specific details on the application of the approach to the case study area (Farlington Marshes).

The development of this methodology required the definition of conceptual criteria that would be used to describe and classify the EGS. The approach is developed based upon previous knowledge from Brett et al. (2015); Liquete et al. (2013); De Groot et al. (2002); Wilson et al. (2005) and Russi et al. (2013). Knowledge from these authors was used as the foundation for the development of the scheme for AESVA (Table 1). This integrated scheme helps the user to have a better understanding of the relation between ecosystem functions and offered services, as it provides an actual list with the main EGS offered by wetlands and therefore allows the translation between the different classification systems, thus making it easier to assign/identify the right categories (when adding new case-specific EGS to the existing list). It also facilitates the realisation of future aggregations and analysis according to the necessities of the user (e.g. management and policy-making, scientific analysis and general information gathering). The AESVA procedures and resources (Figure 3) that have been developed are available as templates and spreadsheets to be used or applied by the professionals interested in applying this approach.

Classification by:			Goods & Services	
Use	**Benefits**	**Functional**	**Sub-Grouping (TEEB Scheme)**	**Detailed**
Indirect Use	**Regulation-Support**	**Primary Ecosystem Services**	**Air quality regulation**	Capturing dust, chemicals, etc.
			Climate regulation	Carbon Sequestration
				Influence of rainfall
			Moderation of Extreme events	Protection against floods
				Protection against storms
			Moderation of Water flows	Natural drainage
				Natural irrigation
			Waste treatment	Water purification
				Regulation of Contaminants
				Regulation of Nutrients
			Erosion Prevention	Coastal Protection
			Maintenance of Soil Fertility	Soil formation
			Maintenance of life cycles	Formation habitats
				Pollination and Propagation of seeds
				Gametes, Larvae and Juvenile dispersal
				Seed dispersal
				Nursery
				Services for Migratory species
			Biological control	Pest and disease control
			Maintenance of genetic biodiversity	Gene pool protection
Direct Use	**Supply Exploitation**	**Secondary Ecosystem Services**	**Food Provisioning**	Fishing
				Hunting
				Aquaculture
				Agriculture
				Harvesting of edible goods
			Water	Water for Irrigation
				Drinking water
				Water for cooling
			Ornamental Resources	Decorative plants
				Pet animals
			Genetic Resources	Models for crop improvement
			Raw materials	Minerals
				Wood
				Peat (energy)
				Fodder-Pasture
			Medicinal resources	Resources for pharmacology-biochemistry
				Models and test-organisms

	Cultural-Logistic		**Opportunities for recreation and tourism**	Landscape and aesthetic features
				Touristic infrastructure
				Sport activities
			Logistic services	Terrestrial Transport: Footpaths, roads
				Aquatic Transport: Navigation route
				Lands for Human Development
			Information for cognitive development	Research
				Education and Pedagogy
No Use			**Spiritual Experience**	Existence-Spiritual Value
				Heritage-Legacy
			The inspiration for culture, art and design	The inspiration for culture, art and design

Table 1. A comprehensive classification scheme for the ecosystem goods and services. (After Brett et al. 2015 and Liquete et al. 2013). Note that the categories included here serve as a general framework, and more categories could be added to the detailed column if additional services are found in a study area.

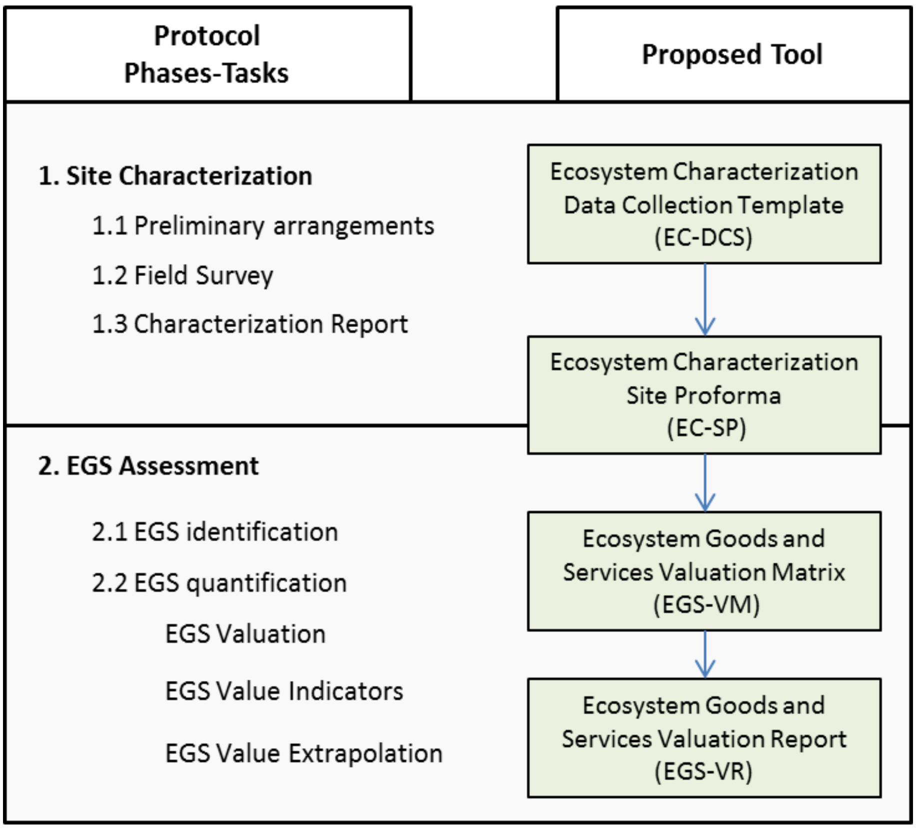


Figure 3. Diagram illustrating the AESVA, specifying the order of the tasks and the tools developed for each phase

2.3 Site Characterization

As shown in Figure 3, the methodology suggests that data collection could be done in two phases. The first phase is to assess the general characteristics of the ecosystem and to identify the various goods and services. The second phase (quantification phase) is to acquire the values of the economic parameters for the valuation of the EGS. For each phase, specific resources have been developed to provide standardised tools to make the assessment easier for the application of this methodology.

The assessment of the general characteristics of the ecosystem focuses on key features such as geomorphology, physical processes, geology, biodiversity, management issues and initial assessment of EGS. For this purpose, the "Ecosystem Characterization Data Collection Sheet" (EC-DCS) (Figure 4) was developed as a fillable template comprising some essential information, field checklists and reference maps. The comprehensive classification of EGS, management and diversity checklist is also required (Table in Figure 4.2). This list should be compiled during the pilot survey. These two field data collection tools cover the detailed information that could be gathered from the field to provide an integral description of the site, the spatial relevance (Hein et al. 2006), classification of EGS, management issues and diversity of the wetland. Note that this form is a suggestion and the fields could be modified or added as desired (e.g. water chemistry parameters), as long as the surveyor is able to gather that information. Following the field, the survey is the processing of the filed data from EC-DCS, into a written description of each site using the "Ecosystem Characterisation Site Proforma" template (EC-SP) (Table not included). This is the final product of the general characterisation. The EC-SP template comes with different sections addressing important aspects that should be of general interest while trying to understand the main ecological and socio-economical characteristics of an ecosystem. Depending on the scale of the project and design of the survey, the site Proformas may feature as a table summarising the EGS offered by the assessed ecosystem.

Moreover, where multiple sites are assessed, Table 2 may include a final column with a total significance index (TSI) for each EGS category (See Formula 1), as an additional aid to quantify how significant is each EGS category for the whole ecosystem. It should be noted that this is a quantitative aid for a qualitative parameter, as the real economic significance should be assessed with actual economic data in the next phases of the methodology. The proposed index is a value between 0 and 100, and it can be interpreted like this: zero implies that the EGS is not existent in the wetland, lower values suggest that the EGS is present in just a few sites or that it is not properly developed and higher values imply that the EGS is fully developed in most of the sites.

$$\mathrm{TSI} = \frac{0.25*\sum(\mathrm{CP})+0.5*\sum(\mathrm{P})+1*\sum(\mathrm{Y})}{\mathrm{n_{sites}}} * 100 \ldots\ldots\ldots\ldots 1$$

Where "TSI" is total significance index (the index is calculated for each EGS category), and the sums brackets in the numerator correspond to the number of sites in which the addressed

EGS category where classified as "CP", "P" and "Y", where "CP" is EGS conditionally potential, "P" is EGS potentially applicable and "Y" means EGS present. Therefore, each of these values ("CP", "P" and "Y") could range between zero and the total number of sites. The remaining categories (Not present "N" and Unknown status "U") are not included in the formula as they do not add significance to the EGS. Then, each summation will be multiplied by the assigned fixed constant (0.25, 0.5, and 1.0 respectively); then, the nominator will be divided by the number of sites (n_{sites}), and then multiplied by 100. For a visual aid, colours could be assigned to the following ranks of values: red (0), orange (1-30), light green (31-70), dark green (71-100) (see an example later in Table 8).

Ecosystem Characterization Data Collection Sheet (EC-DCS) Ref-Page

Project:	Location:	Date: Hour:
Site name:	Site Code	Surveyor:

Type of Wetland: (RAMSAR Classification)	Marine Coastal (A-K):	Inland Wetland (L-Z):	Human-made wetland (1-9):

Site-specific characteristics

Substrate			
Ground	O Dry (Permanent) O Dry (Potentially Floodable) O Wet O Floodable (Periodically) O Flooded (Permanent)	Area (unit)	
		Notes/Sketch	
Water	O Pond O Lagoon O Lake O Course O Beach		

Origin
O Natural O Human made O Nat + Man-Intervention O Unknown

Integrity
Impact Index 1 2 3 4 5 Deteriorated ------- Pristine
Specify:

Processes		
Water Exchange O Tidal O Seasonal O Controlled	Balanced	
	Flood Dominated	
	Ebb Dominated	
O Channels-Inlets O River Mouth O Tributaries	Waves	
	Currents	
O Salt water O Brackish O Freshwater	O Sedimentation O Erosion	
Depth(unit)		

Geology	
Clay/Sand	
Chalk and Sandstone	
Limestone	
Igneous	

Sketch/Notes

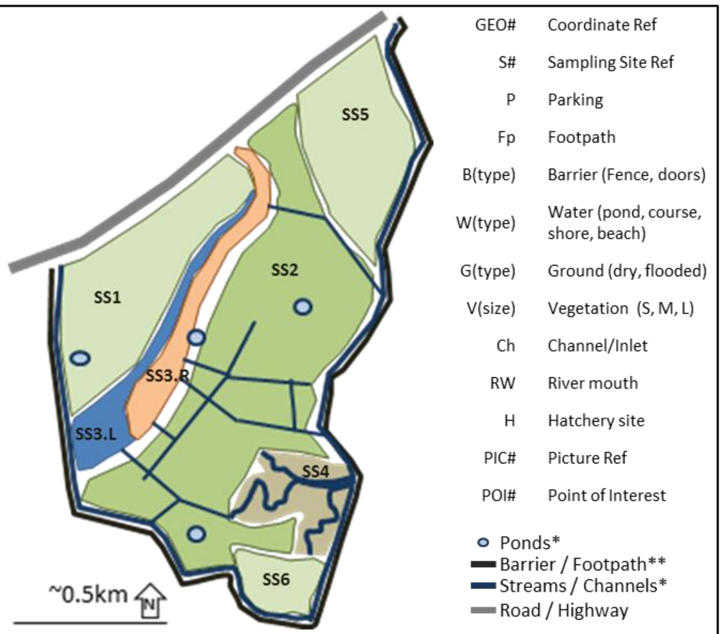


Figure 4.1 Ecosystem characterization data collection sheet (template EC-DCS). Side A The map is referential from this Project.

Goods and Services

Classification			Good & Service		Incidence			
Use	Benefits	Functional	Grouping	Detailed	NO	YES	POT	Notes
Indirect Use	Regulation-Support	Primary Ecosystem Services	Air quality regulation	Capturing dust, chemicals, etc.				
			Climate regulation	Carbon Sequestration				
				Influence on rainfall				
			Moderation of Extreme events	Protection against floods				
				Protection against storms				
			Moderation of Water flows	Natural drainage				
				Natural irrigation				
			Waste treatment	Water purification				
				Regulation of Contaminants				
				Regulation of Nutrients				
			Erosion Prevention	Coastal Protection				
			Maintenance of Soil Fertility	Soil formation				
			Maintenance of life cycles	Formation of habitats				
				Pollination and Propagation of seeds				
				Gametes, Larvae and Juvenile dispersal				
				Nursery				
				Services for Migratory species				
			Biological control	Pest and disease control				
			Maintenance of genetic biodiversity	Gene pool protection				
Direct Use	Supply Exploitation	Secondary Ecosystem Services	Food Provisioning	Fishing				
				Hunting				
				Aquaculture				
				Agriculture				
				Harvesting of edible goods				
			Water	Water for Irrigation				
				Drinking water				
				Water for cooling				
			Ornamental Resources	Decorative plants				
				Pet animals				
			Genetic Resources	Models for crop improvement				
			Raw materials	Minerals				
				Wood				
				Peat (energy)				
				Fodder-Pasture				
			Medicinal resources	Resources for pharmacology-biochemistry				
				Models and test-organisms				
	Cultural-Logistic		Opportunities for recreation and tourism	Landscape and aesthetic features				
				Touristic infrastructure				
				Sport activities				
			Logistic services	Terrestrial Transport: Footpaths, roads				
				Aquatic Transport: Navigation route				
				Lands for Human Development				
			Information for cognitive development	Research				
				Education and Pedagogy				
No Use			Spiritual Experience	Existence-Spiritual Value				
				Heritage-Legacy				
			Inspiration for culture, art and design	Inspiration for art, culture and design				

Management		
Issues	O Erosion O Flooding O Illegal uses O Maintenance **Other**	O Pollution: Sewage O Pollution: Human waste O Pollution: Natural waste-remains. O Pollution: persistent pollutants O Species of interest
Land Use	O Farmland O Grazing O Road O Fishing O Recreation	O Urban Settlement O Rural Settlement O Industrial use O Port **Other:**
Features	O Signalling O Private Prop. O Personnel **Authorities:**	O Infrastructure O Buildings O Care measures

Biodiversity		
Vegetation	O Short (grass) O Medium (bushes) O Tall (trees)	Notes/Sketch
Fauna	**Invertebrates** O Insects O Aquatic Other	
	Vertebrates O Birds O Livestock O Terrestrial (others) O Aquatic (others)	

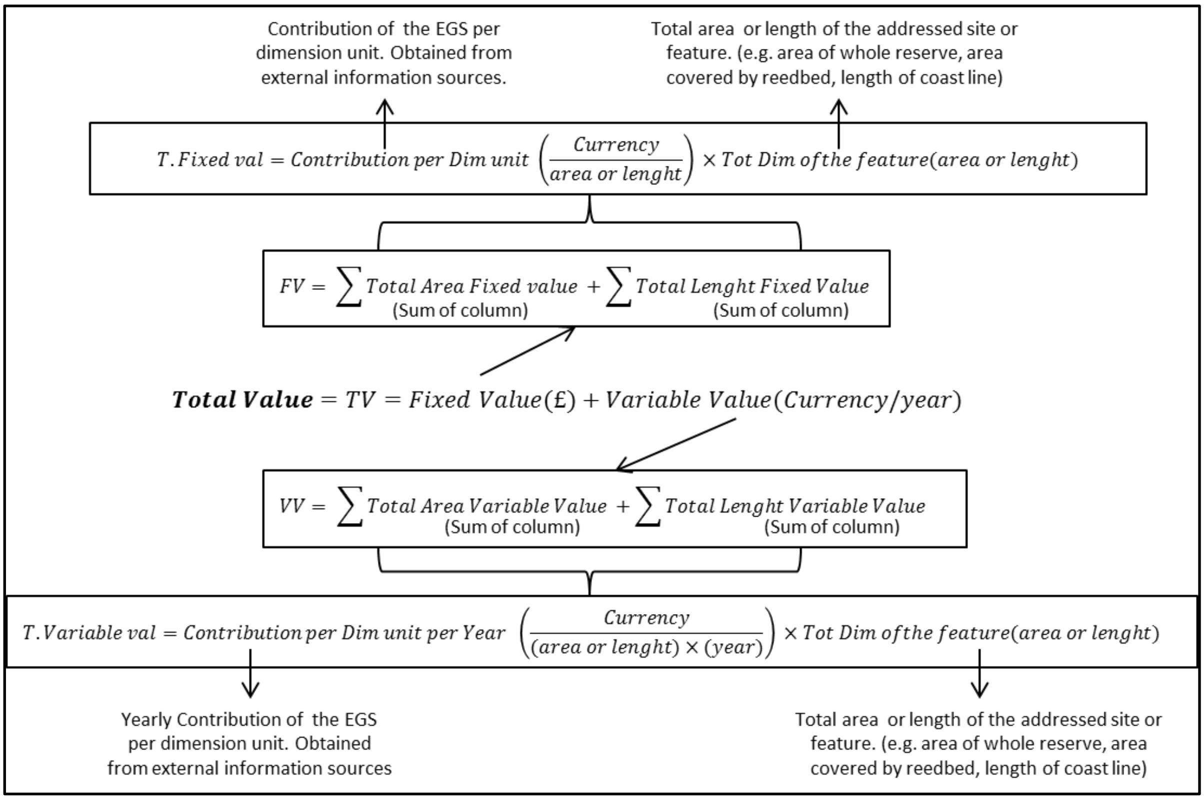
Notes

Figure 4.2 Ecosystem characterization data collection sheet (template EC-DCS). Side B

2.4 EGS valuation

The EGS valuation estimates the total economic value of the ecosystem in terms of the specific EGS assessed in a specific ecosystem. The general assessment carried out in the first phase focus on identifying the potential EGS that should be considered for each site. This assessment should be done focusing on the evidence available on the field through a field surveys (e.g. signs of human activity, and evidence of key services provided by the ecosystem). In addition, previous knowledge and data of the study area obtained from local authorities should be considered. The next step is to confirm and quantify the economic values of the significant EGS identified on the site, which requires estimating the values of specific parameters. The estimate could be the actual market value already defined for the assessed EGS (Kalay et al. 2014; Imberman & Lovenheim 2013), comparative value of EGS that are similar (Costanza et al. 2014), opportunity cost of providing the same benefit on assumption of "what if" scenario (Holland et al. 2016) and the restoration or replacement cost, which is based on assumption of a loss/damage of the actual EGS.

For this quantification phase, the first proposed tool is the "Ecosystem Goods and Services Valuation Matrix" (EGS-VM) (Table, not included), which is an interactive spreadsheet where the user can put in the economic values of the assessed EGS categories. This spreadsheet is designed in a smart way that allows advantages such as the inclusion of the contribution per area unit (e.g. £/hectare) and the automatic estimation of the total value, the fixed contribution for the whole area (e.g. a fixed value such as land value) or the variable contribution (e.g. yearly rates of contribution as £/year). It should be noted that the formulas (Figure 5) and the cells of



this spreadsheet are easily adaptable. It allows users to freely change the proposed layout and adjust it to their own necessities.

Figure 5. Set of formulas to estimate the Total Economic Value of the Ecosystem

Note: T=total, val=value, dim=dimension, FV=Fixed Value, VV= Variable Value

Despite its adaptability, the EGS-VM may be too complex or too big for understanding by some users, and this is why the AESVA suggest that it should be translated into a compact "Ecosystem Goods and Services Valuation Report" (EGS-VR) (Table 2), where the economic value of the addressed ecosystem could be grouped into different aggregation categories (e.g. by type of economic indicator (fixed values, variable values). Once again, this adaptable resource could be modified to meet the terms and the interest of the user.

EGS Type	Value(£)	%	Main EGS Categories
Regulation-Support			
Supply Exploitation			
Cultural-Logistic			

	Value(£)	%
Fixed Value		
Variable Value		
Total value		

Notes: Some categories may be redundant with other categories (e.g. sports included into Recreation-Tourism). Because of this, the task of aggregating information should be done carefully in order to prevent double accounting of value.

Table 2. Ecosystem goods and services valuation report (template EGS-VR).

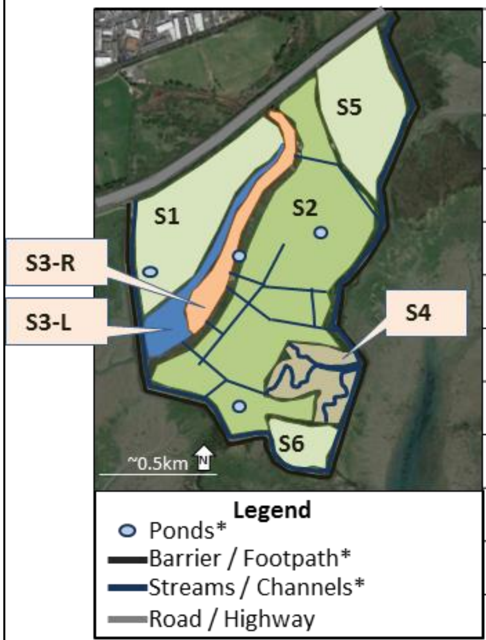
2.5 Application of AESVA to the Farlington Marshes

The approach was tested at the Farlington Marshes to fine-tune the toolkits and the application procedures. It was also to assess the viability of the approach. Farlington Marshes" was identified to be a suitable place to test this approach because of its convenient location and relatively limited valuation research coverage. The application of this approach was carried out as a project called Farlington Marshes Ecosystem Value Assessment" (FAMEVA).

The project aim was to use the AESVA to assess the EGS offered by Farlington Marshes, taking into consideration the different features and characteristics of the wetland. For the purpose of this assessment the area was divided into nine distinctive sections (Figure 6) based on different identifiable features: the bush (S1), the main marsh (S2), the lake with its reedbed (S3-L and S3-R), the ramified lagoon called "the deeps" (S4), the hay field (S5), the point field (S6), the ponds and pools in the whole area (S-PP), the channels-streams (S-CS), and the barrier-footpaths (S-BF).

During the elaboration of the nine sampled sites into site Proformas, some changes were made in order to simplify the comprehension and to prevent excessive repetitive analysis. The modifications include the introduction of a whole-area proforma summarising the general characteristics of the whole wetland (an example of whole-area proforma of the case study is presented in Table 7. In addition, joint proformas and analysis of some sites that featured similar traits were also considered.

For the purpose of EGS valuation/quantification, efforts were made to find some specific economic indicators that have been assessed in the area: direct contact was established with the authorities of HIWWT who manages the reserve. Detailed information about land uses, the number of visitors, economic inputs and outputs, among others were obtained. The search for economic values and indicators (land value, land rent cost for agriculture or grazing land) were carried out. Details on certain goods and services that were not open to the public and therefore could not be properly surveyed during the field survey were identified. Those cases in which no specific economic values were found, the methodology allows the use of estimations from other studies that addressed the economic contribution of similar EGS in more general terms, such as the work of Morris and Camino (2011) and official document from UK's Environmental Agency, as well as the opportunity cost of the EGS under consideration. It is also important to emphasize that in all cases where EGS have a range of values, this project always assumed the lowest one for the valuation to avoid potential overestimation.



		Dimensions		
Code	Site Name	Area (m^2)	Area (%)	Lenght (m)
S1	The Bushes	131.184	12	NA
S2	Main Marsh	461.424	41	NA
S3-L	Lake	30.495	3	950
S3-R	Reed bed	76.729	7	
S4	The Deeps	57.097	5	NA
S5	Hay field	136.094	12	NA
S6	Point field	37.320	3	NA
S-P	Ponds* (>16 units)	15.000**	1	NA
S-SC	Streams / Channels*	NA	NA	7.000**
S-BF	Barrier / Footpath*	NA	NA	9.000**
	Whole area	1.117.348		

*Some features are not completely represented in the map.
(e.g. Additional footpaths can be found across the whole area)
** Approximate values.

Figure 6. Map of the study area with the zonation of the different sites

4. RESULTS

The methodology was successfully applied to the case study area. The performance of the tools could be explained by means of its time efficiency, its versatility and its user-friendliness. In terms of the time and effort used to conduct the full assessment, it is important to point out that the time required to apply the methodology would be subject to certain factors such as the dimension of the assessed site, the design of the survey (number of sites to be addressed or ecosystem features), the accessibility to the site and even the availability of information. For this reason, this work will focus on the approximate time that was applicable to the Farlington Marshes scenario, with an area of 120 hectares and at least 9 specific sites or features to be assessed. This methodology took around 60-85 man-hours to complete the first phase of Ecosystem Characterisation, and 55-75 man-hours to complete the second phase (Figure 3 and Table 3). These times are referential estimations based on the actual times. Because of their qualitative nature, details about the versatility and complexity will be covered later in the discussion.

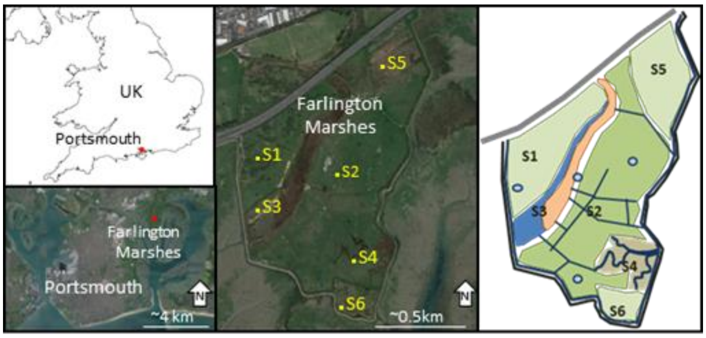
Project phase/task	**Time effort** (units may vary)	Observations
Phase 1: Ecosystem Characterization	Total: **60-85 man-hours**	
Previous preparation	**20-30 man-hours** (2-3 office days that may be considered an appropriate standard time independently of the site)	Includes Previous research; Elaboration of the map; Pre-selection of sites and features to be addressed during the survey; contact with authorities for field-support, permissions, etc.; preparation of materials for the survey.
Characterization Field Survey Data Collection Sheet (EC-DCS)	**10-15 man-hours** Around 30 minutes per site (in the field) + subsequent form amendments.	This was the time required for one surveyor to realize the field survey, take pictures, and fulfil the "EC-Data Collection Sheets" for the 11 sites/features originally proposed for the FAMEVA project. This includes subsequent revisions and amendments (in the office).
Characterization Report Site Proformas (EC-SP)	**30-40 man-hours** Around 2 hours per template + gathering of extra information + Format-details adjustments	The time required to translate the information in the EC-DCS into the Site Proforma (EC-SP) templates. This includes the search for additional information (details, looking at maps, asking authorities).
Phase 2: EGS Assessment	**Total: 25-70 man-hours**	

EGS identification	Included in the previous step.	N/A
EGS quantification Valuation Matrix (EGS-VM) Valuation Report (EGS-VR)	**25-35 man-hours** For ~10 EGS categories addressed in this study-case	Will depend on the number of EGS addressed and the availability of the information.
Optional: Final Written Report	**25-35 man-hours**	Not mandatory as this methodology might be used to get specific data (e.g. from EGS-VM) without the necessity of writing a final report.

Table 3. Time-effort estimations for each phase during the FAMEVA project.

The detailed assessment of each of the sampled sites or features were processed into 9 site proformas to facilitate analysis of data gathered from the field. However, these proformas have been summarised into one general EC-Site Proforma (Figure 7) for the whole area just to reduce the size of the paper. In addition, the general goods and services characterisation results have been presented in Table 5.

Place Name: Farlington Marshes
Site Name: Farlington Marshes
Site **Code:** NA
Location: Portsmouth, Hampshire, UK
Site Coordinates: 50°49'58.13" N 1°01'36.26" W
Area: 1,117,348 m^2
Project: FAMEVA
Date of Survey: 16-June-2016



Map of the study area.

General Overview: This site is a coastal grazing marsh with lagoons, meadows, ponds and pools (may be categorized as a Marine Intertidal marsh (H) according to RAMSAR classification). It has a network of streams and channels and comprises both fresh and brackish glasses of water. The land was reclaimed from the sea in the 18th century and currently, it is enclosed by a concrete barrier with a floodgate inlet controlling the amount of seawater allowed into the main lagoon. As a whole, this marsh appears to be in good condition (4/5). It possesses various conservation designations as it provides feeding and roosting sites for several bird species. For the purpose of this assessment the area has been partitioned into 9 distinctive sections based on different identifiable features: the bushes (S1), the main marsh (S2), the lake with its Reedbed (S3-L. and S3-R), the ramified lagoon called "The Deeps" (S4), the hay field

(S5), the Point field (S6), the Ponds and Pools in the whole area (S-PP), the Channels-Streams (S-CS), and the Barrier-Footpaths (S-BF).

Ecosystem Characteristics

Geomorphology: It includes water bodies such as lagoons, pools/ponds, streams-channels and reed beds; and terrestrial areas such as prairie-like fields, hay fields, footpaths (grass, pebble-rocks, and dirt), and dry areas of the marsh.

Processes: Seawater exchange is controlled by a floodgate inlet in the lagoon, in the west side of the wall, and a network of channels and streams connect this inlet with other water bodies in the whole area. Nevertheless, the rain is also a major contributor to some of the water bodies (e.g. the deeps, and some ponds) where the influence of the seawater may be negligible. Other processes are addressed in the other specific Site Proformas for each site location (not included in this paper).

Biodiversity: In terms of Fauna, the most relevant feature is that it supports different populations of birds (such as Brent Goose, Wigeon, Shoveler, Pintail, Black-tailed Godwit, Marsh Harrier, Short-eared Owl, Bearded Tit, Avocet, Dunlin, Grey Plover, Redshank, Curlew, Ringed Plover, Turnstone, Oystercatcher, Black-necked Grebe, Great Crested Grebe, Peregrine Falcon, Merlin, Sedge Warbler, Reed Warbler, Skylark, Lapwing, among others), including migratory and non-migratory species. Cattle can be found grazing in different areas of the marsh. Though it was historically used for grazing, currently the cattle is there to control the vegetation growth. In addition, many rabbits can be found in the whole area. In terms of vegetation, many flowering plants are present here, including unusual species such as sea barley and Corky-fruited water dropwort. The Reedbed, most of it present in the lagoon (S3), is also a major feature of this marsh.

Ecosystem Goods and Services: In terms of regulation-support, the most relevant are those related to the maintenance of the life cycles and the genetic biodiversity; also, the moderation of extreme events such as floods and storms. In terms of supply and exploitation, the potential use (or previous historic use) of the land for agriculture and fodder-pasture are barely the most relevant as this is a protected site and any extraction is prohibited. In terms of logistic-cultural benefits, the aesthetic features and the infrastructure allows the use of education and pedagogy, hiking and dog walking. See the table (next page) summarizing the EGS addressed for each site.

Management Information: In relation to the uses of the land, it is open to the public (for recreation, dog walking, bird-watching, etc.) with access restriction in some areas. It is a reserve for sensitive species and even the livestock are present not for agricultural purposes, but they are used as a natural cost-effective way to control the growth of vegetation. There are other management interventions by means of infrastructure (fences, doors, house-office, sea-inlet, etc.), signalling (site description and maps, biodiversity description, rules, instructions and security warnings), care measures (staff working, equipment, and evidence of recent maintenance), among others. Some management issues that seem to require permanent or minor attention are: care for the livestock, maintenance of the seawall for cleaning or major amendments in case of extreme events, cleaning of litter or natural waste (vegetation, faeces) in the footpaths and other inner areas, maintenance of the floodgate inlet, surveillance and care measures to protect the biodiversity. It is managed by HIWWT and it holds different protection features or conservation designations, including SPA (Chichester and Langstone Harbours), SAC (Solent and Isle of Wight Lagoons), Ramsar (Chichester and Langstone Harbours), SSSI (Langstone Harbour) and LNR (Farlington Marshes)

Other images:

A)Panoramic view and signs in the Lake, B)Repairs of the inlet, C)Litter on the external side of the barrier, D) The House

Figure 7 EC Site Proforma for Farlington Marshes

The final EGS assessment can be viewed in the EG-Valuation Matrix (sample extract, Table 6) and the EGS-Valuation Report (Table 4). The main outcome from the valuation report was that Farlington Marshes has a total value of £7,754,495, which can be disaggregated into fixed value, £6,180,682 (80%) and variable value £1,573,813 per year (20%). In the same way, the total value can be disaggregated by the type of EGS and the result is that Regulating-Support services are the most relevant with a total contribution of £5,124,956, where Carbon sequestration, protection against floods, protection against storms, natural irrigation, water purification, coastal protection, formation of habitats and services for migratory species are the main services; they are followed by the Cultural-Logistic services that contribute around £2,484,621 being landscape and aesthetic features, tourism and touristic infrastructure, the value of the lands for human development, education and pedagogy are the main categories; and finally, the minor contributor was the group of Supply-Exploitation goods and services where the main categories are agriculture and fodder-pasture with a contribution of £144,917.

Detailed information can be extracted from the Valuation Matrix, where the individual economic contribution of each EGS category and the details about how the values were estimated are presented (because of its size, in this paper we include only an extract of the full table). The most relevant categories surpassing the £1 million limit are: coastal protection with a fixed contribution of £2,800,000 based on the replacement cost of constructing a gabion revetment at the shoreline covered by the reserve; secondly, the value of the lands for human development was estimated at £2,208,863 based on the average purchase price of arable or pasture lands (£8,000 /acre) provided by the RICS (2015); the last big contributing category was the services that relate to the maintenance of life cycles (habitat formation, nursery, services for migratory species, amongst others) that was valued at £1,171,819. Details of the estimations are included in a large table not suitable for this publication.

EGS Type	Value(£)	%	Main EGS Categories
Regulation-Support	5,124,956	66	Carbon Sequestration, Protection against floods, Protection against storms, Natural irrigation, Water purification, Coastal Protection, Formation habitats, Services for Migratory species
Supply Exploitation	144,917	2	Agriculture, Fodder-Pasture
Cultural-Logistic	2,484,621	32	Landscape and aesthetic features*, Tourism and Touristic infrastructure*, Lands for Human Development, Education and Pedagogy*

	Value(£)	%
Fixed Value	6,180,682	80
Variable Value	1,573,813	20
Total value	7,754,495	

* Some categories may be redundant with others, so certain application may require detailed analysis of data to avoid double accounting.

Table 4. Ecosystem Goods and Service Valuation Report (EGS-VR).

Note that this is an extract from the original spreadsheet, where more information could be found (e.g. EGS classification levels, total costs per unit area, etc.) depending on the interest of the user.

5. DISCUSSION

The AESVA is an adaptable and useful approach that can be applied to conduct a full EGS valuation. The provision of the proposed templates and spreadsheet makes it a time-saving the resource, it helps practitioners to avoid spending lots of hours developing and designing materials and tools. In terms of the time and effort, this methodology allows professionals to conduct a full EGS assessment of a location like Farlington Marshes within 85-120 man-hours (equivalent to 9 to 12 days of exclusive dedication), to produce at least, actual valuation report that provides the key economic indicators for decision making (Fisher et al. 2009). Another important goal is to provide a tool to reduce uncertainty related to some EGS assessment methods as described by Hammel & Bryant (2017), by encouraging the use of more credible indicators such as real market value or opportunity cost, with an evidence-based approach in a simple and flexible framework that can be easily adapted, exchanged and updated.

AESVA was developed to be used for multiple scenarios (e.g. different kinds of habitats, information sources, or users), and this can be appreciated in different ways, such as the integrative classification scheme for the EGS allowing the navigation between the different typologies, the simple layout of the ecosystem characterisation templates (DCS and SP) could be useful for both scientific and management applications, as well as the option to put the values of the economic contribution per area using different units (square metres or acres), amongst other examples. It was designed to be easy-to-use, so minimal or no induction is required to be able to use it. Thus, users can save time making calculations and designing the layout of the tables. Further to these characteristics was the possibility to make modifications to the proposed layout to fit their own requirements (e.g. change total area that is going to be used to multiply the unitary value, change the currency symbol, add more EGS categories and use their own colour code among others).

Classification			Good & Service		Site										
Use	Benefit	Functional	Grouping	Detailed	S1	S2	S3-L	S3-R	S4	S5	S6	S-C	S-PP	S-BF	Total Index
Indirect Use	Regulation-Support	Primary Ecosystem Services	Air quality regulation	Capturing dust, chemicals, etc.	P	P	N	P	P	P	P	N	N	N	30
			Climate regulation	Carbon Sequestration	Y	Y	Y	Y	Y	Y	Y	Y	P	N	85
				Influence on rainfall	N	N	N	N	N	N	N	N	N	N	0
			Moderation of Extreme events	Protection against floods	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
				Protection against storms	Y	Y	U	Y	P	Y	Y	Y	P	Y	80
			Moderation of Water flows	Natural drainage	Y	Y	P	P	P	Y	Y	Y	Y	N	75
				Natural irrigation	N	N	P	P	P	N	N	Y	CP	N	28
			Waste treatment	Water purification	P	P	Yi	Yi	Yi	P	P	CP	N	N	53
				Regulation of Contaminants	N	N	CP	CP	CP	N	N	N	N	N	8
				Regulation of Nutrients	P	P	Yi	Yi	P	P	P	P	N	N	50
			Erosion Prevention	Coastal Protection	Y	Y	P	P	P	Y	Y	Yi	P	Y	80
			Maintenance of Soil Fertility	Soil formation	Y	Y	N	P	CP	Yi	Yi	P	N	Y	63
			Maintenance of life cycles	Formation habitats	Y	Yi	Y	Y	Y	Yi	Yi	Y	Yi	Y	100
				Pollination and Propagation of seeds	Y	Y	P	Y	Yi	Yi	Yi	P	P	N	75
				Gametes, Larvae and Juvenile dispersal	Y	Y	Y	Y	Y	Y	Y	Y	P	N	85
				Nursery	Y	Y	Y	Y	Y	Y	Y	Y	P	N	85
				Services for Migratory species	Y	Y	Y	Y	Y	Y	Y	Y	Yi	N	90
			Biological control	Pest and disease control	P	P	P	P	P	P	P	P	N	N	40
			Maintenance of genetic biodiversity	Gene pool protection	Y	Y	Y	Y	Y	Yi	Y	P	Y	Yi	95
Direct Use	Supply Exploitation	Secondary Ecosystem Services	Food Provisioning	Fishing	N	N	CP	N	CP	N	N	CP	CP	N	10
				Hunting	CP	CP	CP	CP	CP	CP	CP	CP	CP	CP	25
				Aquaculture	N	N	CP	N	CP	N	N	N	N	N	5
				Agriculture	P	Yi	CP	CP	P	Yi	Yi	Yi	Yi	P	70
				Harvesting of edible goods	CP	CP	CP	CP	CP	CP	CP	N	N	N	18
			Water	Water for Irrigation	N	N	P	P	P	N	N	P	P	N	25
				Drinking water	N	N	N	N	N	N	N	N	N	N	0
				Water for cooling	N	N	N	N	N	N	N	N	N	N	0
			Ornamental Resources	Decorative plants	CP	CP	CP	CP	CP	CP	CP	CP	CP	N	23
				Pet animals	CP	CP	CP	CP	CP	CP	CP	CP	CP	N	23
			Genetic Resources	Models for crop improvement	P	P	N	P	P	P	P	P	N	N	35
			Raw materials	Minerals	N	N	N	N	N	N	N	N	N	N	0
				Wood	CP	N	N	N	N	N	N	N	N	N	3
				Peat (energy)	N	N	N	N	N	N	N	N	N	N	0
				Fodder-Pasture	Y	Y	Y	Yi	Yi	Y	Y	CP	Y	CP	85
			Medicinal resources	Resources for pharmacology-biochemistry	CP	CP	CP	CP	CP	CP	CP	CP	CP	N	23
				Models and test-organisms	P	P	P	P	P	P	P	P	P	N	45
	Cultural-Logistic		Opportunities for recreation and tourism	Landscape and aesthetic features	Y	Y	Y	Y	Y	P	Yi	Yi	Yi	P	90
				Tourism and Touristic infrastructure	Yi	CP	CP	CP	CP	CP	CP	P	CP	Yi	43
				Sport activities	CP	N	N	N	N	N	N	N	N	CP	5
			Logistic services	Terrestrial Transport: Footpaths, roads	Y	CP	N	N	N	CP	Yi	N	N	Y	35
				Aquatic Transport: Navigation route	N	N	N	N	N	N	N	N	N	N	0
				Lands for Human Development	CP	CP	N	CP	CP	CP	CP	N	CP	CP	20
			Information for cognitive development	Research	P	P	P	P	P	P	P	P	P	P	50
				Education and Pedagogy	Y	Yi	Y	Y	Yi	Yi	Yi	P	P	Y	90
No Use			Spiritual Experience	Existence-Spiritual Value	P	P	P	P	P	P	P	P	P	P	50
				Heritage-Legacy	P	P	P	P	P	P	P	P	P	P	50
			Inspiration for culture, art and design	Inspiration for culture, art and design	P	P	P	P	P	P	P	P	P	P	50

N	Not present (not likely applicable)	P	Potentially applicable
CP	Not Present (conditionally potential)	U	Unknown state

Table 5. Comprehensive classification management and diversity issues of EGS of Farlington Marshes

EGS	TSI	Economic Contribution per						Observations
		Area unit (£/m^2)	Area unit (£/acre)	Total area Variable value (£/year)	Total area Fixed Value (£)	Length unit (£/m)	Total Length of the addressed features (£)*	**Observations** Give information about the economic values assigned to each of the EGS, including detailed calculations and notes that can make this and self-explanatory table. Include citation of the sources of gathered information. Include appropriate explanations when the EGS is not addressed or not applicable to the study case, or if its valuation is being considered or merged into another category.
Carbon Sequestration	85		1,684.80	465,190				-The price of the allowances for the 2014-15 compliance year was set at **15.60 £/tonne of CO_2** for the forecast sale and **16.40 £/tonne of CO2** at the "buy to comply" sale. Carbon Trust (2016). -Carbon Sequestration: Net Carbon Sequestration (Sequestration-Emission) **of 108 tonnes/acre/year.** This corresponds to the amount of carbon stored by wetland (Saline Marsh) (Benedict, 2013). **Estimation:** Approximation to monetary saving by CO_2 emissions mitigation: 15.60 £/tonnesCO2 x 108 tonnesCO2/acre/year= **1684.8 £/acre/year** X (276.11 Acres =**total area**).
Protection against floods	100	0.25		279,114				-Avoidance of damage cost (various examples, complex to estimate in this scenario). -Cost of alternative measures to provide the Service (Protection, Drainage) **Estimation from previous studie**s: Flood control and storm buffering in UK Coastal Wetlands can be valued between **2,498 – 3,730 £/ha/yr** (Morris and Camino 2011)
Protection against storms	80							
Natural drainage	75							
Water purification	53	0.18		200,340				These services are likely to be occurring in the presence of the meadows, reed bed patches and other features aid to keep water bodies clear of an excess of nutrients and even other contaminants. However, in this case, the surrounding areas are not under a specific pressure of this kind and it could be said that these features do not play a special depurative role despite that of keeping balanced their own habitat's quality (if compared with other well-known examples where natural and artificial wetlands are used as green filters for sewage water treatment). In this case, it could be said that the value of these features is related to the cost of restoration-replacement to provide or maintain the same environmental quality. **Estimation from previous studies:** Water quality improvement **1,793 – 2,676 £/ha/yr** (Morris and Camino 2011)
Regulation of Contaminants	8							
Regulation of Nutrients	50							

Coastal Protection	80					2,000	2,800,000	-Price of alternative measures to protect the shoreline against erosion from the sea. Several examples can be used. For this scenario, the Gabion revetment was selected as a suitable option, and its value is **2,000-5,000 £/meter.** UK Environment Agency (2015). Cost estimation for coastal protection.

Table 6. Extract of EG-Valuation Matrix (EGS-VM) for the FAMEVA Project

Though some technical challenges came out in the course of this project, however, they were all fixed effectively. For example, what to do when a multiple-site assessment turns too reiterative or too complex; what to do to save time when converting or unifying the units of the indicators; what to do if the contribution of an EGS category is included or is redundant with another one; among others. Most of these situations were solved during the application of the approach to the case study area. All the templates were reviewed to include solutions developed during the case study. This paper suggests that more application of the approach to wetlands with different characteristics should be considered in order to make this methodology more adaptable and integral to the economic valuation of ecosystem services. It would be useful to apply this approach to a wetland which has been previously assessed with other methodologies, just to evaluate if the findings using this rapid and alternative assessment methodology matches those from the other "revealed preference" methodologies that require higher efforts and opinions of wetland users.

The application of the AESVA to Farlington Marshes and the corresponding economic assessment of the EGS offered by the wetland has a total estimated value of £7,754,495 comprising 80% fixed component and 20% for the variable value. Grouping the economic contribution in terms of the type of benefits: the "Regulation-Support" category was 66% of the contribution, while "Cultural-Logistic" functions followed with 32%, and finally the "Supply-Exploitation" group just added 2% of the total value. This results support the need for protection of Farlington Marshes as a reserve. The marshes offer important valuable services in terms of life cycle maintenance, services for migratory species, the formation of habitat and some regulation functions (HIWWT n.d).

6. CONCLUSION

This paper has developed the AESVA as a versatile and easy to use the resource to achieve a reliable valuation of EGS. The approach is exceptional for its simplicity and the inclusion of innovative traits such as the open-access resources that can be used as a ready-to-use framework or modified to fit different purposes. The application of the AESVA approach to Farlington Marshes was also successful for both pre-established purposes: primarily, serving as a case study to run and test the methodology in order to identify potential gaps and adjust it to the actual demand of a real case scenario. The paper has also contributed to the knowledge of the local nature reserve through the assessment of the economic value of EGS Farlington Marshes.

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