The Economics of Nature-based Solutions

Part II - Handbook for a socioeconomic and environmental assessment of Nature-based Solutions

VERTIGOLAB ECONOMIE & ENVIRONNEMENT

BirdLife INTERNATIONAL EUROPE AND CENTRAL ASIA

IUCN

WETLAND BASED SOLUTIONS

With support from MAVA FONDATION POUR LA NATURE

The following report consists of two parts: Part I is a state of the art on the implementation of Nature-based Solutions and their key operationalization challenges, from a global perspective with a focus on economic features for coastal wetlands. Part II is a handbook for a socioeconomic and environmental assessment of Nature-based Solutions. This report is published as part of the MAVA funded project to improve and share knowledge in order to promote the scale-up of Nature-based Solutions in the Mediterranean, and in particular, to bring to light economic and business arguments for Nature-based Solutions in the Mediterranean wetlands.

Co-authors:

Vertigo Lab: Selma BENZEKRI, Clémentine ANGLADA, Florine DELESSE, Thomas BINET

Birdlife International: Anne-Sophie PELLIER, Naïma CROTTI

IUCN: Lourdes LAZARO

Acknowledgments: We would like to thank the **MAVA Foundation** for their support, MEDSEA and SEO-Birdlife who contributed to the project.

The **MAVA Foundation** finances and supports partners and projects aiming to conserve biodiversity for the benefit of humans and nature.

Vertigo Lab is a French research and consulting company in environmental economics that support companies and territories in transforming their economic models and strategies to accelerate the ecological transition.

BirdLife International is a non-governmental association that covers all continents, landscapes, and seascapes to protect nature and birds in particular.

The **International Union for Conservation of Nature (IUCN)** is the world's leading authority on the state of nature and conservation measures. This is a union of governments and civil society members.

Reading Guide

Assessment task

Information to keep in mind for the assessment

Goal of the phase

This color means that the user should fill the box

Toolbox: Description of the assessment task or tool helping for the assessment.

The reader is informed throughout this handbook of the different tools which could be of use for the assessment. To get more information about those, access the complete content of the guidance and benefit from Vertigo Lab's training and support, refer to the webpage here or contact directly the authors from Vertigo Lab (emails above).

Box: Example description

Case study: Description of a case study from MEDSEA's methodology application in S'Ena Arrubia in Sardinia.

Those elements are a shared version of the application of the handbook toolboxes to the case study. It gives the reader an overview of the application of some methodology tools to a concrete area. To have access to all toolboxes, refer to the Toolbox description above.

Note: This document is the handbook **public version** of a complete decision-aiding tool for Cost-Benefit Analysis and economic assessment of Nature-based Solutions. To benefit from Vertigo Lab's training and support with this methodology, refer to the webpage here or contact directly the authors from Vertigo Lab (emails above).

With support from MAVA

List of acronyms

CARE	Comprehensive Accounting in Respect of Ecology
CBA	Cost-Benefit Analysis
CEA	Cost-Effectiveness Analysis
ES	Ecosystem services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LIFE	L'Instrument Financier pour l'Environnement (European Union's funding instrument for the environment and climate action)
MCA	Multi-Criteria Appraisal
MEA	Millennium Ecosystem Assessment
MPA	Marine Protected Area
NbAS	Nature-based Adaptation Solution
NbI	Nature-based Infrastructure
NbS	Nature-based Solutions
NCP	Natural Capital Protocol
OFB	Office Français de la Biodiversité
PV	Present value
TEEB	The Economics of Ecosystems and Biodiversity
TESSA	Toolkit for Ecosystem Service Site-based Assessment
TEV	Total Economic Value
UN	United Nations
UNEP	United Nations Environment Programme
UN SEEA EA	United Nations System of Environmental-Economic Accounting

With support from MAVA

Table of content

With support from MAVA

Table of toolboxes

Table of boxes

Table of case studies

Introduction

Nature-based Solutions (NbS) are sustainable actions to tackle global societal, climatic, and environmental challenges. They address multiple stakes, provide multiple socio-economic and environmental benefits and are a great opportunity to unleash innovative financial mechanisms. Still, NbS economic interest in the long term remains little known. There is an urge to develop knowledge about NbS so that conservation practitioners, companies, NGOs and all other interested structures can demonstrate their socioeconomic interest before implementing them. The results of this demonstration can enable to communicate and influence key local stakeholders, hence to pledge for NbS implementation and scaling up. Also, this can make decision-makers and policy designers more confident in integrating such solutions in their planning.

To systematize and facilitate NbS assessment, this handbook provides tools and methodology to carry out Costs-benefit Analyses (CbA) of NbS. Its aim is to encourage NbS economic assessments to promote their implementation. Forward, such assessments will enable to scale up NbS among a large diversity of stakeholders and to unleash financial mechanisms in favor of NbS.

After a methodological framing for the assessment in Section II.1, a step-by step methodology for CbAs is described in Sections II.2 and II.3. Following this, Section II.4 gives the user tips and resources to monitor NbS sustainability in the long term. To conclude, Section II.5 provides techniques to communicate on the NbS assessment results.

Part II - Handbook for a socioeconomic and environmental assessment of NbS

Section II.1: Framing for NbS economic assessment

II.1.a. Conceptual framing of NbS monetary valuation

Assessing NbS in economic terms implies considering the functioning of nature by making complex natural systems simpler and estimating the economic benefits of protecting ecosystems. Therefore, it also implies that the assessed values of ecosystem services can be partial or not exact regarding ecological functioning. Still, by offering objective and quantitative elements, those methods enable to sensitize public and private actors to the benefits of biodiversity enhancement through NbS, with the final goal of favoring their implementation and acceptation.

NbS economic assessment aims at:

- ✓ Highlighting the benefits of NbS and other biodiversity policies and strategies;
- ✓ Fostering decisions by comparing the values of goods and services encouraged by solutions;
- ✓ Traducing losses in societal value linked to biodiversity and ecosystems degradation;
- ✓ Rationalizing NbS to make them more easily to seize and promoted by decision makers.

This document describes a particular methodology, assuming that the implementation of NbS is based on the ecosystem services (ES) expressed or potentially expressed on the site of interest. The choice of NbS also depends on the data available on the site. With this method, the provision of those ES directly depends on the habitats comprised in the study perimeter. The perimeter definition of the area is a stake of the assessment, as it determines the challenges of the site, ES assessed, and the result of the assessment[1]. Therefore, the NbS choice and design usually depend on the challenges expressed in the concerned habitats, following the process below:

This document focuses on the Cost-Benefit Analysis of NbS as a decision-support tool. The Cost-Effectiveness Analysis, Multi-Criteria Appraisal and Weighted Sum Model are not described but

[1] Wolff A., Gondran N., Brodhag C., 2017. Les outils d'évaluation de la biodiversité et des services écosystémiques recommandés aux entreprises : compromis entre crédibilité, pertinence et légitimité. https://doi.org/10.4000/developpementdurable.11649

can be interesting methodologies to evaluate the socio-economic interest of scenarios for a site. A comparison of methodologies is presented below[2][3][4].

TABLE 1: COMPARISON OF ASSESSMENT METHODOLOGIES (VERTIGO LAB)

	Cost-Benefit Analysis	Cost-Effectiveness Analysis	Multi-Criteria Appraisal
Definition	CBA is a systematic approach to estimate strengths and weaknesses of alternatives in monetary terms. It is used to determine the choices which provide the best approach to achieve benefits while preserving savings.	CEA is a way to compare the relative costs and outcomes of different scenarios. It distinguishes from CBA as does not only assign a monetary value to measure the effect of the scenarios.	MCA is a decision-making tool used to evaluate scenarios that present different alternatives. Users doing MCAs expect to select the most optimal solution regarding different and sometimes conflicting goals. Several methods of MCA exist, including Weighted Sum Model[5] or Analytic Hierarchy Process[6].
Outcom	Monetary ratio of all costs to all benefits of a scenario	Cost per unit of effect on one outcome of interest	No single ratio, selecting the most acceptable solution for stakeholders
Advantage	Determine whether a scenario is worth the investment	Compare programs when regarding one outcome of interest	No requirement of monetization of social, environmental outcomes, highlights trade-offs between competing options, interests and goals
Limits	Requires strong assumptions about the monetary value of all the different benefits, including the lifetime benefits	Requires using similar methodologies for costs and benefits comparison, and to compare scenarios with common outcome(s)	Requires several estimates, qualitative evaluations, more difficult to communicate for policy-decision makers
Formula	$Net\ present\ value = \sum_{t=0}^{n} \frac{Benefits\ year\ t}{(1+i)^t} - \sum_{t=0}^{n} \frac{Costs\ year\ t}{(1+i)^t}$	$Cost\ per\ additional\ unit\ of\ effect = \frac{Costs}{Incremental\ effect}$	*NA – the criteria varies according to the analysis*

[2] World Bank, 2021. Cost-effectiveness Analysis. Available at: https://dimewiki.worldbank.org/Cost-effectiveness_Analysis
[3] Nef consulting, 2022. Multi-criteria appraisal (MCA). Available at: https://www.nefconsulting.com/what-we-do/evaluation-impact-assessment/multi-criteria-appraisal-mca-2/
[4] Environmental Justice Organisations, Liabilities and Trade, 2015. Multi-criteria assessment. Available at: http://www.ejolt.org/2015/02/multi-criteria-assessment-mca/
[5] Wikipedia, 2022. Weighted sum model. Available at: https://en.wikipedia.org/wiki/Weighted_sum_model
[6] Wikipedia, 2022. Analytic hierarchy process. Available at: https://en.wikipedia.org/wiki/Analytic_hierarchy_process

II.1.b. Methodology overview step-by-step

The methodology presented in those guidelines is set using the following steps:

Stakeholder engagement (¶ II.1.c)

Step 1: Site diagnosis & description	First data collection; Study perimeter definition & description; Ecosystems, habitats & productive areas identification & description; ES characterization; Threats & pressures identification	¶ II.2.a
Step 2: Monetary valuation of ES	Choice of monetary valuation method; Data collection; Ecosystem services assessment; Monetary values	¶ II.2.b
Step 3: Benefit assessment of NbS	Scenarios definition; Prospective workshops; Estimate and characterization of the evolution of ecosystems state, threats, pressures for each scenario; Present Value estimate; Benefits estimate	¶ II.2.c
Step 4: Costs estimation of NbS	Costs assessment estimation for each scenario	¶ II.2.d
Step 5: Cost-benefit analysis	Costs and benefits: comparison for each scenario	¶ II.3

II.1.c. Stakeholder engagement

Crosswise to the five steps of our methodology, it is essential to **engage the relevant actors** to be sure to take all area stakes into consideration and to assess the NbS considering a realistic snapshot of the site.

The stakeholders implied in the site current management or future evolution is a key element of the process. This has to be analysed from the start of the assessment process and the user should be sure of engaging them on the entire project duration. For this, the user should first categorize the stakeholders of the site, according to the most pertinent criteria, by making sure that the sample of people involved in the assessment are representative of the area stakeholders. For example, the criteria to characterize the people can be:

- the type of organization they represent (e.g. institution, economic world, non-profit, inhabitant),
- their interests in the site,
- their main rights in relation to the site (e.g. access, management),
- their impact on the site and its services (current, future potential),
- their dependencies on the site and its services (current, future potential).

For more guidance on the stakeholder analysis, refer to Guidance folter in TESSA: Stakeholders analysis: http://tessa.tools/

With support from MAVA

Section II.2: Step-by-step guidance to make the economic assessment of NbS

II.2.a Site diagnosis and description

This first step comprises the following phases:

II.2.a.i. Preliminary data collection,
II.2.a.ii. Study perimeter definition and description,
II.2.a.iii. Ecosystems, support habitats and productive areas identification and description,
II.2.a.iv. Ecosystem services characterization,
II.2.a.v. Threats and pressures identification.

The goal of this step is to **characterize the ecosystems on the site**, **identify the goods and services** that are significant and should be assessed, and to **exploit the available cartography**. Ecosystem goods and services are significant if they are expressed on the site of interest.

II.2.a.i. Preliminary data collection

A key step of the ecosystem services economic assessment is data collection. To collect the data required for this step, several combinations are possible:

- **Academic and gray literature** consultation on ecosystem services, particularly on coastal areas,
- **Studies and reports** performed **in similar contexts elsewhere**,
- **Studies and reports on the site** (local scientific organizations such as research offices, public organizations etc.).

This bibliographic literature review can be completed with interviews with local pertinent actors, that will be required in the proper assessment phase. It will enable to have a first idea of the major relevant ES expressed around the site, and to prefigure the perimeter definition.

II.2.a.ii. Study perimeter definition and description

To characterise the ecosystems of the site, the **perimeter of the study** is to be defined. For this task, the preliminary study sources (e.g. management plans, local ecological studies) help to know more about the **area's attributes, the economic or recreational activities** on the site and **the different anthropic or natural stakes** that the site is or could be exposed to in the future. The user can access more guidance in Toolbox 1.

Toolbox 1: Study perimeter definition guidance

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

II.2.a.iii. Ecosystems, support habitats and productive areas identification and description

An **ecosystem** corresponds to all the organisms and the physical environment with which they interact[7]. Biotic and abiotic components of ecosystems are linked together through nutrient cycles and energy flows[8].

A **habitat** corresponds to all resources, physical and biotic components of an ecosystem, such as to support the survival and reproduction of a particular species[9].

Ecosystem services (ES) identification directly depend on the assessment perimeter delimitation. Listing the site habitats is a key task to identify what ecosystem services could be provided by those habitats functions within this perimeter. This **identification of support habitats** should be based on available data such as GIS data or/and EUNIS classification (European Nature Information System). This classification identifies the following habitats classes:

- A : Marine habitats
- B : Coastal habitats
- C : Inland surface waters
- D : Mires, bogs and fens
- E : Grasslands and lands dominated by forbs, mosses or lichens
- F : Heathland, scrub and tundra
- G : Woodland, forest and other wooded land
- H : Inland unvegetated or sparsely vegetated habitats
- I : Regularly or recently cultivated agricultural, horticultural and domestic habitats
- J : Constructed, industrial and other artificial habitats
- S : Heathland, scrub and tundra
- T : Forest and other wooded land
- X : Habitat complexes

The user should **consider each habitat, study its characteristics**, more globally its **role for the ecosystem operation**, and **how it was affected by change in the past and could be in the future**. Once the study perimeter of the site is defined and the ecosystem(s) characterized, the user can calculate the areas of the ecological units of the ecosystem depending on the different habitats composing the site, as shown in Toolbox 2.

Toolbox 2: Table for habitat description

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

This description can be coupled with a **cartographic treatment** to show the correspondence between the habitats and the functions those may provide.

[7] Chapin, F. Stuart, III (2011). "Glossary". Principles of terrestrial ecosystem ecology.
[8] Wikipedia, 2022. Ecosystem. Available at: https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapinglossary-2
[9] Krausman P.R., Morrison M.L., 2016. Another plea for standard terminology. Available at: https://wildlife.onlinelibrary.wiley.com/doi/full/10.1002/jwmg.21121

Box 1: Example of habitat characterization with a case study in Haïti

To characterize the habitats of the benthic ecosystems of Aquin-Saint Louis du Sud Marine Protected Area in Haïti, a GIS treatment was made (Figure below).

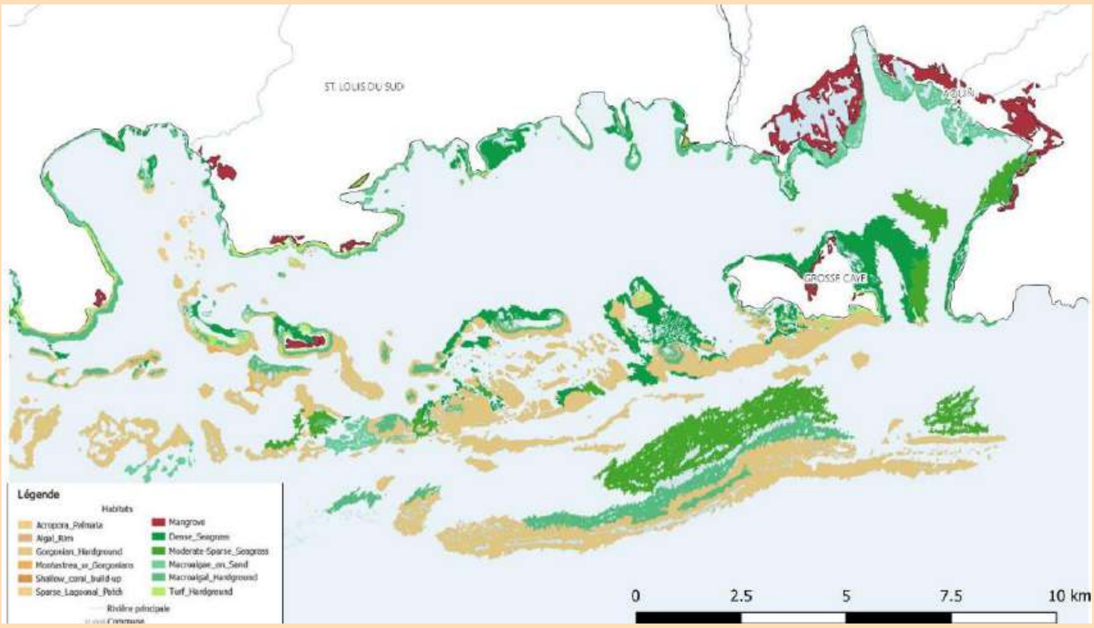


FIGURE 1: BENTHIC ECOSYSTEMS DESCRIPTION IN AQUIN-SAINT LOUIS DU SUD MARINE PROTECTED AREA IN HAÏTI

The associated surface areas were evaluated and presented in a table.

TABLE 2: EXTRACT OF THE DESCRIPTIVE TABLE FOR AQUIN-SAINT-LOUIS DU SUD

Benthic habitat category	Benthic habitat details		Area (ha)
Mangroves	Mangrove tree	82% Red mangrove tree, 10% black mangrove tree, 10% white and gray mangrove tree	341.67
High coral areas	Montastraea and gorgones	About 15% of the surface is made up of corals massifs, of Montastrea or Dendrogyra, upon which gorgonians and sponges	20.33
	Gorgonian hardground	Coral cover composed of gorgonians for over 60%. Scleractiniaria <5%. Sponges and macroalgae occupy the rest.	2,146.69
	Sparse lagoonal patch	1-10m deep, separated by a thick sedimentary cover or seagrass beds. Scleractiniaires, Hydrocoraux. Gorgonian substrate, sponges.	29.11
	Algal rim	Depth break zones, coverage “turf”, limestone algae, small coral colonies	28.14

Full study summary: http://vertigolab.eu/portfolio/evaluation-services-ecosystemiques-grand-sud-dhaiti/

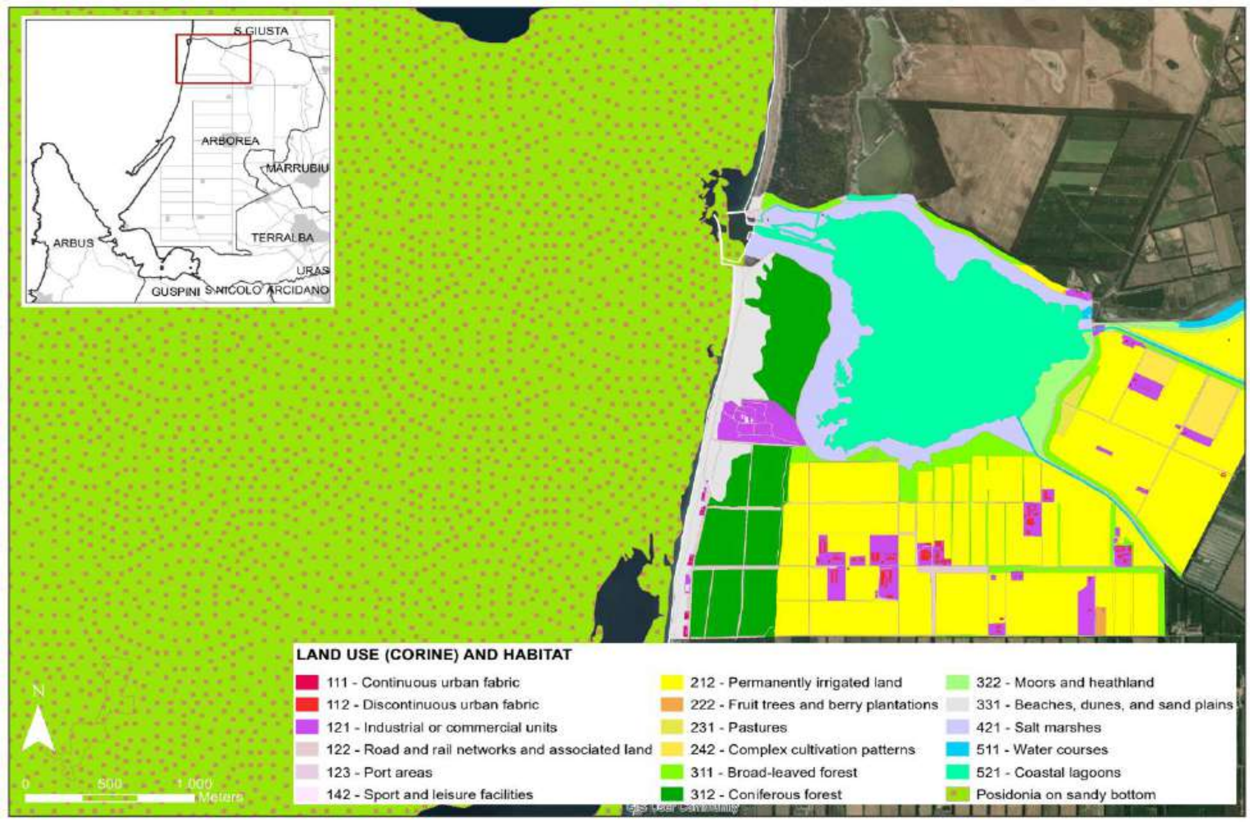
Case study 1: Example of habitat characterization with a case study in S'Ena Arrubia in Sardinia

To characterize the habitats of the Lagoon of S'Ena Arrubia, a Ramsar site and Natura 2000 area in Sardinia, a GIS treatment was made using a shape file created by MEDSEA foundation through the merge of two existing shape files. This treatment was based on Corine Land Use and the satellite images to fill the map gaps (Figure 1). The Lagoon of S'Ena Arrubia remains part of a large and complex system of ponds reclaimed in the past century to control flooding events and to create areas for agriculture. Due to the poor quality of the sandy soil, cattle breeding was implemented to have constant and cheaper sources of nutrients.

This large amount of nutrients created several environmental problems in the past century's decades. After the enactment of the Nitrate Directive from the EU and the creation of the Nitrate Vulnerable Area (2005), the situation improved and the Lagoon of S'Ena Arrubia became one of the most important biodiversity hotspots in Sardina for birds.

Today, several economic activities are in the area, including farming and cattle breeding, fishing and tourism.

FIGURE 2: COASTAL AND MARINE ECOSYSTEMS DESCRIPTION IN THE LAGOON OF S'ENA ARRUBIA IN SARDINIA (MEDSEA)



The total coastal area is 777.98 ha including built areas and 206.37 ha of marine habitats evaluated in the assessment, and described in the table below.

TABLE 2: SUMMARY OF THE DESCRIPTIVE TABLE FOR THE LAGOON OF S'ENA ARRUBIA

Coastal and Marine habitat category	Coastal and Marine abitat details		Area (ha)
Agricultural habitats	Cropland	95% Annual crops (especially ryegrass and maize)	318.99
Forest habitats	Mediterranean broadleaved and conifers	69% Mediterranean Pinewood and 31% eucalyptus implanted in the past century	117.08
	Perennial native plants	61% Sclerophyllous vegetation and 39% Moors and heathland	42.09
Coastal ecosystems	Salt marshes, coastal lagoon and water courses	28% salt marshes, 3% water courses, 69% coastal lagoon	221.57
Marine ecosystems	Posidonia oceanica meadows	Posidonia oceanica on sandy bottom	206.37 (taken into consideration)

II.2.a.iv. Ecosystem services characterization

Once the habitats of the considered ecosystems are listed with their characteristics, ecosystem services should be easier to identify. Beforehand, let's define what are ecosystem services. The value of an ecosystem service can be considered at two inter-related levels as defined by the Millenium Ecosystem Assessment[10]:

- Use and non-use present and future values of the ecosystem services;
- Provided services by the ecosystems.

The Total Economic Value (TEV) of an ecosystem is the total use and non-use current and future values of an ecosystem defined by the Millenium Ecosystem Assessment such as:

TABLE 3: LIST OF DIFFERENT TYPES OF VALUES ACCORDING TO MEA FRAMEWORK

Type of value	Description
Direct use value	Results from the direct use of ecosystem services by individuals
Indirect use value	Stems from regulation services provided by ecosystems
Option value	Translates the importance given by people to the future availability of ecosystem services for their personal benefits
Bequest value	Corresponds to the importance given by individuals to future generations access to the same services (inter-generations equity)
Altruistic value	Corresponds to the importance given by individuals to the fact that other individuals may have access to the same ecosystem services at the same moment
Existence value	Corresponds to the satisfactions that individuals get from the simple fact of knowing that ecosystems and biodiversity maintain their existence.

[10] Millenium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being, A Framework For Assessment. Available at : https://islandpress.org/books/ecosystems-and-human-well-being?prod_id=474

The ecosystem services provided by a given habitat correspond to one or several values cited above. The principal listed ecosystem services are divided in four major categories, according to the CICES classification:

TABLE 4: TYPES OF ECOSYSTEM SERVICES ACCORDING TO CICES CLASSIFICATION

Provisioning Services *(Biotic)*	**Regulation & Maintenance services** *(Abiotic)*	**Cultural Services** *(Abiotic)*
Products obtained directly from ecosystems	Benefits obtained from regulation of natural ecosystem processes	Non-material benefits obtained from ecosystems
Food, Salt, Fish resources, Freshwater, Fuel, Fiber, Biochemicals, Genetic resources etc.	*Climate regulation, Coastal protection, Disease regulation, Water regulation, Water purification, Pollination etc.*	*Spiritual & religious, Recreation & ecotourism, Aesthetic, Inspirational, Educational, Scientific interest, Cultural etc.*
Support services		
Services necessary to produce all other ecosystem services		
Soil formation, Habitats, Nutrient cycling, Primary production, biomass		

At this stage, the user should be able to **select the ecosystem services** of the site for which an assessment of the benefits for populations is pertinent. The selection of the significant ecosystem services is major to characterize and make the benefits of the NbS tangible. This selection will depend on several criteria, including:

- The existing habitat in the study perimeter.
- The level of expression of the ecosystem service: for provisioning services, if the production of resources is a major activity for the beneficiaries; for regulation and maintenance services, if the site is subject to natural hazards or natural processes threatening its sustainability; for cultural services, if the site hosts cultural activities such as experiments or touristic activities.
- The availability of data: if specific data has already been identified or collected, the user should consider the ecosystem service in its assessment.
- The availability of monetary data: provisioning services should be chosen first as monetary data is usually easier to access than other services.
- The significance of the ecosystem service for the planned management: specific ecosystem services can be targeted by certain management actions.

The use of an adequate assessment methodology for each service of interest will enable to estimate the site ecosystem services TEV. That way, each ES can be assessed with diverse methodologies which should be adapted to the type of service the studied habitats and ecosystems provide. Indeed, the use and non-use values correspond to the Total Economic Value when reasoning in terms of ecosystem services[11].

[11] TEEB, 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. http://teebweb.org/publications/teeb-for/synthesis/

TABLE 5: VALUES REPARTITION AS DEFINED IN THE TEV (THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY : ECOLOGICAL AND ECONOMIC FOUNDATIONS)

Ecosystem services category	Values			
	Direct use	Indirect use	Option	Non-use
Provisioning	x		x	
Regulation & Maintenance		x	x	
Cultural	x		x	x
Support	*Support services are directly enhanced through the other services categories*			

Toolbox 3: Material for ecosystem services description

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Case study 2: Material for ecosystem services description in S'Ena Arrubia (MEDSEA)

In 2018, a workshop with several categories of stakeholders was organized by MEDSEA to identify and evaluate the ecosystem services provided by the Ramsar site of S'Ena Arrubia. The results were compared with the same exercise made by experts with different expertise to draw the list of the most significant ecosystems services. Thanks to this list, the final decision concerning the assessment of ecosystem services was taken depending on the data and information availability.

For example, the complexity of the natural and artificial hydraulic systems, including two large dams far from the area 30km and 60km, hindered the possibility to analyze the inland flood regulation service. On the other hand, coastal erosion was included in the analysis as local stakeholders and existing studies indicated that it constituted one of the most serious issues in the area. However, there were real difficulties to find tangible evidence concerning the phenomenon.

Category	Ecosystem service	Beneficiaries	Significance	Assessment
Provisioning services	Agricultural production	Local farmers and companies - regional and national consumers	5	Yes
	Breeding	Local farmers and companies - regional and national consumers	5	Yes
	Fishing and Aquaculture	Local fishermen and companies - regional and national consumers	5	Yes
	Picking	Not allowed in protected areas	0	No
	Apiculture	Local farmers and local consumers	1	No
	Water provision	Not allowed by national legislation	0	No
Regulation and Maintenance services	Global climate regulation	Local residents and companies and regional and national inhabitants	5	Yes
	Local climate regulation	Local residents	3	No
	Air quality regulation	Local residents	2	No

	Noise pollution regulation	n.a	n.a.	No
	Flood regulation	Local residents and companies – regional and national consumers	4	No
	Water quality regulation	Local residents and companies – regional and national consumers	4	Yes
	Soil quality regulation	Local companies – regional and national consumers	1	No
	Coastal erosion regulation	Local residents and companies, long stay tourists and day trippers	4	Yes
	Non coastal erosion regulation	n.a	n.a	No
	Marine submersion regulation	Local residents and companies – regional and national consumers	4	Yes
	Fire protection	n.a	n.a	No
Cultural services	Recreative interest	Local residents and companies, long stay tourists and day trippers	5	Yes
	Landscape amenities	Local residents and companies, long stay tourists and day trippers	4	Ye
	Tourism	Local residents and companies, long stay tourists and day trippers	5	Yes
	Education, scientific, interest	Local residents and companies, long stay tourists and day trippers	4	Yes
Natural patrimony	Protected elements of ecosystems and ordinary biodiversity	Regional residents and local companies, visitors	5	No

Data resources:

- Interviews with local inhabitants, managers, site beneficiaries, scientists, researchers, farmers and other stakeholders,
- Questionnaires dissemination,
- Site scientific literature study,
- Site and surroundings gray literature study,
- Local papers or journalists giving insight about the natural state of the site or its exposure to natural hazards (e.g. flood), etc.

II.2.a.v. Threats and pressures identification

Anthropic or natural factors may damage the state of the ecosystems of the studied site. Those could both threaten the provided services, and disrupt the economic activities that depend on those ecosystems. They can influence ecosystems directly (e.g. ship traffic degrading the Posidonia oceanica herbarium populations) or indirectly (e.g. climate change inducing sea water temperature rise and species death).

This step consists in **identifying the principal pressures and threats that lay on the site ecosystems and describing those**. The presence of certain natural resources (e.g. extraction material, halieutic resources) or the management means of certain areas (e.g. intensive salt production on the shore) can constitute significant anthropic pressures on the ecosystems that have to be taken into account in the assessment. The user can relate to Toolbox 4 below to characterise the pressures and threats of his site (non-exhaustive).

Toolbox 4: Pressures and threats examples census (Vertigo Lab)

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Case study 3: Pressures and threats identification in S'Ena Arrubia (MEDSEA)

In S'Ena Arrubia, the pressures and threats concerning the site were studied and can be described as in the following table.

Natural	Anthropic	Pressure	Detail or example
x		Sea level rise	Climate change effect resulting in the global rise of sea level
x		Air temperature rise	Climate change effect resulting in the global rise of ambient air temperature
x	x	Drought	Rise of temperature and diminution of water availability resulting in serious drought episodes, aggravated by inefficient management practices
x	x	Fire risk	Climatic circumstances (drought, heat, wind) significantly increasing the risk of fire in certain areas / human set fires
x		Marine submersion	Temporary and episodic marine flood resulting from meteorological events (storm, hurricane, high depression, and wind) or oceanographic events (wind waves, tsunami, tides)
x		Coastal erosion	Loss or displacement of land, or long-term removal of sediment and rocks along the coastline due to the action of waves, currents, tides, wind-driven water, waterborne ice, or other impacts of storms
x	x	Stream overflow flooding	Stream overload after a particularly heavy rain resulting in flood, incapacity of the natural soil to absorb the water in excess, aggravated by inefficient management practices and urbanized areas
x	x	Soil erosion	Displacement of the upper layer of soil, aggravated by inefficient farming practices
x	x	Invasive exotic species	Input of a non-native animal or plant species of plant on a site perturbating the natural ecosystem operation
x	x	Water resource decline	Non-reasoned water intake by farmers, local companies and residents generating low groundwater table levels and drastic water shortages
x	x	Water quality degradation	Human (aquaculture, wastewater discharge, overuse of pesticides in agriculture) or natural phenomena (upstream mudslide) causing environment quality degradation

With support from MAVA

	x	Pollution by waste	Human attendance of natural park for hiking generating waste in natural areas / Illegal waste disposal
	x	Urbanization and soil artificialization	Infrastructures such roads, ports, electric grids etc.
	x	Tourist attendance	Tourist over-attendance of a remarkable coastal area

The pressures and threats identification can be fed with literature such as scientific reports, study offices reports, research reports, NGOs reports concerning the area or interviews with site stakeholders. Those elements are crucial for the prospective phase. At the end of this first diagnosis, the user can **synthetise the information in a synthetic table** as shown in Toolbox 5.

Toolbox 5: Synthetic table for the selection of ecosystem services (Vertigo Lab)

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Case study 4: Synthetic table for the selection of ecosystem services for S'Ena Arrubia (MEDSEA)

In the site of S'Ena Arrubia, the ES assessed and the corresponding beneficiaries and habitats can be synthesized as in the following table.

Ecosystem service	Potential beneficiaries	Habitat / Ecological unit	Area (ha)
Provisioning services			
Agricultural production Breeding Fishing and Aquaculture	Local farmers/fishermen and companies - regional and national consumers	2124 Permanently irrigated land 2121 Permanently irrigated land 222 Fruit trees and berry plantations 231 Pastures 5211 Coastal lagoons	471.74
Regulation services			
Global climate regulation Flood regulation Water quality regulation Coastal erosion regulation Marine submersion regulation	Local farmers/fishermen and companies - regional and national consumers	31121 Broad-leaved forest 3121 Coniferous forest 3222 Moors and heathland 3313 Sclerophyllous vegetation 421 Salt marshes 5211 Coastal lagoons 1120 Posidonia oceanica beds	220.54 (coastal) + 206.37 (marine) = 426.91
Cultural services			

Recreative interest Tourism	Local residents and companies, long stay tourists and day trippers	31121 3121 3222 3313 421 5211	Broad-leaved forest Coniferous forest Moors and heathland Sclerophyllous vegetation Salt marshes Coastal lagoons	220.54
Landscape amenities Education, scientific, interest	Local residents and companies, long stay tourists and day trippers	31121 3121 3222 3313 421 5211	Broad-leaved forest Coniferous forest Moors and heathland Sclerophyllous vegetation Salt marshes Coastal lagoons	N220.54

II.2.b. Monetary valuation of ecosystem services

The goal of this step is to **assess each selected ecosystem service from available bibliographic resources and experts' claims**. It can be made by the following steps:

II.2.b.i. Choice of monetary valuation method
II.2.b.ii. Data collection
II.2.b.iii. Ecosystem services assessment
II.2.b.iv. Monetary value resources

This approach is based on the theory and concepts of environmental economy. According to this theory, ecosystems are considered as capital on the economic point of view, as generating value. A great number of scientific works and international projects are based on this approach since reference works exist[12,13,14,15].

II.2.b.i. Choice of monetary valuation method

The user should identify the market or non-market economic value of each ecosystem service. If the ecosystem service leads to a product or service that is or can be sold on a market, then it has a market value. If the ecosystem service leads to a product or service that is not sold and exchanged on a market, then it has a non-market value.

TABLE 6: COMPARING MARKET AND NON-MARKET VALUE APPROACHES (VERTIGO LAB)

Market value	Non-market value
The economic and environmental approach developed by the UN for ecosystems (System of Environmental Ecosystem Accounting [16]) showed that ecosystem services strongly contribute to economic activities. Those combine ecological inputs (provisioning and cultural services) with other inputs (raw materials, service delivery, manpower) to provide goods and services.	According to the approach of this guide, ecosystem services assessments are majorly based on non-market values (cultural and regulation services). Three categories of methods can be painted: ▪ **Declared preferences**: Estimate the value of an ecosystem service with field surveys from a representative sample of the local population. ▪ **Revealed preferences**: Estimate the value of an ecosystem service by observing the behavior of individuals on an existing market. ▪ **Costs methodology**: Evaluate the price that individuals are ready to pay or to avoid to benefit from a given ecosystem service (Willingness to Pay, for consumers) *or* Evaluate the minimum monetary amount that a person is willing to accept to sell a good or service (Willingness to Accept, for producers).

For guidance to select the adapted ES assessment method, refer to Toolbox 6.

[12] Costanza et al, 1997. The value of the world's ecosystem services and natural capital.
[13] TEEB, 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. Available at: http://teebweb.org/publications/teeb-for/synthesis/
[14] Wealth Accounting and the Valuation of Ecosystem Services. Available at: https://www.wavespartnership.org/
[15] Costanza et al, 2017. Twenty years of ecosystem services : How far have we come and how far do we still need to go?
[16] SEEA. Ecosystem Accounting. Available at: https://seea.un.org/ecosystem-accounting

With support from MAVA

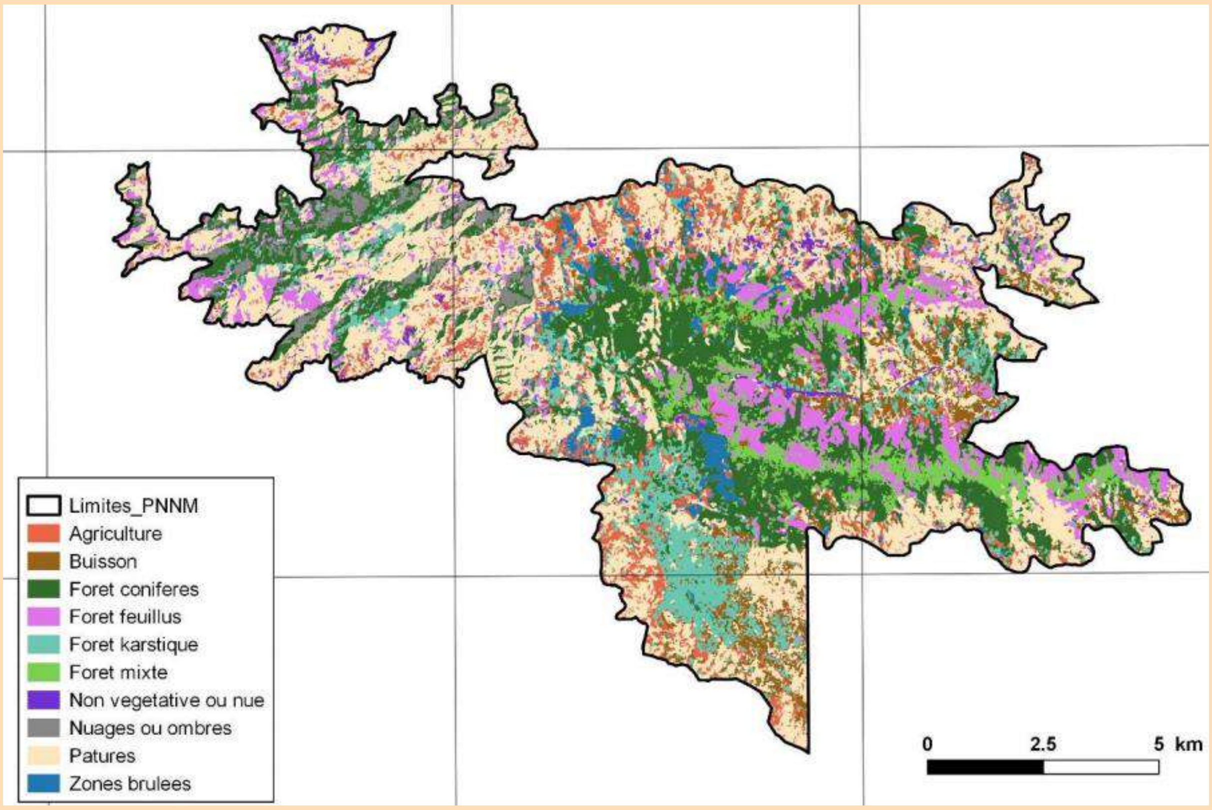
Toolbox 6: Guidance for Ecosystem Services assessment method choice

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Box 2: Example of ecosystem services valuation with a case study in Haïti

In Haïti, flood regulation is a major ecosystem service provided by natural coastal ecosystems such as wetlands or vegetated areas. On one of the watersheds areas of interest of 13 590 ha (according to GIS) covering three watersheds, the avoided costs method was used. It enabled to quantify the damage caused by flooding in the studied area if the forest ecosystems were not present to ensure their risk mitigation function. The GIS model that Vertigo Lab made in the study enabled to obtain the land use on the site and to understand in which ways water is integrated in the land use system, as shown in the map below:

FIGURE 3: GIS MODEL OF THE SUBMERGED LAND IN CASE OF A FLOOD (VERTIGO LAB)



The annual costs of losses for a potential flood was found in a previous study on the studied area led in the context of preparatory studies for investing in protective infrastructures on the watersheds[17]. According to the study, the return flooding period is between 2 and 10 years on various watersheds on which the studied site is situated: Acul Dubreuil, Cavaillon and Ravine du Sud. The value of the average of the costs of losses due to the flood on the three watersheds was considered.

The details of those costs are given by this same study for each watershed:

[17] AECOM, 2015. Réalisation des études préparatoires pour des investissements en infrastructures de protection des bassins versants de la Grande Rivière du Nord, Cavaillon, Ravine du Sud, Artibonite et Acul Dubreuil Premier Rapport.

Watershed	Annual losses (HTG/year)	Average costs for the site (HTG/year)
Acul Dubreuil	174,337,613	430,087,290
Cavaillon	318,599,606	
Ravine du Sud	797,324,647	

According to a governmental study on the territorial goals and strategies to rebuild the area after the flood[18], replacing bushes and cleared areas by forest along the water banks could reduce by 26% the peak flow intensity of those streams. The peak flow intensity reduction rate was hence considered at 26%.

Considering that the losses avoided by the presence of the forest banks are proportional to the peak flow reduction power of these forests, the avoided economic loss owing to the presence of the forest ecosystems is equal to 26% of 430 million HTG, which is approximately 111.8 Million HTG per year.

The economic value of flood regulation provided by the site including the three watersheds is thus 111.8 Million HTG/year or 1.28 Million Euros/year.

Full study summary: http://vertigolab.eu/portfolio/evaluation-services-ecosystemiques-grand-sud-dhaiti/

II.2.b.ii. Data collection

For the data collection, several means can be deployed to complete the preliminary bibliographic review:

- **Interviews**: local actors that take part to the site management (municipal government, collectives, environmental protection association, economic actors), specific specialists on local challenges (breeding, fishing, ecosystem conservationists, scientists etc.). Note that the number of interviews can be low if the sample is representative of the major stakeholders.
- **Survey**: representative sample of users that benefit from the site natural assets. Note that the number of people surveyed can be low if the sample is representative of the local visitors. Surveys can be suitable for cultural services (e.g. asking tourist how long their journey on the site is, how much they spent on their journey), provisioning services (e.g. asking farmers how much crops they produce, at what price they sell them, which input they need).

To help users collect data on the field, a data collection template presented in Toolbox 7 can be used.

Toolbox 7: Data collection toolbox

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

[18] CIAT, Haïti Primature, 2014. Objectifs et Stratégies pour la reconstruction. Available at: https://www.pseau.org/outils/ouvrages/ciat_haiti_demain.pdf

II.2.b.iii. Ecosystem services assessment

The goal of this step is to **assess the ecosystem services** of the site in **monetary terms** by using the methods described before. The different assessment methods are described in Toolbox 5. Some examples are given in the following Boxes 3a, 3b and 3c to illustrate those methods.

Box 3a: Market prices method

This method applies to a good or service that may be exchanged on the market. The market price is the value of a traded or non-traded provisioning good as supposedly sold in a perfectly competitive market. One would attribute to the good its respective market (for a traded good) or marketed equivalent price (for a non-traded good).

For example, to assess the service of salt production, one can use the following steps to obtain the monetary value of the salt produced and the average yield thanks to the functional ecosystem studied:

- **Estimate the average salt production yield** in kg/ha/year (sources: production associations, cooperatives, local agriculture offices etc.)
- **Estimate the average area of productive saltmarshes** in ha (sources: local studies, GIS treatment etc.)
- **Find the market price of salt** in €/kg (sources: salt producers, local agriculture offices, national markets etc.)

Then, calculate the service value as the following:

$$\begin{aligned}&\textit{Service of salt production}\\&\quad = \textit{Salt yield} \times \textit{Average area of productive saltmarshes} \times \textit{Market price of salt}\end{aligned}$$

(€/year) (kg/ha/year) (ha) (€/kg)

Box 3b: Avoided costs method

This method applies to the modified services that may be restored through diverse means. The avoided damage costs method estimates the costs needed to restore the damaged ecosystem services.

For example, to assess the service of coastal flood protection, one can use the following steps to obtain the damage costs of flood in the area and the average occurrence of such flood:

- **Characterise the intensity of the flood**, with the number of hectares impacted, the waves height etc (sources: historical public plans, scientific studies etc.)
- **Find the number of such intensity flood and the return period** of such flood in flood/year (sources: historical public plans, newspaper articles, local studies etc.)
- **Find the costs engaged to fix the damages** caused by such intensity flood in €/flood (sources: historical public plans, newspaper articles, local studies etc.)

Then, calculate the service value as the following:

$$\begin{aligned}&\textit{Service of Flood protection}\\&\quad = \textit{Damage costs generated by the flood} \times \textit{Occurrence of such intensity flood}\end{aligned}$$

(€/year) (€/flood)

(flood/year)

Box 3c: Replacement costs method

This method applies to services that may be reproduced by diverse means. It estimates the costs to implement and manage infrastructure to acquire the same results as the ecosystem providing the service considered.

For example, to assess the service of coastal erosion, one can use the following steps to obtain the costs that would be engaged if the natural area's ecological functions had to be replaced by an artificial device:

- **Find the average cost for an artificial infrastructure that would provide the service of coastal erosion** protection in €/m coastline or €/ha (sources: feasibility prospective studies, or experience of engineering companies agents specialized in coastal management and design)
- **Find the mean lifetime of this type of infrastructure** in years (sources: feasibility prospective studies, or experience of engineering companies agents specialized in coastal management and design)
- **Calculate or estimate the length or area of the coastline concerned by the infrastructure** in m coastline or ha (sources: GIS estimate, local management plans, ecological studies)

Then, calculate the service value as the following:

$$Service\ of\ Coastal\ erosion = Length\ or\ area\ of\ coastline\ concerned\ by\ the\ infrastructure \times \frac{Cost\ for\ an\ artificial\ infrastructure\ that\ would\ provide\ the\ service\ of\ coastal\ erosion}{Lifetime\ of\ this\ type\ of\ infrastructure}$$

For each service, the user should expose the ecological function of the habitat linked to this service, describe the methodology and give the result obtained. He should make sure to go through all the ecosystem services and describe its argumentation even in the eventuality of non-available monetary quantitative data. For a better readability, the user can proceed by ecosystem services category (provisioning services, regulation services, cultural services) as shown in Toolbox 8.

Toolbox 8: Economic values of ecosystem services synthetic table

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

II.2.b.iv. Monetary values resources

With methods such as avoided costs, market prices, or replacement costs methods, ecosystem services have been assessed in a diversity of ecosystems in the world. This can be pertinent for organizations who aim at assessing ecosystem services quickly, as they may transfer the value to their site or territory. Such method is called "benefit transfer method".

The **benefit transfer method** is to be taken with care, as it is not site-specific and presents diverse uncertainty limits. Nevertheless, some international reference guides give reliable values that can be used to evaluate ecosystem services. For this, users should adapt the values they find in similar contexts to the site they are assessing. The principle of the method is as follow:

Service value = Area of the site x Service value in the reference study

(€/year) **(ha)** **(€/ha/year)**

For example, if the reference value of the service of carbon sequestration is in €/ha/year for a mangrove habitat, and that the site comprises a small portion of mangrove, then the reference value should be multiplied by the area of the mangrove to obtain the service value per year.

The benefit transfer method represents high uncertainty and a low level of confidence. The results must be balanced and communicated with care as they don't necessarily entirely fit the ecosystem service specificities. Look-up tables including reference costs that may be transferred can be found in recognized studies treating ecosystem services valuation for similar contexts, as shown in Toolbox 9.

Toolbox 9: Resources for ecosystems Economic values

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Box 4: Example of ecosystem services assessment – Aygalades park Marseille (Vertigo Lab)

The Aygalades park is only a project which feasibility study has been done. It stands as an NbS as it uses ecological engineering techniques and relies on ecological functions rather than grey infrastructure to address urban development challenges (water purification through the creation of ponds rather than the construction of water treatment plants for example).

The project was evaluated regarding the economic benefits in ecosystem services that it could provide[19]. The restoration of wetland ecosystems and the reintroduction of biodiversity in the city are major pillars of the project and are likely to produce numerous services for the residents of the park but also for the city of Marseille.

For example, food production and water quality regulation services were assessed in the study, as the following:

Food production: The shared gardens on the park could enable to fulfill the local food requirements and will be part of the local distribution channel. According to a reference value of fruits and vegetables production [20] (3,400€/year or 0.08ha), considering the surface of the production planned for the park (0.08 ha), a ratio was calculated to get the value of the production for the park.

The method used here is the market prices method, and the food production service is estimated to: (0.33/0.08)x 3,400 = **14,000€/year**.

Water quality regulation: The park's vegetation is watered by water from the Aygalades stream. Still, the quality of the water in this stream is that of a peri-urban then urban watercourse, which means average. The ARS (Regional Health Agency) of the Department recommends that this water should not be used for sprinkling lawns. In the frame of the project, a limited flow of the stream will be treated by phytodepuration to reach a water quality equivalent to that of bathing water. This system has several stages according to the architects:

[19] CDC Biodiversité, Mission Économie de la Biodiversité Et Vertigo Lab,2019. Évaluation socioéconomique des solutions fondées sur la nature.
[20] Aurba, 2016. L'agriculture urbaine à Bordeaux, Panorama des projets exemplaires et premiers éléments de stratégie.

- Vertical percolation planted filters for aerobic degradation of pollutants: abatement of TSS (suspended solids), COD (chemical oxygen demand) and BOD5 (biological oxygen demand), and nitrification;
- Horizontal percolation planted filters in anoxia: additional COD and BOD5 abatement, denitrification;
- Storage tank: reception of the treated water which will be used for watering.

The sizing of the installation was done according to the watering needs of the park. In the absence of this system, the water used would come from the city's drinking water network. The method used here to evaluate the water quality regulation service is **avoided costs**, through the price of collective sanitation for the city of Marseille.

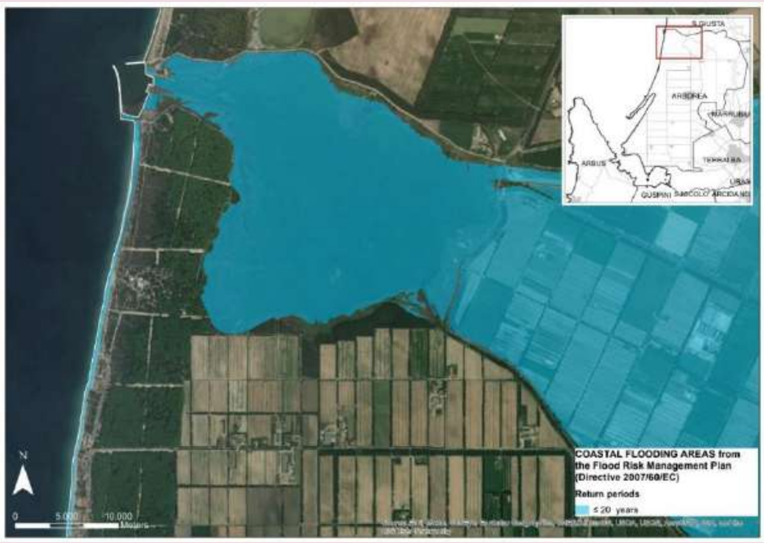
With this price set at €1.69/m3 in 2017 (National French agency numbers), the value of the service of water quality regulation corresponds to the benefits of using vegetation to treat the 38,618 m3 needed to water the park, estimated at: 1,69x38 618 **= 65,265.10€/year**.

Case study 5: Example of ecosystem services valuation in S'Ena Arrubia in Sardinia

In Sardinia, coastal flood regulation is a major ecosystem service provided by natural coastal ecosystems such as wetlands or vegetated areas. Due to the increase in the climate change consequences, the Regional Government estimated that a large area will be flooded in 2040. In the area of interest, 414.15 ha will be flooded according to the GIS model.

To assess the service of flood protection provided by natural coastal ecosystems, the avoided costs method was used. It enabled to quantify the damage caused by flooding in the studied area, if the dunes, forests, salt marshes and Posidonia oceanica ecosystems were not restored to ensure their current risk mitigation function. Using a GIS tool, the MEDSEA team understood which areas could be flooded if such event happened, as shown in the map below.

FIGURE 3: GIS MODEL OF THE SUBMERGED LAND IN CASE OF A FLOOD (MEDSEA ELABORATION ON PGRA, 2018)



The annual costs of losses for a potential flood were estimated considered the economic value of damages from the last three main medicanes and cyclones in Sardinia. Based on the newspaper articles and Regional Government documents, the average costs of damages per municipality of the last 3 events in the past 8 years were estimated. A discount rate of 3% was used to estimate the 2040 value, taking into account an increase in damages and in the occurrence of events every 8 years. The details of those costs are given below:

Wetland	Annual losses (€/year)
S'Ena Arrubia Lagoon	10,276,573.08

II.2.c. Scenarios definition and benefits assessment

The goal of this step is to **define and describe two different scenarios** for the assessment. Each scenario must be defined according to a **time horizon**. The choice of temporality can be part of the questions asked to the consulted people in the interviews and surveys during the primary data collection (II.b.ii).

The major tasks of this step are:

II.2.c.i. Scenarios definition,
II.2.cii. Prospective workshops organization,
II.2.c.iii. Estimate and characterization of the evolution of ecosystems state and threats and pressures for each scenario,
II.2.c.iiv. Present Value estimate,
II.2.c.v. Benefits estimate from the comparison of scenarios.

Prospective scenarios enable to imagine the different evolutions that a site can experience in the future. It allows to calculate the benefits provided by a NbS scenario by comparing different management scenarios in the long term. In general, people use to compare *status quo* to NbS scenarios. Those benefits correspond to the benefits of the protection of goods of services provided by the natural site.

II.2.c.i. Scenarios definition

First, the user should define a timeframe for the scenarios. This timeframe helps the involved stakeholders to imagine what can be happening to the site within a given time, considering possible and realistic evolutions for the site.
The scenarios construction depends on the context of the site. For this task, the user should first take into consideration the elements gathered in its preliminary literature review and interviews. The constructed scenarios should be based on current tendencies and be coherent with global existing forecasts. Some resources, such as Climate Central[21], provide scientific forecasts that can be used to fine-tune stakeholders' thoughts.

The user should describe its two scenarios, considering that one of those is the NbS scenario. To choose the NbS for a given site, the user can refer to Box 5 below.

Box 5: Tools to select a specific NbS for a given site

The implementation of an NbS is usually specific to a site context or an issue. To select a NbS, few tools exist, some of them are listed below.

- The **Nature4cities project, as part of the H2020 program**, proposes a classification to explore NbS according to the following criteria, available on an online platform . Those NbS are adapted to urban environments, but some of them are applicable in a wider

[21] Climate central website: https://www.climatecentral.org/

frame and the exploration of the tool may also give a glance at what is feasible according to the following hierarchy:

TABLE 7: NATURE4CITIES NBS TYPOLOGY (NATURE4CITIES PROJECT)

Criteria	Variables
Category of Urban challenge	Climate issues
	Water management and quality
	Air quality
	Biodiversity and urban space
	Soil management
	Ressource efficiency
	Health and well-being
	Environmental justice and social cohesion
	Urban planning and governance
	People security
	Green economy
Type	Objects, shapes, physical projects
	Strategies, management
	Actions
Sub-category	On the ground
	Water-related
	On building structures
	Urban spaces management
	Waste management
	Protection and conservation strategies
	Urban planning strategies
	Monitoring (bio-indicators)

This first list of variables is a good start to choose among NbS, and can be completed with the following criteria, to act as decision-support arguments: implementation and management costs, level of technicity and of man force involvement needed, specific site issues, etc.

- The **Nature-based Solutions Evidence Platform** from the University of Oxford[22] is an online tool to compare and have a global vision on NbS concerning numerous ecosystems and regions in the world. It gives access to a database of resources (studies, reports, articles) conducting NbS analysis and enables to be inspired by past or planned NbS projects. The selection criteria of the tool are in the following table.

[22] Nature-based Solutions Evidence Platform, 2022. Copyright Nature-based Solutions Evidence Tool.

TABLE 8: SELECTION CRITERIA OF NATURE-BASED EVIDENCE PLATFORM

Sorting criteria	Possible values
Climate change impact (CCI)	Reduced water availability, Soil erosion, Loss of timber production, Loss of food production, Freshwater flooding, Biomass cover loss, Reduced water quality, Other climate impact, Coastal erosion, Loss of other ecosystem goods, Reduced soil quality, Drought, Wildfire, Storm surge, Wind damage, Coastal inundation, Desertification, Mudslides / Landslides, Coastal salt water intrusion, Increased incidence/changing distribution of disease, Increased pests
Ecosystem type	Created forest, Montane/alpine, Temperate forests), Created grassland, Streams, rivers, riparian, Tropical and subtropical grasslands, Tropical & subtropical forests, Temperate grasslands, Created other, Mediterranean shrubs and Forests, Wetlands, Boreal forests and taiga, Mangroves, Coastal, Created wetland, Saltmarsh, Coral reefs, Deltas and estuaries, Ecosystem not specified, Deserts and xeric shrublands, Other ecosystem type, Temperate oceans, Ponds and lakes, Seagrass, Peatland, Tropical oceans
Intervention type	Created habitats, Restoration, Management, Combination, Protection, Mixed created/non-created habitats
Effect of the NbS on the CCI	Positive, Unclear results, Negative, Mixed results, No effect, Not addressed
Social outcomes	Not reported, Positive, Mixed, Unclear, Negative, No-effect
Ecological outcomes	Not reported, Positive, Mixed, Unclear, Negative, No-effect

II.2.c.ii. Prospective workshops organisation

The aims of this workshops are to elaborate and characterise future alternative scenarios and estimate the impacts of scenarios on services and beneficiaries. Indeed, to measure the benefits of NbS actions, the user should have a long-term vision so-called "prospective vision".

For this, a workshop should be organised with key stakeholders that have been identified since the framing of the study in the stakeholders analysis (e.g. local farmers, inhabitants, government representatives, government officers for the forest, wildlife, services experts, site managers, the people interviewed during the data collection, scientists). Then, the user should share a few elements with the participants, as listed below:

- **Prospective is not prevision or prediction**: the workshop aims at defining impossible or possible future scenarios within the current perceptions, so there are no possible errors. The people involved will imagine what could be happening on their territory.
- **A common time horizon has to be set to imagine the future scenarios**: this common framework should be defined by the start in order to conceive realistic evolutions for the site.

- **Coherence between the evolution of the ecosystem services state is key**: ecosystem services specialist can help arbitrate the debate and the discussions on the possible evolution of the services regarding the scenarios.
- **The outcome of the workshop has to lead to a consensus**: the goal is to lead to a consensual definition for each scenario and ecosystem services evolutions.

For more insight on the prospective workshops, refer to the Tessa toolkit Guidance: Stakeholder workshops: http://tessa.tools/.

To describe the scenarios, Toolbox 10 proposes a table that can be filled by the user leading the workshop. It can be helpful to organise workshops with local stakeholders aware of the area characteristics to precisely define scenarios.

Toolbox 10: Alternative project options description template

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Case study 6: Alternative project options description for S'Ena Arrubia (MEDSEA)

For the site of S'Ena Arrubia, MEDSEA described the planned actions in the following table.

	Status quo option	NbS option
Management actions	Low	Higher
Ultimate natural health goal	Dunes and pinewood in a bad status – 2% Posidonia beds to be restored	Dunes protected and pinewood restored – Posidonia beds totally in a good status
Challenges tackled	Weak mitigation measures to contrast climate change	Strong mitigation measures to offset climate change consequences
Improved ecosystem services	All the ecosystem services will be negatively affected	Global climate regulation, coastal erosion and flood protection improved; provisioning and cultural ES partially able to offset the negative consequences of climate change
Economic actors concerned	Farmers, fishermen, tourist operators, residents	Farmers, fishermen, tourist operators, residents
Governance modalities	At municipal level	Integrated governance with other municipalities/regional park
Risks	Loss of habitat; loss of habitat productivity; loss of farming and fishing productivity; reduction in the number of tourists; increased coastal erosion; large area flooded	Increase in the habitat dimension; improvement in habitat productivity; improvement in the market value of farming and fishing productivity; improvement in the tourists expenses; avoided coastal erosion phenomena; limited flooded area

II.2.c.ii. Estimate and characterization of the evolution of ecosystems state and threats and pressures for each scenario

Once the scenarios are set, the user should estimate the impact of the actions planned in each scenario. This impact corresponds to the evolution of productive surface areas in terms of ecosystem services and ecosystem state. The estimate should integrate the impacts of threats and pressures on those ecosystems. This task enables the user the user to obtain the impacts of his scenarios on ecosystem services. This assessment is based on the results of the interviews, workshops and on the local available bibliography. Toolbox 11 gives some guidance to make the workshop.

Toolbox 11a: Tools for ecosystem services evolution assessment during the workshop

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Once this task is completed, the information can be synthetized in a table, as shown in Toolbox 11:

Toolbox 11b: Tool for a synthetic presentation of ES variation

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Case study 7: Synthetic presentation of ES variation in S'Ena Arrubia (MEDSEA)

In S'Ena Arrubia, the variation of ES were evaluated qualitatively and synthesized as the following.

Service	Ecological unit or habitat	Status quo scenario		NbS scenario	
		Service variation	Description	Service variation	Description
Provisioning services					
Farming	Total amount of production - Annual value of the production	Large reduction	Reduction in the number of cattle and in the cattle production	Smaller reduction	Reduction in the number of cattle and in the cattle production but increase market price due to more sustainable practices
Fishing	Total amount of production - Annual value of the production	Reduction	Climate change negative effect will increase the negative production trend	Reduction	Improvement in the environmental quality of ecosystems could partially offset negative effects of climate change
Regulating services					
Global climate regulation	Tonnes of CO_2 emitted or stocked	Reduction	Loss of habitats and habitat capacity to stock CO_2	Increase	Increase in the hectares of restored habitats and improved capacity to stock CO_2
Coastal erosion	Hectares of lost coastal area	Increase	Loss of habitats	Reduction	Increase in the hectares of restored habitats could avoid that more areas will be eroded
Coastal flooding	Hectares of flooded area	Increase	Loss of habitats and revenues from the economic activities	Reduction	Increase in the hectares of restored habitats could avoid that some areas will be flooded
Cultural services					
Tourism and recreational activities	Total number of visitors - Annual value of the long-stay tourist and daytrippers expenses to visit the site	Large reduction	Loss of habitats and climate change negative effects (for example, increase in temperature, in tropical diseases, drought…) could reduce the number of tourists and related expenses	Smaller reduction	Increase in the hectares of restored habitats and improvement in environmental quality could partially offset the lost of tourists and related expenses

II.2.c.iii. Present Value estimate

The goal of this task is to calculate in monetary terms the Present Value (PV) of all ecosystem services of interest on the site according to the information gathered previously. The Present Value (PV) corresponds to the sum of annual economic values of an ecosystem service a on the scenarios given time period (considering *n* years in total), weighted on an actualization rate *i*. For each ecosystem service, the present value is calculated as follows:

$$Present\ Value\ a = \sum_{t=1}^{n} Ecosystem\ Service\ a\ Value\ year\ t\ \times (1+i)^{-t}$$

To get the total value of the site in each scenario, the Total Economic Value (TEV) can be calculated as follow taking for example the NbS scenario, and considering *m* ES in total:

$$Total\ Economic\ Value\ (NbS\ scenario) = \sum_{a=1}^{m} Present\ value\ a$$

With this formula, the user will obtain the TEV of the studied ecosystems in each defined scenario. From this ES assessment, the following task enables to calculate the total benefits of the NbS scenario over the *statu quo* scenario.

II.2.c.iv. Benefits estimate from the comparison of scenarios

Studying the impact of future NbS actions enables to draw recommendations to enhance the preservation of the given site by highlighting the socio-economic resulting from the NbS scenario. That way, this task enables to compare the benefits engendered by a NbS option scenario over a status quo option scenario. The following figure illustrates what is calculated during this step.

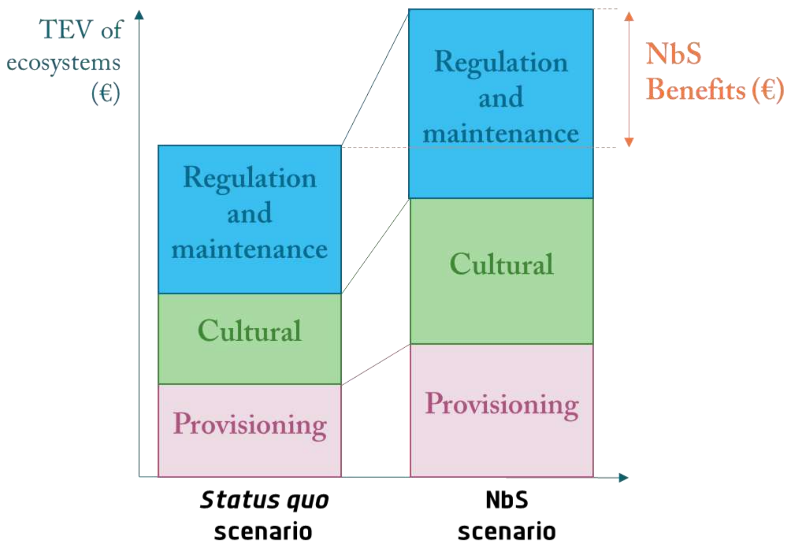


FIGURE 4:SCHEMATIC REPRESENTATION OF NBS BENEFITS CALCULATED THROUGH THE ECONOMIC ASSESSMENT (VERTIGO LAB)

With support from MAVA

Therefore, for each ecosystem service, the difference of Economic value will be calculated:

$$Benefits\ of\ Ecosystem\ Service\ a = \ Statu\ quo\ Present\ Value\ a - NbS\ Present\ Value\ a$$

At this point, the user will have an estimate of each of its services of interest on his site.

The next step is optional, but if the sample of ecosystem services valued is large enough, the calculation can enable to get a global vision of the contribution of the NbS on the site for each ecosystem service provision. For this, the user can sum all the benefits values and calculate the percentage of benefits provided by the services of interest:

$$Benefits\ percentage\ Ecosystem\ Service\ a = \frac{Total\ Benefits\ Ecosystem\ Service\ a}{\sum_{k=1}^{m} Total\ Benefits\ Ecosystem\ Service\ k}$$

The following Toolbox 12 helps the user synthetizing the information concerning the benefits provided by his NbS project option.

Toolbox 12: Synthetic presentation of ES values

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Box 6a: Example of presentation for a site in Corsica (Vertigo Lab)

An application of this methodology was made for a site in Corsica [23]. The scenarios are management actions that will be made on the Coast Conservatory selected sites over 35 years. The status quo scenario is a protection status weakening, while the NbS scenario is a protection status improvement, by closing access to visitors and having natural sites managers take care of the area.

TABLE 9: ES VALUES FOR THE COASTAL CONSERVATORY SITES OF CORSICA (VERTIGO LAB)

Service	NbS scenario Present Value (€)	Status quo scenario Present Value (€)	Total Benefits (€)	Percentage (%)	Annual benefits (€/year)
Provisioning services					
Breeding	6,757,000	5,000,000	1,575,000	1,5 %	45,000
Apiculture	324,500	300,000	24,500	0%	700
Regulating services					
Tourism	338,500,000	300,000,000	38,500,000	41%	1,100,000
Education	114,000	100,000	14,000	~0%	400
Natural areas attractiveness for inhabitants	406,500,000	375,000,000	31,500,000	33%	900,000

[23] Binet T. et al., 2015. Estimation des bénéfices de la protection des sites du Conservatoire du littoral : état des lieux et perspectives à l'horizon 2050.

Hunting	14,025,000	13,500,000	525,000	0,5	15,000
Nautical activities	227,500,000	210,000,000	17,500,000	19%	500,000
Cultural services					
Flooding regulation	22,125,000	19,500,000	2,625,000	3%	75,000
Global climate regulation (prairies)- *capture*	25,000	-500,000	525,000	0,5%	15,000
Global climate regulation (praries) - *sequestration*	1,515,000	990,000	525,000	0,5%	15,000
Pollination	75,000	-800,000	875,000	1%	25,000
Fires regulation	153,500	150,000	3,500	~0%	100
TOTAL				100%	2,691,200

NB: To ease the case study appropriation, the values were rounded up.

Case study 8: Synthetic presentation of ES values for S'Ena Arrubia (MEDSEA)

The application of this methodology was made for the Lagoon of S'Ena Arrubia in Sardinia, for two management scenarios over 18 years. The status quo scenario is the current weak level of maintenance and management, taking into consideration the effects of climate change, while the NbS scenario is a protection status improvement, by restoring endangered habitats, improving environmental quality through a better management of the area, the improvement of sustainability practices in agriculture, more ecotourism activities, as shown in case study 6.

Service	NbS scenario Present Value (€)	Status quo scenario Present Value (€)	Total Benefits (€)	Percentage (%)	Annual benefits (€/year)
Provisioning services					
Farming	8,552,112.77	8,526,660.05	25,452.72	0.11%	1,414.04
Fishing	107,540.36	96,605.33	10,935.03	0.05%	607.50
Regulating services					
Flooding regulation	9,291,478.80	- 10,276,573.08	19,568,051.88	86.31%	1,087,113.99
Coastal erosion	392,031.62	(included in the tourism valuation)	392,031.62	1.73%	21,779.53
Global climate regulation (stock)	6.317.214,48	3,646,079.44	2,671,135.04	11.78%	148,396.39
Cultural services					
Tourism	173,352.62	170,387.97	2,964.65	0.01%	164.70
TOTAL				100%	1,259,476.16

Box 6b: Example of benefits assessment for a potential NbS in the South of France (Vertigo Lab)

The benefits of an NbS with an *ex ante* economic assessment for the park project of Aygalades in Marseille[24]. The previewed land for this urban park project can enable to lay on ecological functions rather than grey infrastructure to tackle key societal challenges (e.g. water management , quality improvement, social cohesion, health and well-being). Wetlands restoration and the reintroduction of biodiversity in the city are major pillars for the studied NbS and provide a variety of ES for inhabitants and visitors.

Table 10: Benefits assessment for a potential NbS in Marseille (Vertigo Lab)

Ecosystem service	Assessment Method	Description of the benefits	Annual benefits *(€/year)*
Provisioning services			
Water provision	Avoided costs	Plants watering avoided by direct abstraction in the Aygalades stream crossing the park instead of public drinking water distribution abstraction	75,700
Food production	Market prices	Produced goods on the park could participate in the local food needs, estimating the production value of fruits and veggies	14,000
Regulation services			
Global and local climate regulation	Avoided costs Benefits transfer	Energy savings enabled by the cooling down effect of green spaces, reducing the use of conditioning Avoided GHG emissions from CO2 storage, avoided mortality linked to heat waves	743,000
Water quality	Avoided costs	Phytoepuration treatment prior to gardens watering instead of pumping in the public sanitation network of the city	65,000
Flood protection	Avoided damages costs	Wetlands as sponges and buffers to limit and reduce flood risks and built areas destruction	500,000
Cultural services			
Landscape amenities	Hedonic prices	Presence of a green space rising the value of the properties close or nearby the park	2,000,000
Recreative activities and health	Travel costs	Practice of activities enable to fit in the health national agency recommendations, estimating that the population in the vicinity of the park is three times more active than others	7,000,000
Support services			
Biodiversity	Transfer value	Habitat and species presence reflecting the value of biodiversity	13,800
TOTAL			**10,411,500 €/year**

This assessment shows that the socio-economic benefits enabled by the park would represent an opportunity.

[24] CDC Biodiversité, Mission Économie de la Biodiversité Et Vertigo Lab,2019. Évaluation socioéconomique des solutions fondées sur la nature.

II.2.d. Costs assessment of NbS

The previous step described the methodology to calculate the benefits of a NbS scenario in terms of ecosystem services. The goal of this step is to **characterize and assess the costs of the different management scenarios for the site** in order to prepare the Cost-Benefit Analysis.

To get a costs estimate of NbS over Statu quo scenario, the wo major tasks are:

- Characterize, assess and calculate the investment costs of the NbS and the status quo scenario,
- Characterize, assess and calculate the management costs of the NbS and status quo scenario.

A typology of values to take into consideration is listed as shown in Toolboxes 13a and 13b. To find reference values, the user can also refer to the figures by the US National Oceanic and Atmospheric Administration Training module "Nature-Based Solutions: Benefits, Costs, and Economic Assessments"[25] identifying the major investment and management costs by type of activity in their database.

Toolbox 13a: Table of costs data collection (investment costs)

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage..

Toolbox 13b: Table of costs data collection (maintenance costs)

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Box 7: TESSA: A toolkit to assess ecosystem services and its benefits

The Toolkit for Ecosystem Service Site-based Assessment (TESSA) provides accessible guidance on low-cost methods for how to evaluate the benefits people receive from nature at particular sites in order to generate information that can be used to influence decision making. TESSA is primarily aimed at conservation practitioners, although the methods may be applicable to a wide range of users, including natural resource managers, land-use planners, development organisations, and the private sector.

The methods in the toolkit are designed to be applicable to users from developing and developed countries, and across all terrestrial and wetland habitats (excluding marine areas). The toolkit describes how to undertake a preliminary scoping appraisal, provides methods for the following services: coastal protection, cultivated goods, cultural services, global climate regulation, harvested wild goods, nature-based recreation, pollination, and water (provision, quality and flood control). It includes an overview of key concepts, decision trees to lead the user to the most appropriate methods according to the characteristics of the site, methods for measuring the ecosystem services and valuation of an 'alternative state' in order to estimate the impact of potential or actual changes on the ecosystem services provided, and guidance on how to synthesize data for each service into a summary of ecosystem service change at site scale. The methods range from household surveys and participatory mapping to habitat surveys and the use of simple modelling software.

The toolkit is designed to be used both online and, in the field, and is provided as a 'user manual' in a simple workbook structure. An interactive PDF is available to download onto a computer or other device (e.g. laptop, notebook, tablet) so that the methods and guidance can be accessed in remote locations. TESSA has been developed through a collaboration of six institutions (BirdLife

[25] NOAA, 2020. Nature-Based Solutions: Benefits, Costs, and Economic Assessments. Available at: https://coast.noaa.gov/digitalcoast/training/gi-practices-and-benefits.html

International, Anglia Ruskin University, University of Cambridge, Royal Society for the Protection of Birds, Tropical Biology Association, UNEP World Conservation Monitoring Centre) with input generously provided by scientists and practitioners from multiple disciplines. A beta version 3.0 will be released in 2022. For further information, refer to Tessa presentation here.

Case study 9a: Table of cost data collection (investment costs) in S'Ena Arrubia (MEDSEA)

	Surface (ha)	Type of data	Unit value	Amount	Partial cost	Total cost	Source of data	CBA notes	Annual costs
Price of the planning studies									
Survey data (altimetricals quotas, distances,...)	NA	NA	NA	NA	NA	3.900,00 €	Rules for cost calculation for public works in Italy	investment cost for two years (2022-2023)	1.950,00 €
Bathymetric analysis	NA	NA	NA	NA	NA	6.000,00 €	Market investigation		3.000,00 €
Seabed morphological survey	NA	NA	NA	NA	NA	4.000,00 €	Market investigation		2.000,00 €
Habitat and species list and evaluation	NA	NA	NA	NA	NA	8.000,00 €	Market investigation		4.000,00 €
Climate change analysis and effects	NA	NA	NA	NA	NA	10.000,00 €	Market investigation		5.000,00 €
Design of the solutions	NA	NA	NA	NA	NA	199.062,00 €	Compulsory rules for cost calculation for public works in Italy in the 3-design level, works management, plans coordination through project and realization, administrative checks)		99.531,00 €
Price of the planning works									
Naturalistic engineering solutions for the dune system (NAT)-restoration of the Dunes	11	Number of people employed	number	20,00	-	476.410,00 €	Total costs estimated for one hectare and proportionate to the total area of intervention	investment cost for two years (2024-2025)	238.205,00 €
		Salaries of the people employed	euro/h	30,00 €	214.384,50 €				
		Time spent for the activity	days	568,44	-				
		Material acquisition	euro/ha	12.993,00 €	142.923,00 €				
		Other costs	euro/ha	10.827,50 €	119.102,50 €				

With support from MAVA

Thickening of the pine forest (Pines' planting)	53,5	Number of people employed	number	8,00	-	936.250,00 €	Total costs estimated for one hectare and proportionate to the total area of intervention	investment cost for two years (2024-2025)	468.125,00 €
		Salaries of the people employed	euro/h	30,00 €	337.050,00 €				
		Time spent for the activity	days	343,75	-				
		Material acquisition	euro	NA	365.137,50 €				
		Other costs	euro	NA	234.062,50 €				
Planting of the native species Posidonia	4,85	Number of people employed	number	6,00		306.000,00 €	Estimated costs in coherence with the MEDSEAGRASS projects (proportionated to the total area of intervention)	investment cost for two years (2024-2025)	153.000,00 €
		Salaries of the people employed	euro/sqm	31,25 €	300.000,00 €				
		Time spent for the activity	days	30,00	NA				
		Material acquisition	euro/sqm	NA	NA				
		Other costs (Boat rental and petrol)	euro	NA	6.000,00 €				
Preparatory remediation management									
Remediation of dune and pine forest (old trees, waste, ecc..)	53,5	Number of people employed	number	16,00	-	45.475,00 €	work estimate for one hectare and proportionate to the total area of intervention	investment cost for two years (2022-2023)	22.737,50 €
		Salaries of the people employed	euro/h	30,00 €	30.468,25 €				
		Time spent for the activity	days	26,10	-				
		Material acquisition	euro/ha	68,00 €	3.638,00 €				
		Other costs	euro/ha	212,50 €	11.368,75 €				
Legal or administrative fees engaged									
All fees								investment cost for two years (2022-2023)	17.186,60 €

Case study 9b: Table of cost data collection (maintenance and monitoring costs) in S'Ena Arrubia (MEDSEA)

	Surface (ha)	Type of data	Unit value	Amount	Partial cost	Total cost	Note	CBA notes	Annual costs
Monitoring studies									
Survey data (altimetricals quotas, distances,...)	NA	NA	NA	NA	NA	3.900,00 €	Market investigation	maintenance and monitoring cost for 5 years (2026-2030)	780,00 €
Posidonia monitoring (ex ante and ex post)	NA	NA	NA	NA	NA	45.000,00 €	Based on the cost per hectares in the MEDSEAGRASS project		9.000,00 €
Habitat and species monitoring	NA	NA	NA	NA	NA	8.000,00 €	Market investigation		1.600,00 €
Climate change effects/monitoring	NA	NA	NA	NA	NA	10.000,00 €	Market investigation		2.000,00 €
Project protection									
Restoration of damaged barriers/structure	NA	NA	NA	NA	NA	23.820,50 €	The costs evaluation of these actions could be estimated at 5% of the total amount of the intervention.	maintenance and monitoring cost for 5 years (2026-2030)	4.764,10 €
Replacement of plants	NA	NA	NA	NA	NA	62.112,50 €			12.422,50 €

	Percentage of surface (ha)	Number of interventions until 2040 (average)	Partial cost	Total cost	Note	CBA notes	Annual costs
Long-term management							
Restoration of the Dunes							
Unitary cost of the intervention			95.282,00 €		20 % of the construction cost (Source: Data processed on the basis of the indications in the Guidelines for ordinary and extraordinary maintenance of the Regional Forest Agency)	maintenance cost for 15 years (2016-2040) - one intervention every 5 years	
Frequency of interventions	100,00%	3,00	95.282,00 €	285.846,00 €	one intervention every 5 years		19.056,40 €
Pines' planting							
Unitary cost of the intervention			93.625,00 €		10 % of the construction cost (Source: Data processed on the basis of the indications in the Guidelines for ordinary and extraordinary maintenance of the	maintenance cost for 15 years (2016-2040) - one intervention every year	

					Regional Forest Agency)		
Frequency of interventions	30,00%	15,00	28.087,50 €	421.312,50 €	one intervention every year		28.087,50 €
Planting of the native species Posidonia							
Unitary cost of the intervention			30.600,00 €		10 % of the construction cost	maintenance cost for 15 years (2016-2040) - one intervention every 5 years	
Frequency of interventions	30,00%	3,00	9.180,00 €	27.540,00 €	one intervention every 5 years		1.836,00 €

The total discounted costs in 2040 (with a discount factor of 3%) are therefore 2.636.008,25 euros.

Section II.3: Make the Cost-Benefit Analysis

The goal of this final step is to **compare the benefits** (ecosystem services monetary values) **and costs of each scenario** to **help the decision-making process** considering the ecosystem services value.

Once the data collection is complete with the previous steps, the user should have got values for both the benefits and the costs. They are then to be compared in order to assess if the NbS scenario is interesting on the socio-economic and environmental point of view. This method has shown efficiency in the past to influence the choices of planning and to support sustainable planning and building choices.

To conclude on this Cost-benefit Analysis, the user should eventually calculate the Net Present value of his two scenarios to understand which scenario is the most interesting from the socio-economic point of view. The following formula gives the guidance for this calculation:

$$Net\ Present\ Value = \sum_{t=0}^{n} Benefits\ year\ t \times (1+i)^{-t} - \sum_{t=0}^{n} Costs\ year\ t \times (1+i)^{-t}$$

To synthetize the information, the Toolbox 14 below gives an example of synthetic presentation of the results.

Toolbox 14: Table for scenarios Cost-benefit analysis

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Box 8: Cost-benefit analysis for a NbS in Camargue (Vertigo Lab, Tour du Valat)

Facing the issue of rising sea levels and the associated coastal risks in the salines of Camargue in the south of France, two scenarios were considered in the following case study. The goal here is to **compare two types of solutions to combat the consequences of natural hazards** on a portion of the Camargue coastline by analyzing the costs and benefits generated by each of those.

TABLE 11: NBS DESCRIPTION FOR CAMARGUE SALINES

Conventional scenario	NbS scenario
Rehabilitation of a protection system on the sea front to limit the phenomena of erosion and marine submersion	Renaturing of former salt pans recently abandoned so that they can play a role of buffer zone during episodes of submersion and provide a means of natural adaptation to the variations of the coastline and to the rise of the sea level. These extension spaces also enable to limit the height of the surges, reduce the impacts on the structures behind.

The **costs** associated with the restoration of the dike would be significantly higher than those of the renaturation of the salt flats. Indeed, the materials and work required to restore the dike would imply greater expenses than the work of hydrological reconnection intended to restore the natural functioning of an ecosystem. Moreover, since a natural ecosystem evolves naturally according to the constraints to which it is exposed, the costs that would be necessary for its maintenance would be reduced, unlike those of a development subject to swell, which would have to be regularly maintained and consolidated[26].

Even if it was not possible to affirm that these two solutions were similarly effective, the maintenance of the coastline and protective infrastructures on sectors exposed to strong erosion would represent very significant costs and would not sustainable in the long term. Also, while the **benefits** of the dike would be limited to coastal protection, the restoration of the old salt pans, in addition to providing protection against the natural risks present on the Camargue coast at a lower cost, would improve the quality of the ecosystem services provided by the site (carbon storage, biodiversity support, environmental education, etc.).

In the study area, the NbS is therefore less costly to implement and maintain, and provides additional benefits compared to the artificial solution.

Box 9: Example of Cost-Benefit Analysis result in the Carribean[27]

The Now Jade artificial coral reef was an experimental field to perform a cost-benefit analysis. For a 20-years period, it demonstrated that the artificial coral reef provided a Net Present Value of US $2,504,309. By adding the benefits of coastal flood risk reduction, it could represent a NPV of US $4,392,106. In terms of costs, the major interest of artificial reefs is the high upfront capital investment balanced by the rather low maintenance costs. Besides, those costs are reducing, and eventually entirely counter balancing the costs associated with an alternative scenario implying artificial sand replenishment. Therefore, the Cost-benefit Analysis demonstrated that the investment in NbS was economically viable and was easy to be displayed as a strong alternative from the business-as-usual approach.

[26] Tour du Valat, 2018. La restauration des anciens salins de Camargue : une solution fondée sur la nature pour s'adapter à l'élévation du niveau marin. Available at : https://tourduvalat.org/dossier-newsletter/ la-restauration-des-anciens-salins-de-camargue-une-solution-fondee-sur-la-naturepour-sadapter-a-lelevation-du-niveau-marin/

[27] DB, UNEP, 2021. Resilient by Nature - Increasing Private Sector Uptake of Nature-based Solutions for Climate-resilient Infrastructure. A Market Assessment for Latin America and the Caribbean. Available at: https://publications.iadb.org/publications/english/document/Resilient-by-Nature-Increasing-Private-Sector-Uptake-of-Nature-based-Solutions-for-Climate-resilient-Infrastructure-A-Market-Assessment-for-Latin-America-and-the-Caribbean.pdf

Section II.4: Monitor the sustainability of the NbS

II.4.a. Assess the sustainability of NbS with the IUCN Global Standard

Prior or after their implementation, NbS interest and sustainability can be assessed by their designer thanks to the IUCN Global Standard Self-assessment tool. It comprises a set of indicators to fill-in, aiming to operationalize best-practices of NbS and enhance their uptake. The principle of the tool is described in theBox below.

II.4.b. Purposes of monitoring and indicators framework

Box 10: IUCN self-assessment tool

The **IUCN self-assessment tool** is part of the IUCN Global Standard. It enables the user to assess a project of NbS, upscale pilots by identifying gaps, or assess past projects and future proposals. The 8 criteria and 28 indicators must be filled for the project to stand as NbS for the IUCN. The output of the self- assessment comes in the form of a percentage match compared against good practices. The grading principle is described in the grid below and helps identify whether the intervention adheres to the IUCN Global Standard for NbS.

From the assessment of a project, a grade from 0 to 100 enables to translate the Criterion evaluation into a color. A traffic light system enables to identify areas for further work and adherence to IUCN Global Standard. Each color corresponds to a level of adequation to the IUCN Global Standard for NbS:

- 0 to 25 : **Insufficient** : The intervention does not adhere to the IUCN Global Standard for NbS.
- 25 to 50 : **Partial** : The intervention adheres to the IUCN Global Standard for NbS.
- 50 to 75 : **Adequate** : The intervention adheres to the IUCN Global Standard for NbS.
- 75 to 100 : **Strong** : The intervention adheres to the IUCN Global Standard for NbS.

TABLE 12 : LIST OF CRITERIA USED FOR THE IUCN SELF-ASSESSMENT TOOL AND THEIR SIGNIFICATION

Criterion title	Explicit signification	Grade			
Criterion 1 – Societal Challenges	NbS effectively address societal challenges				
Criterion 2 – Design at scale	Design of NbS is informed by scale				
Criterion 3 – Biodiversity net gain	NbS result in a net gain to biodiversity and ecosystem integrity				
Criterion 4 – Economic feasibility	NbS are economically viable				
Criterion 5 – Inclusive governance	NbS are based on inclusive, transparent and empowering governance processes				
Criterion 6 – Balance trade-offs	NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits				
Criterion 7 – Adaptative management	NbS are managed adaptively, based on evidence				
Criterion 8 – Mainstreaming & Sustainability	NbS are sustainable and mainstreamed within an appropriate jurisdictional context				

With support from MAVA

Socio-economic and environmental features of NbS can be evaluated and monitored to assess the sustainability of the NbS, by measuring the value of specific indicators. This action enables wetlands managers as well as policy decision makers to ensure the effectiveness and success of their planning decisions. The effectiveness of an NbS can be related to the NbS pertinence towards complementary notions [28] (climate resilience enhancement, environmental benefits, social benefits, economic benefits, biodiversity benefits).

As of today, several indicators frameworks are shared amongst the scientific world and economic actors of the building sector. In particular, EKLIPSE (Establishing a European Knowledge and Learning Mechanism to Improve the Policy-Science-Society Interface on Biodiversity and Ecosystem Services) proposes a breakdown into several categories of societal challenges, adapted to a wider range of ecosystem types and described as follows[29]:

TABLE 133: SOCIETAL CHALLENGES DEFINITION (ADAPTED FROM EUROPEAN COMMISSION, 2021[30])

Great category	Societal Challenge	Purposes of NbS regarding the challenge
Planet	Climate Resilience	Ecosystem services provision, social awareness and actions to combat climate change
	Water Management	Reduction of anthropogenic impacts on the water cycle (water quality, water availability, groundwater and surface water levels, recharging of aquifers, stormwater management, water treatment, wetland habitat management, soil water management, and ecological quality)
	Green Space Management	Planning, establishment and maintenance of green and blue infrastructure and ecological connectivity in built and natural or semi-natural areas
	Biodiversity enhancement	Combating biodiversity loss and ecosystem collapse
	Air Quality	Air-pollutants and Carbon dioxide removal, air temperature reduction, Oxygen concentration increase by the creation, enhancement, or restoration of ecosystems in human-dominated environments
People	Place Regeneration	Contribute to sustainable place regeneration by connection between people and nature, and green space enhancement
	Participatory Planning & Governance	Support of accessibility to green spaces and maintenance of their quality Integration of people participation in planning and governance choices
	Social Justice & Social Cohesion	Exploration of the role of supporting urban processes involving equal access to neighbourhood green space in fostering social cohesion for the cultural integration of typically-excluded social groups
	Health & Well-being	Critical social and environmental determinants of health, including clean air, safe drinking water, sufficient food and secure shelter, are impacted by climate change
Prosperity	Natural & Climate Hazards	Disaster risk reduction, social, human, environmental co-benefits delivery
	New Economic Opportunities & Green Jobs	Cost-effectiveness of NbS, capacity to provide environmental, societal and economic benefits

[28] Raymond C.M., Frantzeskaki N., Kabisch N. et al., 2017. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. https://doi.org/10.1016/j.envsci.2017.07.008.
[29] European Commission, Directorate-General for Research and Innovation, 2021. Evaluating the impact of nature-based solutions : a handbook for practitioners. https://data.europa.eu/doi/10.2777/244577
[30] Ibid.

II.4.c. List of relevant indicators for NbS monitoring

As part of a sustainability process, an NbS project must be monitored regarding a series of criteria. This table proposes a set of indicators regarding societal challenges criteria.

TABLE 14: INDICATORS PROPOSITION (ADAPTED FROM EUROPEAN COMMISSION, 2021)

Societal challenge	Indicator	Unit
Climate Resilience	Total carbon removed or stored in vegetation and soil per unit area per unit time	kg/ha/y
	Avoided greenhouse gas emissions from reduced building energy consumption	t CO2e/y
	Monthly mean value of daily maximum temperature (TXx)	°C
	Monthly mean value of daily minimum temperature (TNn)	°C
	Heatwave incidence: Days with temperature >90th percentile, TX90p	No./y
Water Management	Surface runoff in relation to precipitation quantity	mm/%
	Water quality: general urban	various
	Water quality: TSS content	mg/L
	Nitrogen and phosphorus concentration or load	%
	Metal concentration or load	%
	Water quality: total faecal coliform bacteria content of NbS effluents	No
Green Space Management	Green space accessibility	%
	Share of green urban areas	0-1
	Soil organic matter content	%
	Soil organic matter index	0-1
Place Regeneration	Derelict land reclaimed for NbS	ha
	Quantity of bluegreen space (as a ratio to built form)	0-1

Societal challenge	Indicator	Unit
Biodiversity enhancement	Structural connectivity of urban green and blue spaces	various
	Functional connectivity of urban green and blue spaces	various
	Number of native species	Number
	Number of nonnative species introduced	Number
	Number of invasive alien species	Number
	Species diversity within a defined area	Number
	Number of species within a defined area	Number
Air Quality	Number of days during which ambient air pollution concentrations in the proximity of the NbS (PM2.5, PM10, O3, NO2, SO2, CO and/or PAHs expressed as concentration of benzo[a]pyrene) exceeded threshold values during the preceding 12 months	No. of days
	Proportion of population exposed to ambient air pollution (PM2.5, PM10, O 3, NO 2, SO 2, CO and/or PAHs expressed as concentration of benzo[a]pyrene) in excess of threshold values during the preceding 12 months	%
	European Air Quality Index	Good, Fair, Moderate, Poor, Very, Extremely Poor
Social Justice and Social Cohesion	Bridging– quality of interactions within and between social groups	Quali.
	Bonding – quality of interactions within and between social groups	Quali.

Societal challenge	Indicator	Unit
	Perceived quality of urban blue-green spaces (accessibility, amenities, natural features, incivilities and recreational facilities)	various
	Place attachment: Place identity or "sense of place"	various
	Recreational value of public green space	Various
	NbS incorporated in building design / incorporation of environmental design in buildings	0-5
	Cultural heritage protection	0-5
Natural and Climate Hazards	Disaster Resilience	unitless
	Disaster-risk informed development	unitless
	Mean annual direct / indirect losses due to natural and climate hazards	€
	Risk to critical urban infrastructure	%
New economic opportunities and green jobs	Valuation of NbS: Value of NbS calculated using GI-Val	€
	Economic value of urban nature	€
	Mean land and/ or property value in proximity to green space	€
	Change in mean house prices/ rental markets	€
	Average land productivity and profitability	€/ha
	Property betterment and visual amenity enhancement	€/m2
	Direct economic activity (Dea): Number of new jobs created	€/year
	Dea: Retail / commercial activity in green space vicinity	%
	Dea: Gross added value to local economy from new business creation	%/year
	Recreational monetary value	€/year
	Overall economic, social and health well-being	HDI

Societal challenge	Indicator	Unit
	Inclusion of different social groups in NbS co-co-co processes	0-5
	Trust within the community	Quali.
	Solidarity among neighbours	Quali.
	Tolerance and respect	Quali.
	Availability and equitable distribution of blue-green space	map
Health and Well-being	Level of outdoor physical activity	Quali.
	Level of chronic stress (perceived stress)	0-4
	General wellbeing and happiness	0-7
	Self-reported mental health and wellbeing	1-6
	Prevalence of cardiovascular disease	%
	Incidence of cardiovascular disease	% per year
	Quality of life	1-5
Participatory Planning and Governance	Openness of participatory processes	1-5
	Proportion of citizens involved in participatory processes	%
	Sense of empowerment: perceived control, influence over decision-making	Quali.
	Adoption of new forms of participatory governance: PPPs activated	No
	Policy learning for mainstreaming NbS: Number of new policies instituted	No
	Trust in decisionmaking procedure and decision-makers	1-5

Section II.5: Communication to decision makers

To achieve the planned goal of NbS implementation, the engagement and communication to key stakeholders, notably decision makers, is invaluable and should start at the beginning of the project. Informing decision makers on the results of a study can influence policies in land use or management planning related to a NbS implementation and related actions.

The objectives of communicating the Net Present Value of benefits of a site under a NbS scenario compared to a Status quo scenario to these stakeholders will be multifold:

- ✓ Highlight the benefits that people obtain from the ecosystems, and especially provided by a NbS,
- ✓ Raise awareness on pressures generated by human activities on the environment to limit those through NbS,
- ✓ Instigate interests amongst actors (industrials, planners, government officials, and other sectors) on the opportunities brought by those NbS and its multiple benefits,
- ✓ Prioritise sustainable management actions within the NbS implementation,
- ✓ Attract investors (governments, businesses, etc.) and prioritise conservation fundings towards NbS implementation and its maintenance.

II.5.a. Key elements to a successful communication to key stakeholders

Although there is no straightforward formula on how to communicate to decision makers, there are two key elements (as a non-exhaustive list) that need to be applied: **have a clear communication strategy and tailor the messages to the audience**. The former should be in place at the beginning of the project and be set by experts in communication (e.g. communication officers) with a list of key audiences to disseminate information to and the type of materials used to communicate according to the different audience. The stakeholder analysis will thus be used to shape this strategy.

The latter element is an important one to not only ensure that the audience understands but can also easily process the findings communicated. To tailor the user's message to the specific audience that selected, the user will need to ask himself what information is more important to the specific audience, and what the results mean to these individuals, agencies, organization, members of the governments etc. Additionally, technical results are often perceived as complex to decision makers and the message to communicate will need to be kept simple, concise, and clear. It is always very helpful to keep the presentation of the results and information visual using figures, photos, and simple graphics.

II.5.b. Key elements to a successful communication to policy decision makers

Policy makers are looking for credible, relevant and legitimate scientific evidence to consider this information and act on recommendations. The user will need to understand how policy makers' process evidence and the context in which they operate to ensure their message will have an influence. The following elements can be applied in this process:

With support from MAVA

1. Synthesise and frame the evidence in a way that policy makers demand and understand information.

The user will need to be clear, concise, and avoid the key findings to be diluted into lengthy discourse, and/or irrelevant, or sometimes to detailed, information. They will need to communicate what they want to obtain for their site (e.g. wetland restoration) in a pro-active manner and solely provide the most relevant evidence to do so. Also, they should be aware of the amount of evidence needed from the audience point of view. When presenting their results, they should also include uncertainties and discuss it on demand of the policy makers.

2. Translate your findings more effectively

In the case it is not clear whether the policy makers have a technical background or understand complex and/or technical information, the user should keep a simple and non-technical language. Some interesting means of communication are among : figures that show the tangible outcomes of the study for the site, the meaning it has to people, different sectors in the area, or to global policies.

3. Communicate the data or information in alignment with policy initiatives

The user should also be aware that a stronger influence will be triggered if the message conveys how the study and findings align with the policy initiatives of these decision makers. For instance, they will need to ensure that the findings relate or directly influence a specific current or future management/land-use planning in the area of interest.

4. Local versus global scale communication

Policy makers are often very busy and have specific objectives of their own, and those are different at the local and global scales. The way that the user communicates their results to local and global policy makers will be different. An example of each way of communication features is shown is shown in Toolbox 15.

Toolbox 15: Comparison of local and global policy makers communication

To access the handbook full version and have access to this toolbox, see Reading Guide and refer to this webpage.

Case study 10: Communication activities in the Lagoon of S'Ena Arrubia (MEDSEA)

Ecosystem services assessment is one of the activities part of the Maristanis project, a 5 year-long project aiming at creating a new governance model in the 6 Ramsar of the Gulf of Oristano. All the stakeholders settled or operating in the area were involved since 2017 in several project activities. They became members of the Blue Community of MEDSEA and/or in the Club Friends of Maristanis. In that framework, specific projects were developed with them. Besides, all the mayors and representatives of relevant local institution are involved in the Coastal Wetland Contract Action Plan.

MEDSEA and the local private and public stakeholders exchange information continuously. This trust relationship has been precious to support capacity building, dissemination of best practices, training activities on environmental education, raising awareness, project proposal presentation and new collaboration opportunities.

ES are an interesting topic for local stakeholders and are also promoted through the EU documents and directives. Some dissemination activities will be organized in the months following the publication of this document. Those concern ES and address:

- People working in municipalities, Regional government agencies and departments,
- Local environmental activists,
- Local companies,
- Teachers and students.

Communication material will be created on ES and spread in the coming months, thanks to:

- Articles on MEDSEA's website,
- Posts on social networks,
- Factsheets and small reports.

The aim is to train people about the concept and the use of ES and make them able to use the results of the assessment in their activities.

II.5.c. Key communication materials

To efficiently disseminate the findings, the type of communication material is important to be tailored to the targeted audience. Decision makers usually have many subjects to deal with, so this is why having concise communication materials is key. With the communication materials listed hereafter and the means to communicate the results, decision-makers can better understand why they should pay attention to an issue, and it can prompt them to demand more evidence to help solve it. Indeed, this can highlight their own interests in implementing an NbS thanks to very concrete and tangible information. Different materials can be used to present the findings to decision-makers. A non-exhaustive list is presented below and can be used co-jointly:

- **Short summaries and abstracts**. The user should favor short summaries over lengthy reports if otherwise not indicated. For instance, policy briefs are useful materials to share findings and indicate policy relevance (e.g. The Union for the Mediterranean 2022[31]).
- **Detailed abstract**. The user should provide a more detailed structured abstract if the decision makers are interested to have further information.
- **Meetings either face-to-face or online**. The user should present the results in a meeting with key decision-makers if possible, and follow-up via emails to keep contact from time to time to not lose the end goal.
- **On the ground engagement**. As much as possible, the user should aim to engage the decision makers in local events to meet with other key stakeholders in the area where the NbS would need to be implemented. Decision-makers will usually have good knowledge on what is important when it is presented to them in a tangible way. Therefore, this can have a powerful influence on policies. During these meetings, the

[31] Wetland based solutions, 2022. Mediterranean wetland restoration, an urgent priority. Available at : https://wetlandbasedsolutions.org/2022/03/15/mediterranean-wetland-restoration-an-urgent-priority

user can prompt decision makers on what they intend to do to solve a specific problem or whether they agree with what is presented to them. This is a key step to be sure that the measures are effectively implemented on the ground. If possible, the user should also keep a record of the meetings to be able to remind the decision-makers of their agreement and/or promises at a later stage if necessary.

- **Be visual by using maps**. Maps are a good communication material to show visually and in an interactive manner the issue(s) or solution(s) for the area of interest (e.g. Restoration effort cost map, Tour du Valat[32])

These communication materials can be used to present the findings to businesses that may want to implement NbS or invest in them to achieve carbon neutrality, net zero or nature positive targets within their operations.

[32] https://tourduvalat.org/

Conclusion

Nature-based Solutions represent a key concept that private, public, and civil society stakeholders should grab to catalyze implementation on the ground. Those solutions represent a strong potential to address key societal and economic challenges, from their multifunctionality and "no regret" attribute.

Still, the most significant limitations constraining the development of those solutions remain: (i) the lack of knowledge and quantitative monetary information on NbS, making investment and confidence less engaged in economic spheres, (ii) the lack of structuration of ecological engineering sector and little technical market development, making the informed decision of NbS limited, (iii) the incompatibility between short term political governance and the necessary long term vision for NbS effectiveness.

The translation of NbS projects into monetary implications is crucial to enhance their further development. The Cost-Benefit method is a privileged tool to make the economic purposes of NbS more tangible, when compared to traditional infrastructures choices, or grey infrastructures. First, to highlight the benefits of NbS, an approach by ecosystem services value assessment appears as pertinent, by considering the project on the long term. Then, to estimate their costs, a detailed review of the once and for all costs (implementation) and regular costs (management, maintenance) should be carried out to obtain a complete understanding of the project. That way, the analysis of the costs and benefits help decision-makers to appreciate the interest of investing in nature, rather than using it and contributing to its gradual loss. The last element of this economic pledge for NbS is the communication bolt of the process includes the means to communicate to the right stakeholders, with the adapted words and means. According to the stakeholders to whom the Cost-Benefit Analysis is addressed, the purposes and approach will be tailored. Also, the economic implication of such results should be described and expressed clearly to stakeholders.

Hence, the business-as-usual economy is not sustainable on the long term. Traditional economic approaches suppose the coupling of economic growth with natural resources exploitation. Conservation practitioners, and all stakeholders taking part in environmental purposes have the means to dissociate those elements. Adopting NbS approaches by translating them into economic schemes represents a major lever to act for an improved management of nature.

Discussion

The authors of this document are aware of the bias of the economic assessment of ES and NbS. Therefore, such evaluation is not always as relevant or adapted to complex or specific local contexts (e.g. very large area, limited diversity of stakeholders engaged). The methodology presented in the handbook can be discussed and remodeled accordingly, in order to fit the specificities of the studied areas. Some limits of the methodology are listed below:

- **ES economic assessment is anthropocentric**: it relies on the fact the nature provides services and goods benefiting humans, and that can be evaluated in economic terms. This reasoning can be subject to controversies as some consider that this does not reflect the real value of a natural ecosystem, and that it can lead to perverted behaviors regarding natural assets (e.g. company granting itself the destruction of a wetland if they pay the amount of the ES they destroy to a nature protection organization). When doing an ES assessment, people should be aware of the final objective of this assessment, to be able to create an adapted sensitizing phase and produce a beneficial argument regarding nature.
- **ES economic assessment is only a small reflection of nature's value and significance:** when estimating ES value, users are focusing on certain natural functions considering ecosystems from a certain focal point. Even by aiming to be exhaustive when choosing the panel of ES to assess, the result remains partial regarding the complexity of natural processes and of their interactions. Also, certain ES can be difficult to estimate despite their significance in the studied area, which can make the final displayed value incomplete.
- **ES assessment does not always reflect biodiversity loss in the long term:** ES values depend on a number of hectares of habitats, which can be stable in two future scenarios, besides two different management plans. To measure the impact of scenarios on biodiversity enhancement, other tools (e.g. specific biological indicators, diversity indexes) can be coupled to ES assessment.
- **Prospective reasoning is usually mostly based on qualitative and subjective assumptions** about the possible evolution of the area concerned by the ES assessment. Therefore, depending on the surveyed people, whether they are old or new inhabitants, public institutions, managers, or other stakeholders, they can have very diverging point of views or specific interests that can alter their perception of future trends of the site.
- **Prospective methodology relies on the linear evolution of current ES values** in the long term, which is not realistic with how the value is actually going to change. This approach is useful as it simplifies the ES assessment methodology, but the user should keep in mind that in some cases, the valuation of an ES in a future snapshot can be more adapted.

Our transmission and application of the methodology to SEO/BirdLife and MEDSEA in the framework of the project enabled to perceive how ES assessment could be complex for conservation practitioners. The persons in charge of the assessment do not always have human, financial and technical resources to apply the methodology literally. This confirms how the methodology should be adapted to local contexts, studies objectives and data availability.

Finally, considering the bias of the proposed approach, we believe that the purpose of such process is to **demonstrate the economic value of ES to be used as a pledge, communication medium, or for a sustainable development strategy of certain concerned activity sectors**. This is the ambition of the Policy brief coupled with this publication which is intended for policy decision makers.

Glossary

Altruistic value	Corresponds to the importance given by individuals to the fact that other individuals may have access to the same ecosystem services at the same moment
Bequest value	Corresponds to the importance given by individuals to future generations access to the same services (inter-generations equity)
Cost-Benefit Analysis	CBA is a systematic approach to estimate strengths and weaknesses of alternatives in monetary terms. It is used to determine the choices which provide the best approach to achieve benefits while preserving savings.
Cost-Effectiveness Analysis	CEA is a way to compare the relative costs and outcomes of different scenarios.
Direct use value	Results from the direct use of ecosystem services by individuals
Ecosystem	An ecosystem corresponds to all the organisms and the physical environment with which they interact [33]. Biotic and abiotic components of ecosystems are linked together through nutrient cycles and energy flows.
Existence value	Corresponds to the satisfactions that individuals get from the simple fact of knowing that ecosystems and biodiversity maintain their existence.
Habitat	A habitat corresponds to all resources, physical and biotic components of an ecosystem, such as to support the survival and reproduction of a particular species.
Indirect use value	Stems from regulation services provided by ecosystems
Multi-Criteria Appraisal	MCA is a decision-making tool used to evaluate scenarios that present different alternatives. MCA results expect to select the most optimal solution regarding different and sometimes conflicting goals.
Multifunctionality	Multifunctionality (or multiple benefits) corresponds to the capacity of actions or to provide a solution to a variety of challenges.
Natural Capital	"The stock of renewable and non-renewable natural resources (e.g., plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people (adapted from Atkinson and Pearce 1995;

[33] Chapin, F. Stuart, III (2011). "Glossary". Principles of terrestrial ecosystem ecology. P. A. Matson, Peter Morrison Vitousek, Melissa C. Chapin (2nd ed.). New York: Springer. ISBN 978-1-4419-9504-9. OCLC 755081405

	Jansson et al. 1994)" (Natural Capital Protocol, 2022[34]). Society uses and exploits Natural Capital, which provides numerous benefits (goods and services). This Natural Capital plays a primary role in human lives existence and maintenance, which justifies the pertinence of assessing its value in monetary terms, just like another capital type (financial, human). Natural Capital is a useful concept to link natural assets and economic features, and could enable to integrate nature into accounting systems to influence decisions.
Nature-based Solutions	Actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits. (IUCN Global Standard, 2016)
Option value	Translates the importance given by people to the future availability of ecosystem services for their personal benefits
Total Economic Value	Total economic value is a concept in Cost–benefit Analysis that refers to the value derived by people from a natural resource, a man-made heritage resource or an infrastructure system, compared to not getting it. It appears in environmental economics as an aggregation of the values provided by a given ecosystem. (Plottu, Eric; Plottu, Béatrice, 2007)[35]

[34] Natural Capital Protocol, Natural Capital Coalition https://capitalscoalition.org/capitals-approach/natural-capital-protocol/

[35] Plottu, Eric; Plottu, Béatrice (2007). "The concept of Total Economic Value of environment: A reconsideration within a hierarchical rationality". Ecological Economics. **61** (1): 52-61. doi:10.1016/j.ecolecon.2006.09.027

References

AECOM, 2015. Réalisation des études préparatoires pour des investissements en infrastructures de protection des bassins versants de la Grande Rivière du Nord, Cavaillon, Ravine du Sud, Artibonite et Acul Dubreuil Premier Rapport. Available at: https://www.climateinvestmentfunds.org/sites/cif_enc/files/meeting-documents/optional_electronic_link_6_-_final_revise_1er_rapport_pmdn_0.pdf

Aurba, 2016. L'agriculture urbaine à Bordeaux, Panorama des projets exemplaires et premiers éléments de stratégie.

Binet T. et al., 2015. Estimation des bénéfices de la protection des sites du Conservatoire du littoral : état des lieux et perspectives à l'horizon 2050.

Cairney P., Kwiatkowski R., 2017. How to communicate effectively with policymakers: combine insights from psychology and policy studies. https://doi.org/10.1057/s41599-017-0046-8

CDC Biodiversité, Mission Économie de la Biodiversité Et Vertigo Lab,2019. Évaluation socioéconomique des solutions fondées sur la nature.

Chapin, F. Stuart, III (2011). "Glossary". Principles of terrestrial ecosystem ecology.

CIAT, Haïti Primature, 2014. Objectifs et Stratégies pour la reconstruction. Available at: https://www.pseau.org/outils/ouvrages/ciat_haiti_demain.pdf

Climate central website: https://www.climatecentral.org/

Costanza et al, 1997. The value of the world's ecosystem services and natural capital.

Costanza et al, 2017. Twenty years of ecosystem services : How far have we come and how far do we still need to go?

DB, UNEP, 2021. Resilient by Nature - Increasing Private Sector Uptake of Nature-based Solutions for Climate-resilient Infrastructure. A Market Assessment for Latin America and the Caribbean. Available at: https://publications.iadb.org/publications/english/document/Resilient-by-Nature-Increasing-Private-Sector-Uptake-of-Nature-based-Solutions-for-Climate-resilient-Infrastructure-A-Market-Assessment-for-Latin-America-and-the-Caribbean.pdf Raymond C.M., Frantzeskaki N., Kabisch N. et al., 2017. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. https://doi.org/10.1016/j.envsci.2017.07.008.

Environmental Justice Organisations, Liabilities and Trade, 2015. Multi-criteria assessment. Available at: http://www.ejolt.org/2015/02/multi-criteria-assessment-mca/

European Commission, Directorate-General for Research and Innovation, 2021. Evaluating the impact of nature-based solutions : a handbook for practitioners. https://data.europa.eu/doi/10.2777/244577

Krausman P.R., Morrison M.L., 2016. Another plea for standard terminology. Available at: https://wildlife.onlinelibrary.wiley.com/doi/full/10.1002/jwmg.21121

Millenium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being, A Framework For Assessment. Available at : https://islandpress.org/books/ecosystems-and-human-well-being?prod_id=474

Nature-based Solutions Evidence Platform, 2022. Copyright Nature-based Solutions Evidence Tool.

Nef consulting, 2022. Multi-criteria appraisal (MCA). Available at: https://www.nefconsulting.com/what-we-do/evaluation-impact-assessment/multi-criteria-appraisal-mca-2/

NOAA, 2020. Nature-Based Solutions: Benefits, Costs, and Economic Assessments. Available at: https://coast.noaa.gov/digitalcoast/training/gi-practices-and-benefits.html

SEEA. Ecosystem Accounting. Available at: https://seea.un.org/ecosystem-accounting

TEEB, 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. http://teebweb.org/publications/teeb-for/synthesis/

Tour du Valat website: https://tourduvalat.org/

Tour du Valat, 2018. La restauration des anciens salins de Camargue : une solution fondée sur la nature pour s'adapter à l'élévation du niveau marin. Available at : https://tourduvalat.org/dossier-newsletter/ la-restauration-des-anciens-salins-de-camargue-une-solution-fondee-sur-la-naturepour-sadapter-a-lelevation-du-niveau-marin/

Wealth Accounting and the Valuation of Ecosystem Services. Available at: https://www.wavespartnership.org/

Wetland based solutions, 2022. Mediterranean wetland restoration, an urgent priority. Available at : https://wetlandbasedsolutions.org/2022/03/15/mediterranean-wetland-restoration-an-urgent-priority

Wikipedia, 2022. Analytic hierarchy process. Available at: https://en.wikipedia.org/wiki/Analytic_hierarchy_process

Wikipedia, 2022. Ecosystem. Available at: https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapinglossary-2

Wikipedia, 2022. Weighted sum model. Available at: https://en.wikipedia.org/wiki/Weighted_sum_model

Wolff A., Gondran N., Brodhag C., 2017. Les outils d'évaluation de la biodiversité et des services écosystémiques recommandés aux entreprises : compromis entre crédibilité, pertinence et légitimité. https://doi.org/10.4000/developpementdurable.11649

World Bank, 2021. Cost-effectiveness Analysis. Available at: https://dimewiki.worldbank.org/Cost-effectiveness_Analysis