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on biodiversity and ecosystem assessment reports

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Working paper on biodiversity and ecosystem assessment reports

TABLE OF CONTENTS

1. INTRODUCTION	5
2. SOURCES OF INFORMATION	6
2.1 PORTUGAL MILLENNIUM ECOSYSTEM ASSESSMENT	6
2.2 MILLENNIUM ECOSYSTEM ASSESSMENT OF SPAIN	7
2.3 UK NATIONAL ECOSYSTEM ASSESSMENT	7
3. SELECTION OF ECOSYSTEMS	8
4. SELECTION OF ECOSYSTEM SERVICES	11
5. ANALYSIS OF ECOSYSTEMS AND ECOSYSTEM SERVICES	14
6. BIODIVERSITY IN THE ECOSYSTEM ASSESSMENTS	18
7. BIODIVERSITY AND ECOSYSTEM SERVICES	19
8. DRIVERS OF CHANGE	22
9. RESPONSE OPTIONS AND MANAGEMENT	24
10. SCALE	25
11. INDICATORS	26
12. LINKS WITH HUMAN WELL-BEING	27
13. VALUATION OF ECOSYSTEM SERVICES	28
14. SCENARIOS	30
15. POLICY QUESTIONS	34
16. GOVERNANCE	39
17. CONCLUSIONS	40

REFERENCES..... 42

**ANNEX 1 – VISUAL REPRESENTATION OF THE ANALYSIS OF ECOSYSTEMS
AND ECOSYSTEM SERVICES ACROSS THE THREE NEAS 42**

**ANNEX 2 – VISUAL REPRESENTATION OF THE BIODIVERSITY
INFORMATION PROVIDED IN THE THREE NEAS..... 58**

**ANNEX 3 – VISUAL REPRESENTATION OF THE DRIVERS OF CHANGE
ACROSS THE THREE NEAS 60**

This document was prepared by a project team from the European Topic Centre on Biological Diversity – Sophie Condé, MNHN, Amor Torre-Marín and Ben Delbaere, ECNC (July 2013)

1. Introduction

Several national ecosystem assessment reports have been published in the last years and others are in preparation. Action 5 of the EU biodiversity strategy to 2020 ‘Improve knowledge of ecosystems and their services in the EU’ will certainly increase this tendency. One key question is how biodiversity is addressed in these assessments.

The goal of this task is to prepare a working paper to assess how biodiversity is covered in the context of ecosystem assessments, also from the broader perspective of the policy questions (Table 1.1) and the analytical framework for ecosystem assessment developed by the MAES (Mapping and Assessment of Ecosystems and their Services) Working Group (Maes et al., 2013). The work is based on the analysis of a selection of three existing national ecosystem assessments: the Portuguese Millennium Ecosystem Assessment, the Millennium Ecosystem Assessment of Spain and the UK National Ecosystem Assessment. Issues such as biodiversity related information, selection of ecosystems and ecosystem services and drivers of change have been analysed and compared across the three assessments.

Table 1.1: MAES policy questions

Q1: What are the current state and trends of the EU’s ecosystems and the services they provide to society? What are emerging trends and projected future state of the EU’s ecosystems and the services they provide to society? How is this currently affecting human well-being and what are the projected, future effects to society?
Q2: What are the key drivers causing changes in the EU’s ecosystems and their services?
Q3: How does the EU depend on ecosystem services that are provided outside the EU?
Q4: How can we secure and improve the continued and sustainable delivery of ecosystem services?
Q5: How do ecosystem services affect human well-being, who and where are the beneficiaries, and how does this affect how they are valued and managed?
Q6: What is the current public understanding of ecosystem services and the benefits they provide (some key questions could usefully be included in the 2013 Eurobarometer on Biodiversity)?
Q7: How should we incorporate the economic and non-economic values of ecosystem services into decision making and what are the benefits of doing so (question to be addressed 2020)? And what kind of information (e.g. what kind of values) is relevant to influence decision-making?
Q8: How might ecosystems and their services change in the EU under plausible future scenarios - What would be needed in terms of review/revision of financing instruments?
Q9: What are the economic, social (e.g. employment) and environmental implications of different plausible futures? What policies are needed to achieve desirable future states?
Q10: How have we advanced our understanding of the links between ecosystems, ecosystem functions and ecosystem services? More broadly, what is the influence of ecosystem services on long-term human well-being and what are the knowledge constraints on more informed decision making (question to be addressed to the European Commission (DG RTD and Joint Research Centre) and research community in the context of EU mechanism, KNEU15, and SPIRAL16).

Source: Maes et al., 2013

2. Sources of information

The sources of information analysed for the elaboration of this report are the following:

1. Portuguese Millennium Ecosystem Assessment (ptMA):
MA summary: <http://www.maweb.org/en/SGA.Portugal.aspx>
Final report: <http://www.ecossistemas.org/pt/relatorios.htm>
2. Millennium Ecosystem Assessment of Spain (EME):
EME: <http://www.ecomilenio.es/>
Report of results: <http://www.ecomilenio.es/informe-de-resultados-eme/1760>
Cartographical information: <http://www.ecomilenio.es/documentos/informacion-cartografica>
3. UK National Ecosystem Assessment (UK NEA):
UK NEA: <http://uknea.unep-wcmc.org/>
Technical report: <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>

2.1 Portugal Millennium Ecosystem Assessment

Led by the ‘Centro de Biologia Ambiental’ at the Science Faculty of the University of Lisbon, the Portuguese Millennium Ecosystem Assessment (ptMA) work started in 2003. The ptMA analyzed the condition and recent trends of biodiversity and ecosystem services in Portugal, identified the main drivers of change, and analyzed the available policy responses and scenarios for the next 50 years, following the conceptual framework of the Millennium Ecosystem Assessment (MA). The ptMA comprises several documents that were developed according to the multiple phases in which the assessment was divided:

- Report on User Needs and Response Options (Pereira et al., 2003)
- State of the Assessment Report (Pereira et al., 2004)
- Final report ‘Ecosystems and Human Well-Being: Results of the Evaluation for Portugal of the Millennium Ecosystem Assessment’ (ptMA, 2012)

The ptMA final report is divided in four parts (ptMA, 2012):

1. The first part presents the general concepts and the methodology, including the description of the conceptual framework of the MA and its multi-scale evaluation characteristics. Ecosystem services, ecosystems classes and the basic structure of the analysis are described, which includes: direct and indirect drivers of change; current state of biodiversity, ecosystem services and their trends; possible scenarios of future changes in ecosystem services; and management responses to current and projected trends on ecosystem services.
2. The second part of the report presents a group of chapters organized according to the different classes of ecosystems analyzed by the ptMA. The same conceptual model is used to assess all these ecosystems.

3. The third part of the book presents case studies at sub-national level. This recognizes one of the issues raised by the MA, which is the need of making evaluations at the decision-making process level.
4. The report ends with a synthesis of results, analyzing each ecosystem service across the different ecosystems analyzed and integrating response options presented for each ecosystem and each scale.

2.2 Millennium Ecosystem Assessment of Spain

Promoted by the Biodiversity Foundation of the Spanish Ministry of Agriculture, Food and Environment, the Millennium Ecosystem Assessment of Spain (EME) comprises two main documents:

- Synthesis Report (EME, 2011)
- Report of Results (EME, 2012)

The Report of Results has 8 sections:

- 1- Conceptual framework, methodology and characterization of the operational ecosystem types
- 2- Evaluation of the state of biodiversity
- 3- Evaluation of the operational ecosystem types
- 4- Analysis of the direct drivers of change of the operational ecosystem types
- 5- Cartographic information
- 6- Future scenarios
- 7- Communication and involvement of the groups of interest
- 8- Evaluation at local scale: case studies

2.3 UK National Ecosystem Assessment

The UK National Ecosystem Assessment (UK NEA) was carried out between mid-2009 and early 2011 as part of the Living With Environmental Change Partnership following the recommendation in 2007 of the House of Commons Environmental Audit Committee to the Government to conduct a full MA-type assessment for the UK. The assessment was supported by the Department for Environment, Food and Rural Affairs (DEFRA), and several country governments and agencies, and scientific bodies (NERC and ESRC). The UK NEA comprises two main documents:

- Synthesis Report (UK NEA Synthesis of the Key Findings) (UK NEA, 2011a)
- Technical Report (UK NEA, 2011b)

The Technical report has 27 chapters structured in several sections:

- 1- Setting the scene: conceptual framework and methodology
- 2- Assessing change: drivers of change in ecosystems and ecosystem services
- 3- Assessing biodiversity: biodiversity in the context of ecosystem services
- 4- Broad habitats: 8 chapters covering the broad habitat types

- 5- Ecosystem services: supporting, regulating, provisioning and cultural
- 6- Synthesis: status and changes in ecosystems and their services to society for England, Northern Ireland, Scotland and Wales
- 7- The bigger picture: UK dependence on non-UK ecosystem services
- 8- Human well-being: economic values, health values and shared values
- 9- Plausible futures: scenarios and scenario analysis
- 10- Making decisions: response options

3. Selection of ecosystems

Portugal Millennium Ecosystem Assessment

At the national scale the ptMA was organized into reporting units based on the global MA systems (MA 2003 in Pereira et al., 2004), but adapted to the needs of the Portuguese users through the selected ecosystem classes.

Table 3.1: Reporting units used for the national scale assessment in the ptMA

Reporting unit	Description
Marine	Corresponds to marine areas where the sea is deeper than 50 m
Coastal	Is the interface between ocean and land, typically areas between 50 m below sea level and 50 m above high tide level
Inland Water	Permanent water bodies inland from the coastal zone
Montado	Evergreen oak woodland, where the predominant tree species are the cork-oak (<i>Quercus suber</i>) and holm-oak (<i>Quercus ilex</i> ssp. <i>rotundifolia</i>)
Forest	Land dominated by trees but excluding Montado
Cultivated	Lands dominated by domesticated plant species
Mountain	Steep and high lands
Islands	Correspond mainly to the Azores and Madeira archipelagos
Urban	Human settlements with a population of 5000 or more

Source: Pereira et al., 2004

Table 3.2: Ecosystem classes analysed by the ptMA

Ecosystem class
Forests
Agriculture
Montado
Mountains
Surface inland waters
Subterranean waters
Coastal environment
Oceans
Oceanic islands

Source: ptMA, 2012

Millennium Ecosystem Assessment of Spain

In the EME, the selection of ecosystem types for which services were evaluated was based on general ecosystem types of operational character suitable for the articulation and development of the EME. The typology tries to identify the main sorts of expression of nature in Spain, defined by general environmental conditions and with a well-known influence on ecosystem characteristics.

The following considerations were taken into account for the selection of the ecosystem types:

- The number of ecosystem types evaluated should be sufficient to gather in an efficient and summarized way the character and diversity of Spanish nature.
- The selection should consider the importance that the services of the ecosystem types selected have in relation to the well-being of the Spanish population and therefore be representative of the Spanish natural capital.
- Ecosystems are differentiated according to geophysical conditions (e.g. microclimate, altitude, presence of water) and human influence or control (e.g. contrast between urban ecosystems and rural ecosystems with predominance of agricultural use).

For terrestrial ecosystems, the following criteria were considered: altitude, aridity, macroclimate and human use.

According to these criteria fourteen operational ecosystem types were considered in the EME (EME, 2011).

Table 3.3: Operational ecosystem types considered in the EME

A. Terrestrial ecosystems
1- Sclerophyllous forest and bush land
2- Mediterranean continental forest and bush land
3- Atlantic forest
4- Alpine mountains
5- Mediterranean mountains
6- Arid zones
7- Macaronesian ecosystems (Canary islands)
8- Agro-ecosystems
B. Aquatic ecosystems
9- Marine
10- Rivers and river banks
11- Lakes and inland wetlands
12- Aquifers
C. Transition ecosystems
13- Coasts
D. Urban ecosystems
14- Urban

Source: EME, 2011

UK National Ecosystem Assessment

The UK NEA uses Broad Habitat types based on those from the Countryside Survey for classifying ecosystems. These Broad Habitats are a convenient subdivision of the UK environment, which reflect differences in both ecological processes and management (UK NEA 2011a).

Table 3.4: Broad Habitat Types used in the UK NEA

Broad Habitat Type
Mountains, Moorlands and Heaths
Semi-natural Grasslands
Enclosed Farmland
Woodlands
Freshwaters – Openwaters, Wetlands and Floodplains
Urban
Coastal Margins
Marine

Source: UK NEA, 2011a

Comparison of the ecosystem selection across the three assessments

Comparing the selection of ecosystem types across the three NEAs, the EME has a more detailed classification of ecosystems with 14 operational ecosystem types, whilst the ptMA has defined 9 ecosystem classes and the UK NEA 8 Broad Habitat Types. For example, the EME has identified 3 types of forest ecosystems, whilst the ptMA and the UK NEA group all types of forests under one forest ecosystem type. The EME and the UK NEA have included urban ecosystems in their classifications, but not the ptMA. Subterranean waters and aquifers are considered ecosystem types by the ptMA and the EME, but not by the UK NEA. Arid zones are included as an ecosystem type only by the EME.

Table 3.5: Comparison of ecosystem types in the three NEAs

ptMA ecosystem classes	EME operational ecosystem types	UK NEA Broad Habitat Types
Terrestrial ecosystems		
	Urban	Urban
Agriculture	Agro-ecosystems	Enclosed Farmland
Montado		Semi-natural Grasslands
Forests	Sclerophyllous forest and bush land	Woodlands
	Mediterranean continental forest and bush land	
	Atlantic forest	
Mountains	Alpine mountains	Mountains, Moorlands and Heaths
	Mediterranean mountains	
	Arid zones	
Oceanic islands	Macaronesian ecosystems (Canary islands)	
Freshwater ecosystems		
Surface inland waters	Rivers and river banks	Freshwaters – Openwaters,

	Lakes and inland wetlands	Wetlands and Floodplains
Subterranean waters	Aquifers	
Marine ecosystems		
Oceans	Marine	Marine
Coastal environment	Coasts	Coastal Margins
Number of ecosystem types		
9	14	8

4. Selection of ecosystem services

Portugal Millennium Ecosystem Assessment

The ptMA assessed both extractive services such as fiber production and agricultural production, as well as non-extractive services such as biodiversity and recreation. The choice of the services analysed at the national scale was done according to the following criteria:

- to guarantee that both extractive and non-extractive services were assessed;
- to guarantee that there was know-how on those services in the research team (although the research team was also iteratively adapted to fit the services which were going to be studied);
- to respond to the requirements of the users.

Most of these services were also analysed at the basin and local levels, but in some instances other services were added.

Table 4.1: Services assessed at the national scale in the ptMA

Biodiversity
Provisioning services
Water
Food
Fibre
Regulating services
Climate regulation (carbon sequestration)
Soil protection, water cycle regulation and water quality
Cultural services
Recreation and tourism

Source: Pereira et al., 2004 and ptMA, 2012

Millennium Ecosystem Assessment of Spain

The EME selected 22 services to be evaluated for each of the 14 operational ecosystem types. The services included are the result of a consensus agreed by all the teams involved in the EME and implies an operational relationship to be used in each of the evaluations of services per ecosystem type. The definition of service adopted by the EME ‘direct and indirect contributions from ecosystems to human well-being’ differs slightly from the one used in the MA ‘benefits that humans obtain from ecosystems’. This definition tries to avoid the

ambiguity of the term ‘benefit’ when carrying out the evaluation of services, since it may lead to consider only those services reflected in the market and therefore its monetary dimension.

Table 4.2: Ecosystem services evaluated in the EME

Provisioning services
1- Food
2- Water
3- Biotic raw materials
4- Mineral raw materials
5- Renewable energy
6- Genetic resources
7- Medicinal resources
Regulating services
8- Climate regulation
9- Air quality regulation
10- Regulation of water flows
11- Erosion control
12- Soil fertility
13- Regulation of natural hazards
14- Biological control
15- Pollination
Cultural services
16- Scientific knowledge
17- Local ecological knowledge
18- Cultural identity and sense of place
19- Spiritual and religious experience
20- Aesthetic information
21- Recreation and ecotourism
22- Environmental education

Source: EME, 2011

UK National Ecosystem Assessment

The UK NEA, like the MA, recognizes four categories of ecosystem service:

- Supporting Services
- Regulating Services
- Provisioning Services
- Cultural Services

However, the UK NEA also incorporates post-MA advances and focuses on ‘final ecosystem services’ to avoid the double counting of services which are part of a suite of primary processes, including supporting services (UK NEA, 2011a). The UK NEA focuses on ‘ecosystem services’ that are derived from ecosystem processes including biotic interactions; as such, it does not provide an assessment of ‘environmental services’ that may be purely abiotic in origin such as minerals extracted from the ecosystem (UK NEA, 2011b).

Table 4.3: Final ecosystem services considered in the UK NEA

Provisioning services	Crops
	Livestock/aquaculture
	Fish
	Trees, standing vegetation, peat
	Water supply
Cultural services	Wild species diversity
	Environmental settings
	Undiscovered services
Regulating services	Climate regulation
	Disease and pest regulation
	Water quality
	Soil quality
	Air quality
	Pollination
	Hazard regulation
	Noise regulation

Source: UK NEA, 2011a

Comparison of the ecosystem services selection across the three assessments

Comparing the ecosystem services considered by the three NEAs, the EME has the more detailed classification of ecosystem services with 22 types of services in total, including 8 types of regulating services and 7 types of cultural services. The EME does not consider biodiversity as an ecosystem service, whilst the ptMA does and the UK NEA includes wild species diversity. The UK NEA is the only one that considers noise regulation as an ecosystem service.

Table 4.4: Comparison of ecosystem services in the three NEAs

ptMA	EME	UK NEA
Biodiversity		Wild species diversity
Provisioning services		
Food	Food	Crops
		Livestock/aquaculture
		Fish
Water	Water	Water supply
Fiber	Biotic raw materials	
	Mineral raw materials	
	Renewable energy	Trees, standing vegetation, peat
	Genetic resources	
	Medicinal resources	
Regulating services		
	Air quality regulation	Air quality
Soil protection, water cycle regulation and water quality	Regulation of water flows	Water quality
	Regulation of natural hazards	Hazard regulation
	Erosion control	

Climate regulation (carbon sequestration)	Climate regulation	Climate regulation
	Soil fertility	Soil quality
	Pollination	Pollination
	Biological control	Disease and pest regulation
		Noise regulation
Cultural services		
	Spiritual and religious experience	
	Aesthetic information	
Recreation and tourism	Recreation and ecotourism	Environmental settings
	Cultural identity and sense of place	
	Local ecological knowledge	
	Scientific knowledge	Undiscovered services
	Environmental education	

5. Analysis of ecosystems and ecosystem services

Portugal Millennium Ecosystem Assessment

The ptMA makes an analysis of the selected ecosystems using the same conceptual model to assess each of the 9 ecosystem types. The analysis includes:

- key messages
- descriptions and characteristics of the system
- drivers of change: climate, changes in land use, pollution, overexploitation, invasive species, economic growth, social context, tourism, sectoral and environmental policies, fire, biotic agents, etc.
- evaluation of ecosystem services status and trends: food production, bioenergy, soil protection, carbon sequestration, climate regulation, water provision, biodiversity, primary production, recreation, etc.
- comparative analysis of response options: fire, climate, biotic agents, bioenergy, soil protection, food production, water provision, carbon sequestration, biodiversity, recreation, institutional framework, integrated and adaptive management, sectoral policies, multifunctionality and new needs, etc.
- scenarios: global orchestration; order form strength; adaptive mosaic; and technogarden.

In addition, a cross-cutting evaluation of the drivers of change, scenarios and state of biodiversity was undertaken (ptMA, 2012).

Millennium Ecosystem Assessment of Spain

In the EME the 14 operational ecosystem types are described and analysed. The information provided for each ecosystem type covers the following issues:

- general characteristics of the ecosystem type
- geographical distribution

- figures of land use
- general conservation status and trends of the different ecosystem types
- ecosystem services delivered by the ecosystem types
- conditions and trends of the services evaluated
- direct drivers of change, impact and future trends
- analysis of trade-offs and synergies
- evaluation methods and sources of data
- responses and management interventions
- the conservation of the ecosystem type and human well-being

UK National Ecosystem Assessment

In the UK NEA the following information is provided for each of the 8 Broad Habitat Types:

- the state of knowledge of the condition and trends of the Broad Habitat from the end of the Second World War (WWII) to the present day
- an examination of what is driving that change
- the ecosystem services provided and their links to human well-being
- trade-offs and synergies between different ecosystem services
- sustainable management options
- knowledge gaps

Comparison of the analysis of ecosystems and ecosystem services across the three assessments

The different information provided by the three NEAs in relation to each ecosystem type is summarized in the table below. Some examples of the visual representation of this information are included in Annex 1.

Table 5.1: Information provided per ecosystem type in the three NEAs

	ptMA	EME	UK NEA
Ecosystem description and characteristics	yes	yes	yes
Surface and surface change	yes	yes	yes
Geographical distribution	yes	yes	yes
Conservation status and trends	yes	yes	yes
Drivers of change	yes	yes	yes
Provision of ecosystem services status and trends	yes	yes	yes
Trade-offs and synergies		yes	yes
Response options and management	yes	yes	yes
Links with human well-being		yes	yes
Scenarios	yes		
Evaluation methods and sources of data		yes	
Knowledge gaps			yes

- Ecosystem description and characteristics

Ecosystem descriptions are provided in the three NEAs and are mainly based on explanatory texts, graphs and photographs. The information provided also relates in some cases to land use; societal use; associated species and habitats; biophysical, ecological and socio-economic characteristics; or environmental conditions.

- Surface and surface change

In relation to land use/ecosystem type surface and surface change, the ptMA and the EME provide the information on land cover change based on the Corine Land Cover classification, whilst the UK NEA also provides the net change per Broad Habitat Type. Specific information on surface change and distribution for certain ecosystem types is provided in the form of various tables and graphs by the three NEAs.

- Geographical distribution

Regarding geographical distribution, the three NEAs provide an overview map with the geographical distribution of the selected ecosystem types. Specific maps for some of the ecosystem types are also provided.

- Conservation status and trends

In relation to the status and trends of the different ecosystem types, information is provided for the different ecosystem types, but not in a common harmonized way and in many cases based on textual descriptions. Information on the status and trends of specific habitat types is also provided. For the habitat type semi-natural grasslands the UK NEA provides information on the status of the habitat type using the favourable conservation status assessment under Article 17 of the EU Habitats Directive; for the habitat type coastal margins it provides information on the current condition of SACs (Special Areas of Conservation) and SSSIs (Sites of Special Scientific Interest) as the percentage of those areas assessed based on the monitoring condition of SACs and SSSI/ASSIs, reported by Natura 2000 habitat types. The EME and the UK NEA use the criteria of the Water Framework Directive as one of the elements to provide information on the status of freshwater ecosystems.

- Drivers of change

The main drivers of change of the different ecosystem types are described in the three NEAs. Summary tables reflecting the trends and the impacts of the different drivers are provided. Specific analyses of certain drivers are also included.

- Provision of ecosystem services, status and trends

An overview of the provision of ecosystem services by the different ecosystem types is provided by the three NEAs. The information is presented in a matrix form with colour coding representing the importance and the trends of the services. Textual descriptions of the ecosystem services are also provided. Detailed analyses of the services provided by specific ecosystem types are also included in the three NEAs. In addition, specific ecosystem services have been described in detail, analysed and mapped. However, the information is provided in a heterogeneous way across the three NEAs, with different indicators, units and ways of representation (maps, graphs and tables).

- Trade-offs and synergies

The EME identifies the different processes that influence factors and scales that could have an impact on the different ecosystem services. It also provides examples on how decisions to enhance one service could have positive and negative impacts on other services and human well-being. These types of interactions are described and a summary is presented in tabular form. The UK NEA provides a qualitative analysis of the trade-offs and synergies between the provision of the different ecosystem services for each habitat type, with textual explanations and summary tables.

- Response options and management

Some response options and management strategies are presented in the ptMA for each ecosystem type according to user views and needs. The response options are grouped under four categories: governmental interventions; private initiatives; civil society initiatives; and knowledge, technological and research responses. The EME includes different response options in relation to legal and institutional interventions, economic related responses and technical related responses. A different set of responses is considered depending on the ecosystem type. The UK NEA presents options for improving ecosystem service delivery through sustainable management for each habitat type. It also includes some information and case studies of ecosystem services recovery through restoration.

- Links with human well-being

The conservation of the ecosystem type and its links with human well-being is provided in the EME through textual descriptions. Some explanatory figures are also included. The UK NEA includes a description of the ecosystem good and services for human well-being provided by the different habitat types.

- Scenarios

The ptMA includes a scenario analysis in each ecosystem chapter. It provides an assessment of the implications for the specific ecosystem type of the 4 different scenarios of the MA, adapted to Portugal: global orchestration; order form strength; adaptive mosaic; and technogarden. The EME has a specific chapter dealing with scenarios, but information on scenarios is not provided in the ecosystem chapters. In the scenarios chapter the description and the trend of the ecosystem services under the different scenarios is provided. In the UK NEA the implications of the different scenario storylines for the habitat types are described in the chapter dedicated to scenarios, but they are not provided in the habitat chapters (UK NEA 2011a).

- Evaluation methods and sources of data

The main indicators used for the characterization of the services provided by each ecosystem type, the sources of information used and the measurement units are provided by the EME in a tabular form.

- Knowledge gaps

The UK NEA brings into focus a range of limitations in the understanding of changes in extent and perceived quality of habitat types since the Second World War, the factors underlying those changes, and what they mean to society. It summarises major knowledge gaps under broad headings.

6. Biodiversity in the ecosystem assessments

Portugal Millennium Ecosystem Assessment

The ptMA states that all users suggested that biodiversity should be assessed by the ptMA. An analysis of biodiversity conditions and trends is included. The analysis is first carried out service-wise, for two services: water provisioning and biodiversity. These two services are being assessed at a national scale across ecosystems. The chapter dedicated to biodiversity includes the following information:

- an introductory section
- the description of biodiversity in Portugal
- direct drivers of change: changes in land use, forests, dams, road infrastructure, fires, population, water pollution, air pollution, overexploitation of natural resources and invasive species
- indirect drivers of change: demographic factors, economic and socio-political factors and cultural factors
- conditions and trends of natural habitats and species
- responses to biodiversity loss in relation to: conservation of species and habitats diversity; agriculture; forest exploitation; dams; fire; pollution; overexploitation; invasive species; tourism; public and private projects
- scenarios: global orchestration; order form strength; adaptive mosaic; technogarden

Millennium Ecosystem Assessment of Spain

Specific chapters are dedicated to biodiversity in the EME. The chapters cover the following information:

- an analysis of what is biodiversity (conservation) and its importance in the maintenance of human well-being
- an analysis of the state of biodiversity knowledge and of Spanish biodiversity in the European context
- the state and trends of biodiversity in Spain (species and genetic diversity)
- the effect of the main direct drivers of change on biodiversity (species) in Spain
- functional diversity, biodiversity and tipping points
- analysis and proposal of conservation strategies
- response options

UK National Ecosystem Assessment

The complex role of biodiversity in the delivery of ecosystem services has been addressed in the UK NEA both in an individual chapter and in each of the habitat chapters. The report

addresses the position of biodiversity in the context of the UK NEA, the role of biodiversity in UK ecosystem services, its status and trends and the drivers of change.

Regarding response options, biodiversity is tackled as a sector, focusing on capturing the range of response options that promote the conservation of biodiversity, allowing it to serve its many functions (UK NEA, 2011b). In relation to scenarios, the implications of the different storylines for biodiversity are described in the chapter dedicated to scenarios (UK NEA 2011a).

Comparison of biodiversity information provided in the three NEAs

Comparing the biodiversity related information provided by the three NEAs, the EME includes information on the importance of biodiversity for the maintenance of human well-being, making reference to an instrumental vision of biodiversity conservation. The EME also refers to non-linear dynamics of biodiversity conservation and tipping points. The ptMA and the UK NEA include an analysis of biodiversity under the different scenarios.

Table 6.1: Biodiversity information provided in the three NEAs

	ptMA	EME	UK NEA
Biodiversity in the context of human well-being		yes	
Role of biodiversity in the delivery of ecosystem services		yes	yes
Description of biodiversity in the country	yes	yes	yes
State and trends	yes	yes	yes
Drivers of change	yes	yes	yes
Conservation strategies and responses to biodiversity loss	yes	yes	yes
Functional diversity, biodiversity and tipping points		yes	
Scenarios	yes		yes

Some examples of visual representations of this information are included in Annex 2.

7. Biodiversity and ecosystem services

Portugal Millennium Ecosystem Assessment

In the ptMA biodiversity is treated as an ecosystem service and it is assessed like the other ecosystem services. The report states that biodiversity is the fundamental support to ecosystem services (ptMA, 2012).

Millennium Ecosystem Assessment of Spain

The EME states that biodiversity, including all its dimensions (genetic diversity, species and communities diversity and maintenance of habitats), is the main supplier of ecosystem services and should not be considered as a service *per se*.

It is also stated that from all the components that make up biodiversity, the functional diversity associated to microorganisms, plants and invertebrates has a major contribution to

the delivery of ecosystem services, mainly to regulating services. However, these components of biodiversity have received less scientific and political attention so far (EME, 2011).

Table 7.1: Ecosystem services and their direct or indirect relationship with the services providers related with biodiversity

Ecosystem services	Service providers
Provisioning	
Food	<ul style="list-style-type: none"> • Vegetation • Microorganisms • Invertebrates • Vertebrates
Raw materials of biotic origin	<ul style="list-style-type: none"> • Vegetation • Herbivores
Natural medicines and active principles	<ul style="list-style-type: none"> • Vegetation • Microorganisms • Vertebrates
Regulating	
Climatic regulation	<ul style="list-style-type: none"> • Vegetation
Air quality regulation	<ul style="list-style-type: none"> • Vegetation • Microorganisms
Water purification	<ul style="list-style-type: none"> • Vegetation • Microorganisms • Aquatic invertebrates
Soil fertility	<ul style="list-style-type: none"> • Soil microorganisms • Soil invertebrates • Nitrogen fixation vegetation
Pollination	<ul style="list-style-type: none"> • Vegetation • Insects
Biological control	<ul style="list-style-type: none"> • Parasitoid invertebrates • Predators
Cultural	
Recreational activities and ecotourism	<ul style="list-style-type: none"> • Fish • Birds • Mammals

Source: EME, 2011

UK National Ecosystem Assessment

The UK NEA states that they were unable to comprehensively quantify the relationships between UK biodiversity and the ecosystem services it supports. The difficulty arises partly because of differences in the depth of knowledge of particular taxonomic groups, in relation to knowledge of the different ecosystem services those taxonomic groups functionally underpin (UK NEA, 2011a).

Compared to the MA the UK has taken a slightly different approach to the treatment of biodiversity and explicitly separate out the underpinning natural processes that depend to a greater or lesser degree on biodiversity, from landscapes, seascapes, habitats and wild species. The UK NEA states that these latter elements of biodiversity are part of the natural heritage

and, through the pleasure they bring to many people, form one kind of cultural ecosystem service. The report also mentions that all ecological processes are the product of interactions between different groups of organisms and in this sense, biodiversity – the variety and variability of living organisms – ultimately underpins the functioning of all ecosystems and thereby the delivery of all ecosystem services. In addition, it is stated that, in general terms, the level and stability of ecosystem services tend to improve with increasing biodiversity (UK NEA, 2011a).

The UK NEA states that there are three different ways in which biodiversity is considered in the UK NEA (UK NEA, 2011b):

- Firstly, biodiversity is important for the fundamental ecosystem processes that underpin final ecosystem services.
- Secondly, biological diversity at the level of genes and species may directly contribute to some goods and their values. Hence, the UK NEA includes wild species diversity as a final ecosystem service that contributes to both provisioning and cultural services.
- Thirdly, many components of biodiversity are valued by people for other reasons. Therefore, biodiversity is sometimes also a good in itself and delivers a distinct value.

Table 7.2: The importance of different biodiversity groups in underpinning the final ecosystem services based on expert opinion

Final ecosystem services (based on the UK NEA Conceptual Framework)	Biodiversity groups																
	Microorganisms		Fungi		Lower plants			Higher plants		Invertebrates		Fish		Amphibians	Reptiles	Birds	Mammals
	Terrestrial	Marine	Non-lichens	Lichens	Phytoplankton	Macroalgae	Bryophytes	Seagrasses	Land plants	Terrestrial	Marine	Freshwater	Marine				
Crops, livestock, fish	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Trees, standing vegetation & peat	●		●	●		●	●	●	●	●				●			●
Climate regulation	●	●	●		●	●		●	●		●		●				●
Water supply	●	●	●		●		●		●								●
Hazard regulation	●	●	●	●		●	●	●	●		●						
Waste breakdown & detoxification	●	●	●		●	●		●	●	●	●		●	●			
Wild species diversity	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Purification	●	●	●						●	●	●			●			
Disease & pest regulation	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pollination									●							●	●
Meaningful places*	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●
Socially valued land & waterscapes*	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●

* Note: For the purposes of the Cultural Services chapter (Chapter 16), Cultural services have been combined into 'environmental settings'.

High importance

Amount of evidence (theory, observations, models) →

Level of agreement ↑	●	●	●
	●	●	●
	●	●	●

Medium importance

Amount of evidence (theory, observations, models) →

Level of agreement ↑	●	●	●
	●	●	●
	●	●	●

Low importance

Amount of evidence (theory, observations, models) →

Level of agreement ↑	●	●	●
	●	●	●
	●	●	●

Source: UK NEA, 2011b

Note: Importance is colour-coded: high (maroon), medium (beige), low (green), unimportant on the basis of available evidence (blank). The size of the circle in each cell is used to illustrate the level of uncertainty in the available evidence

Comparison of the consideration of biodiversity as an ecosystem services across the three NEAs

Biodiversity is considered an ecosystem service by the ptMA and the UK NEA; however the approach is different in the two assessments since the UK separates the role of biodiversity underpinning natural processes from landscapes, seascapes, habitats and wild species. The EME states that biodiversity should not be considered an ecosystem service *per se*, since it is the main supplier of ecosystem services.

Table 7.3: Consideration of biodiversity as an ecosystem services in the three NEAs

	ptMA	EME	UK NEA
Biodiversity as an ecosystem service	Biodiversity	No	Wild species diversity

8. Drivers of change

Portugal Millennium Ecosystem Assessment

According to the ptMA, the most important drivers of ecosystem change at the national scale are: fire regime, land use changes (including abandonment of agricultural fields, afforestation, urban expansion and development of transportation infrastructures), EU common agricultural policy, global markets, and economic growth. Other important drivers include environmental legislation, social attitudes towards the environment, tourism, demography and exotic species. The importance of each driver differs with the site at the local or basin scale. Drivers were assessed through expert judgment exercises in workshops with the research team and the users and through a literature review by the scientific team. The drivers of change are summarized at national level and also per ecosystem class (Pereira et al., 2004). The drivers of change on biodiversity are described in the biodiversity chapter (ptMA, 2012).

Millennium Ecosystem Assessment of Spain

The EME evaluated 6 direct drivers of change that have a direct impact on the functions or the capacity to generate services of Spanish ecosystems and their biodiversity: land use change, pollution, climate change, invasive species, overexploitation and changes in biogeochemical cycles. The effects of the six direct drivers of change at national level were integrated and illustrated in a graph; in addition, specific graphs are provided for each ecosystem type in their corresponding chapters in the EME.

The EME also provides an analysis of the five indirect drivers of change proposed by the MA (demographic, economic, socio-political, science and technology and cultural), and takes into account an additional driver: gender.

UK National Ecosystem Assessment

In examining the drivers of change, the UK NEA looked in particular at how societal changes have influenced both demand for different services and the ability of ecosystems to deliver them, often by affecting the extent and quality of different habitats (UK NEA, 2011a). The primary drivers of change in UK ecosystem services during the past 60 years have been: i) conversion and intensification of natural habitats to farmland; ii) exploitation of natural resources, especially marine fish; iii) air and aquatic pollution, especially nitrogen, sulphur and phosphorus; and to a lesser extent iv) climate change, and v) invasive species, including plant pests and animal diseases (UK NEA, 2011a).

Summaries of the relative importance and trends in the impact of the drivers of change on biodiversity, Broad Habitat Types and ecosystem services are summarized in tables. Specific tables of the drivers of change and their impacts on the different Broad Habitat Types and ecosystem services are also provided in the corresponding chapters in the UK NEA.

Comparison of drivers of change across the three NEAs

In relation to the main drivers of change, the UK NEA considers five main direct drivers of change (habitat change, climate change, pollution, invasive species and overexploitation), whilst the EME also includes changes in biogeochemical cycles. The ptMA has a slightly different approach and includes indirect drivers such as economic growth and environmental legislation; it also considers a different selection of drivers for each ecosystem type.

Table 8.1: Comparison of the drivers of change on ecosystems across the three NEAs

ptMA	EME	UK NEA
Land use changes	Land use change	Habitat change
	Climate change	Climate change
	Pollution	Pollution and nutrient enrichment
Exotic species	Invasive species	Invasive species
	Changes in biogeochemical cycles	
	Overexploitation	Overexploitation
Fire regime		
Land tenure and farm structure		
Tourism		
Economic growth		
Population distribution and migration		
Environmental legislation and attitudes		
EU Common Agricultural Policy and global markets		

In relation to the assessment of the impacts of the drivers of change on biodiversity, ecosystems and ecosystem services, the ptMA provides a description of the drivers of biodiversity change, whilst the EME and the UK NEA provide descriptions and also visual representations of the information. Regarding the drivers of change on ecosystems, the three

assessments provide descriptions and matrix-forms representations of the information. In relation to the drivers of change of ecosystem services, the three assessments provide descriptions and the UK NEA also includes a matrix-form representation. Both the EME and the UK NEA provide matrixes with colour codes and arrows to represent the trends and impact level of the different drivers, whilst the ptMA uses a number rating. Specific assessments of the drivers of change for certain ecosystem types are also included in the three assessments. Detailed information on specific drivers (e.g. number of invasive species, nitrogen deposition, exceedance of critical loads for acidification) is also provided in different types of graphs, tables and maps.

Examples of the visual representation of the information provided on the drivers of change are included in Annex 3.

9. Response options and management

Portugal Millennium Ecosystem Assessment

Some response options and management strategies are presented in the ptMA according to user views and needs. The choice of responses had the aim of considering responses at multiple scales, ranging from scales above that of the assessment (agri-environmental measures in the EU's Common Agricultural Policy), through the national scale (the response of the Portugal government to the 2003 wildfires) to local scale responses (acquisition of farms by NGOs for biodiversity protection). The response options are grouped under four categories: governmental interventions; private initiatives; civil society initiatives; and knowledge, technological and research responses (ptMA, 2012).

Millennium Ecosystem Assessment of Spain

The EME includes different response options in relation to legal and institutional interventions, economic related responses and technical related responses. A different set of responses is considered depending on the ecosystem type.

UK National Ecosystem Assessment

The UK NEA states that there are three types of activity that can be used to influence the management of ecosystems: i) generating and sharing knowledge and information (foundational activities); ii) establishing legal, policy and institutional frameworks, and also understanding and influencing social behaviours (enabling activities); and iii) changing markets, incentives, technologies and practices, as well as voluntary actions (instrumental activities) (UK NEA, 2011a).

The report includes an assessment of alternative, policy-relevant response options. These are considered in a structure that differentiates among relevant sectors, types of interventions and actors. The different sectors prescribe the general area of policy within which options may be relevant: biodiversity; agriculture; fisheries; forestry; water; recreation and tourism; planning, transport and energy; and integrated, including marine. For each one of these sectors, interventions are considered across seven categories: knowledge; legislation; policy and institutions; social/behavioural responses; markets/incentives; technologies; and voluntary initiatives. For each sector and intervention type, there are also alternative actors:

governments; local authorities; the private sector; non-governmental organisations; civil society organisations; and individuals and communities. The majority of the assessment is undertaken by sector (UK NEA, 2011b).

10. Scale

Portugal Millennium Ecosystem Assessment

The ptMA was conceived from the outset as a multi-scale assessment. Scales and sites were chosen to balance relevance to users with availability of data. The assessment was undertaken at three scales: national, drainage basin and local.

At the national scale the assessment was organized into reporting units based on the global MA systems, but adapted to the needs of the Portugal users. For the basin scale, it was decided to choose basins for two rivers with contrasting situations: almost “natural” (Mira, in Alentejo, with 1576 km²); and heavy human influence (Mondego, in Beira Litoral, with 6670 km²). At the local level, the sites were chosen based on users’ needs, the existence of past or on-going research and/or demonstration activities, and as to cover different reporting units (Pereira et al., 2004).

The analysis of conditions and trends in the ptMA is first carried out service-wise for two services: water provisioning and biodiversity. These two services were assessed at a national scale across ecosystems. The analysis was then carried out system-wise, for three systems: marine/coastal; forest/montado; and cultivated. For these systems, the full set of services considered in this assessment was analyzed (Pereira et al., 2004).

At the sub-national level, the ptMA presents case studies including key messages, system characteristics, descriptions of methodology, drivers of change, status and trends of main ecosystem services, comparative analysis of response options, cost analysis and scenarios (ptMA, 2012).

The ptMA ends with a synthesis of results, analyzing each ecosystem service across the different ecosystems analyzed and integrating response options presented for each ecosystem and each scale (ptMA, 2012).

Millennium Ecosystem Assessment of Spain

The EME worked at different scales and then integrated the results obtained with the same conceptual framework but using evaluation methodologies not directly associated to the EME. The analytical framework was applied at the following scales: national scale; regional scale (Bizkaia and the Catalonian coastal area); ecosystem scale related to the 14 operational ecosystem types; river basin scale (a selection of two river basins from the southeast); and detail scale from case studies (the socio-ecological system of Doñana and transhumance in the Real Conquense drovers road).

Five case studies developed by different research teams were included in the EME, with different spatial scales but with the same conceptual framework (EME, 2011).

UK National Ecosystem Assessment

The UK NEA provides information at national level and also at the level of its four constituent countries: England, Northern Ireland, Scotland and Wales. Information on ecosystem services is also provided at case study level. At the national scale, the UK NEA assesses terrestrial, freshwater and marine ecosystems, which are categorized into eight Broad Habitats. The picture at country level is captured in four separate individual syntheses, while the local level is addressed through a series of case studies within different chapters (UK NEA 2011b).

11. Indicators

Portugal Millennium Ecosystem Assessment

The ptMA states that one question that arose in the evaluation of the condition of ecosystem services is how to use an indicator, such as the diversity of a taxon, to infer the condition of the services that an ecosystem provides. Another important question was how to define the reference condition.

The ptMA used the Conceptual Framework of the MA, which considers five components of human well-being: material minimum for a good life, health, good social relations, security and freedoms and choice. Indicators related to ecosystem services, covering the five components of human well-being, were used in the ptMA, linked for example to income and employment (e.g. primary sector and environment-related employment), fresh water and clean air (e.g. drinking water quality, air quality and related diseases), recreation and learning (e.g. nature and rural tourism, use of protected areas as places of environmental education and awareness, environmental education projects), environmental hazards (e.g. contaminated soil, soil threatened by desertification, formal complaints for environmental reasons), and environmental governance (e.g. number of environmental NGOs, environmentally related public participation) (Pereira et al., 2004).

Millennium Ecosystem Assessment of Spain

In the EME, the development of the ecosystem services evaluation process, as in the MA, was done through a number of indicators that address two main issues: the state and the trends of ecosystem services. More than 400 indicators were selected that allow the assessment of: a) the increase or decrease of human use of each ecosystem service; b) the improvement or degradation of each ecosystem service. The DPSIR (Drivers, Pressures, State, Impact, Response) conceptual framework of the MA was simplified to PSR in the EME (EME, 2011).

The information analysed through the quantitative indicators was integrated and associated with the state of biodiversity, ecosystem services (provisioning, regulating and cultural), human well-being (related to basic materials, health, security, social relations and freedom of action) and drivers of change, both direct (land use change, climate change, pollution, introduction of invasive species and overexploitation of services) and indirect (demography, economy, socio-political, scientific-technological, gender and cultural) (EME, 2011).

UK National Ecosystem Assessment

The UK NEA refers to the UK's Biodiversity Indicators to assess the condition of biodiversity in the UK. A significant amount of indicators are used in the habitat type chapters and the ecosystem service chapters to assess the condition and trends of habitats and ecosystem services. Indicators are also used in the framework of a quantitative and qualitative assessment of the dependencies and impacts of UK consumption of biomass on overseas ecosystems. However, the report states that the specific impacts of the changes reflected by the indicators on well-being are not easy to quantify (UK NEA, 2011a).

12. Links with human well-being

Portugal Millennium Ecosystem Assessment

The ptMA follows the Conceptual Framework of the MA, which considers five components of human well-being: material minimum for a good life, health, good social relations, security, and freedom and choice. Freedom and choice is closely linked to the other four dimensions of well-being and reflects, in particular, the ability to achieve what a person values doing or being. In the ptMA, well-being is being studied at two scales, the national scale and the local scale (Pereira et al., 2004).

Millennium Ecosystem Assessment of Spain

The EME states that ecosystems contribute to human well-being through a group of functions with the capacity to provide services that satisfy society. This implies that the interactions established between the structure and ecological processes have the capacity to generate services through ecosystem functions. Therefore, 'ecosystem functions' is an intermediate concept between ecosystems and biodiversity (intrinsic value) and the services they generate (instrumental value). The main difference between functions and services is that functions exist independently of their use, demand, enjoyment or social valuation and they are translated into services only when they are used, consciously or unconsciously by the population. The translation of a function into a service implies necessarily the identification of the beneficiaries, the type of use, and the space and temporal location of the use (EME, 2011).

Working with services highlights the potential of ecosystems to generate well-being, further than the traditional approach of natural resources or natural goods. The holistic vision of services reflects on working with the capacity of ecosystems to generate a renewable flow of services instead of working with the sectoral and analytical approach of natural resources. Therefore, a forest is not considered any more a forest resource or a river a hydric resource; they are considered 'natural capital' able to deliver a rich and diverse flow of services further than the timber or hydric resource (EME, 2011).

Table 12.1: Connections between ecosystem services and the different dimensions of human well-being in Spain

Ecosystem services	Human well-being
Provisioning (e.g. food, water, energy)	1. Basic materials for a good life
	2. Security and stability of life
	3. Health
	4. Freedom of action and election

	5. Good social relationships
Regulating (e.g. hydric, climatic, air quality)	1. Basic materials for a good life
	2. Security and stability of life
	3. Health
	4. Freedom of action and election
	5. Good social relationships
Cultural (e.g. local ecological knowledge, identity, landscape)	1. Basic materials for a good life
	2. Security and stability of life
	3. Health
	4. Freedom of action and election
	5. Good social relationships

Legend:

	Weak connection
	Medium connection
	Strong connection

Source: EME, 2011

UK National Ecosystem Assessment

The UK NEA conceptual framework is structured around the processes that link human societies and their well-being with the environment. It explores the drivers of change impacting on ecosystems, and the services which flow from them to deliver a range of goods that we value individually and as a society (UK NEA, 2011a). The UK NEA's shared understanding of the meaning of well-being within a policy context includes good social relationships, financial and personal security, and a healthy and attractive environment (UK NEA, 2011b).

The UK NEA identifies three distinct types of well-being value: economic value, health value, and shared social value. The report states that although the conceptual framework identified three categories of well-being value, there was little existing evidence, and insufficient time and resources, to undertake new studies to specifically relate changes in ecosystem services to more than economic value. The UK NEA also mentions that a full understanding of who and where the beneficiaries of ecosystem services are, and how this influences the ways in which ecosystem services are valued and managed, requires more detailed spatial analysis and case studies, which is beyond the remit of the report (UK NEA, 2011a).

13. Valuation of ecosystem services

Portugal Millennium Ecosystem Assessment

In the ptMA all users stressed the need for tools for economic valuation of ecosystem services and for assessing the condition of ecosystem services (Pereira et al., 2003). Economic valuation of ecosystem services has been provided comprehensively for the forest ecosystem. In other ecosystems, only market valued services were economically valued (Pereira et al., 2004).

Millennium Ecosystem Assessment of Spain

The EME did not consider the Total Economic Value (TEV) to value ecosystem services. In fact, the TEV is a valuation process which tries to assign a monetary measure of the services that are not captured by the market and therefore have no price with the objective of addressing trade-offs between services in the decision-making process. The approach is based in the assumption that the monetary value of ecosystem services not considered in the market is not integrated in the decision-making process and therefore those ecosystem services are degraded. (EME, 2011).

But the EME considers that just taking into account the monetary valuation of ecosystem services simplifies in an extreme way the links between ecosystems and human well-being. The relationships between ecological systems and humans are too complex to simplify them to a single monetary value. The TEV as unique expression of the value of ecosystem services (of the contributions that those ecosystems provide to society) separates the ecosystems from the ecological and social sphere, whilst the objective of the MA is to highlight that the ecosystem services are the basis of the different components of human well-being in general and of the economy in particular. Therefore it seems evident that it is necessary considering other values such as the ecologic value (intrinsic value) and the sociocultural value of ecosystem services before considering the monetary value and never use the monetary value as unique valuation process (EME, 2011).

Therefore, the EME diverges from the framework of monetary valuation as unique measure of the value of ecosystem services without market prices and develops a process of evaluation and determination of trade-offs between services through multiple biophysical, socioeconomic and cultural indicators, as developed by the MA. The EME only considers the monetary benefit of those ecosystem services which have a real market, with real prices directly linked to those ecosystem services (EME, 2011).

UK National Ecosystem Assessment

For the economic valuation of ecosystem services the UK NEA focuses on 'final ecosystem services' to avoid the double counting of services which are part of a suite of primary processes, including supporting services (UK NEA, 2011a).

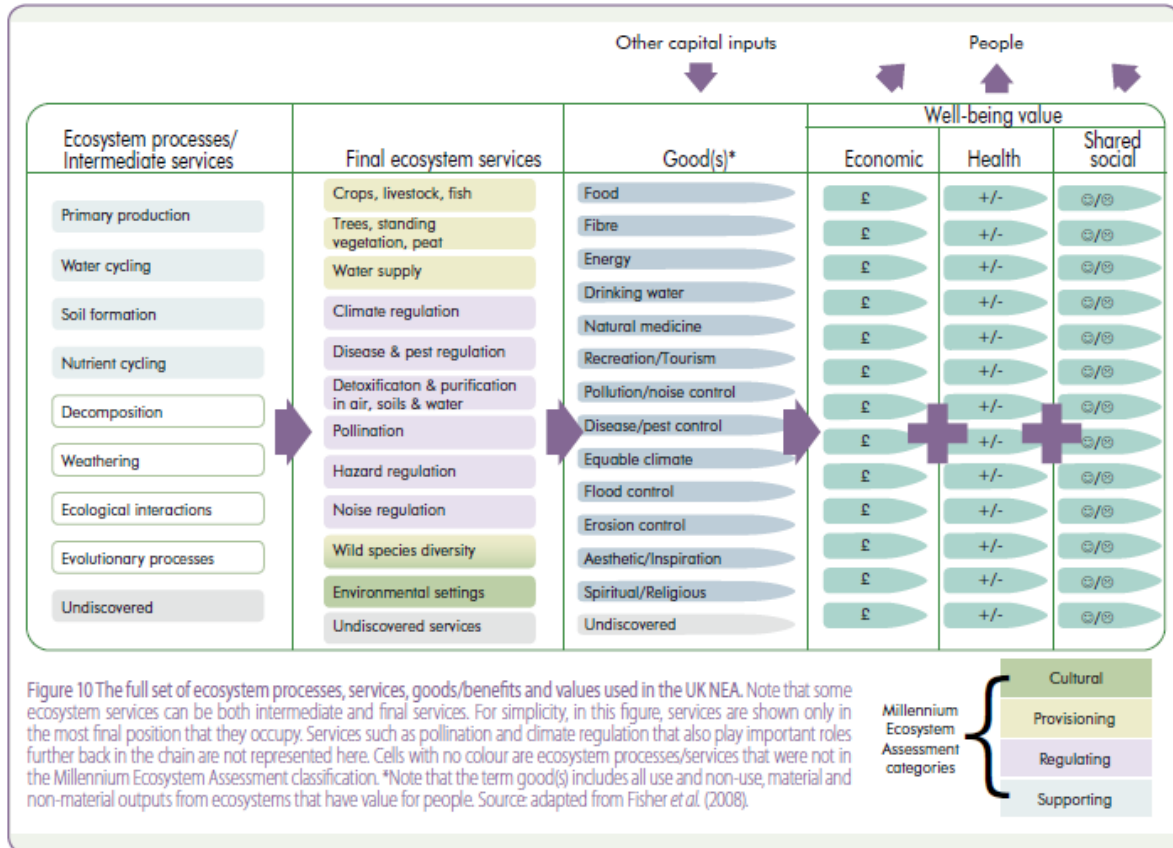
In order to assess the contribution of ecosystem services and goods to human well-being, the UK NEA developed an innovative approach to valuing ecosystem services which takes into account the full range of monetary (market and non-market) and non-monetary values of ecosystem service flows to individuals and collectively to society (UK NEA, 2011a). While some values can be measured using monetary valuation, certain kinds of benefits to people from ecosystems are not measurable through quantitative economic approaches. Therefore, the UK NEA defined additional wellbeing measures as health and shared (social) values (UK NEA, 2011b).

Alongside better valuation of both market and non-market goods, the UK NEA conceptual framework also emphasises the need to recognise the spatially explicit nature of ecosystem services and benefits (UK NEA, 2011a).

The UK NEA's valuation of ecosystem services is focused upon feasible incremental changes to ecosystem services, rather than some abstract notion of their total value. This is implemented by first assessing the change in values under a 'do-nothing' baseline. With this

baseline analysed, it is possible to examine the further changes in value expected under various alternative scenarios for the future incorporating, for instance, proactive policies, societal changes or alternative trends in environment and population (UK NEA, 2011b).

Table 13.1: The full set of ecosystem processes, services, goods/benefits and values used in the UK NEA



Source: UK NEA, 2011a

14. Scenarios

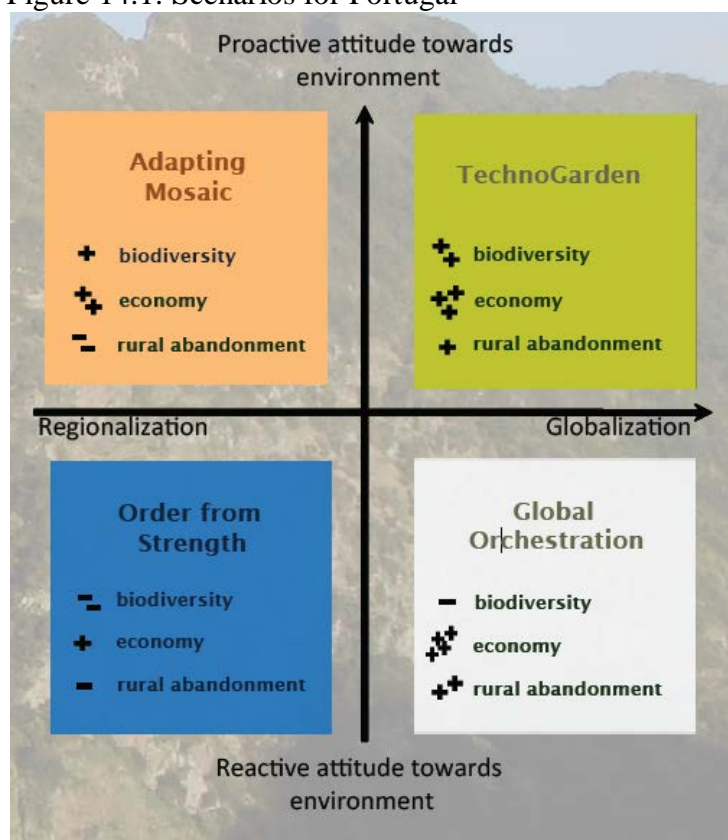
Portugal Millennium Ecosystem Assessment

In relation to scenarios, the ptMA scenarios result from the adaptation of the global MA scenarios to the Portuguese reality. The scenarios developed by the MA were established along two axis: globalization vs. regionalization; public attitude towards environment. The two axis originate four scenarios:

- Global orchestration – a world which emphasizes global policies and socioeconomic development
- Order form strength – a world where protection from borders is the main concern
- Adaptive mosaic – a world where local and regional management of ecosystems is dominant
- Technogarden – a world where the management of ecosystems is developed through technologies that maximize ecosystem services.

The ptMA adapted those scenarios to the Portuguese reality, regional details were added and the feasibility of global scenarios was tested at the regional scale.

Figure 14.1: Scenarios for Portugal



Source: ptMA, 2012

The draft scenarios were developed in two workshops of the research team and the users. First, the research team and the users were asked to rank drivers of ecosystem change by degree of impact on ecosystems and by unpredictability. The drivers that ranked higher on unpredictability and on impact were society's attitudes towards the environment and the development of agriculture in Portugal in the context of EU policies (ptMA, 2012).

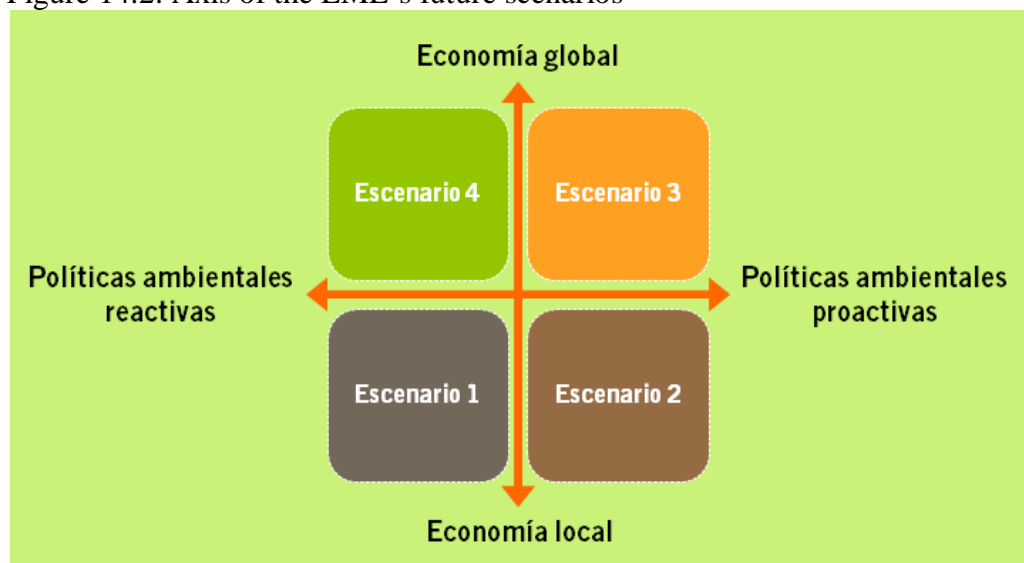
Millennium Ecosystem Assessment of Spain

Within the EME, the 2040 future scenarios were developed by the Future Scenarios Unit with the aim to explore the implications of the different alternative development paths for biodiversity, ecosystem services and human well-being. Five scenarios were developed:

- Techno-polar: there are big polarizations at the territorial, population, economic and well-being levels in a very technical Spain, with an economy that tends to the local versus the global and reactive environmental policies.
- Eco-well-being: an eminently local economy with a participative governance and proactive environmental policies in the form of a social pact towards a zero ecological deficit that achieve a better urban-rural balance besides a change of economic growth paradigm towards a care paradigm.

- Homo eco-technologicus: an eminently urban society structured according to 'the environmentally correct' based on technology, but with commercialized social rights and a rural environment that acts as factory of services for the city.
- Conflict in sight: in a context of globalized economy and reactive environmental policies there is environmental degradation, vulnerability, dependency, inequality and social conflict in Spain in 2040.
- Naturally free: sustainability, social equality, good health, valuable culture and the understanding of the interdependency of relationships between human beings and ecosystems gives us a lot of freedom in a natural way.

Figure 14.2: Axis of the EME's future scenarios



Source: EME, 2012

The characteristics of the EME future scenarios study are the following:

- Exploratory/normative: exploratory and normative
- Quantitative/qualitative: qualitative
- Axis/factors considered: 1. environmental policies (ecosystem management) reactive or proactive. The policies are designed to avoid non desirable ecological consequences (proactive); the policies are designed to answer to environmental problems once these are evident or visible. 2. Economic model (global/local). This axes indicates the degree and the scale of connection between and within the institutions, specially economic, having in one side the trend to globalization and the reduction of commercial barriers and in the other side the trend to regionalize or localize the economy.
- Number of scenarios: five
- Themes: biodiversity; intersectoral (environment and sustainability, global future, demography)
- Specific themes: ecosystem services and human well-being
- Integration of environment/society/economy: integration of socioeconomic factors in the environmental evaluation.
- Policy goals: integrate environmental issues in sectoral policies developing a tool box for public and private decision makers and also for society in general, including different types of instruments that link conservation policies in Spain with international and European policies.

- Spatial scale: national: Spain
- Temporal scale: 2040
- Publication: 2012
- Source: original. Own elaboration.
- Research/policy/company: research.
- Focus (analytical/participative/both): both, but mainly participative.
- Level of involvement of social actors: consultation on the degree of agreement with some of the key messages of scenario zero; consultation for the selection of the most relevant drivers of change for their selection as axes; participative elaboration of the scenarios' narratives; participative revision of the scenarios' narratives; participative elaboration of the response options (proposals of change) for the socio-ecological transition of Spain; consultation on the degree of agreement with the response options.

UK National Ecosystem Assessment

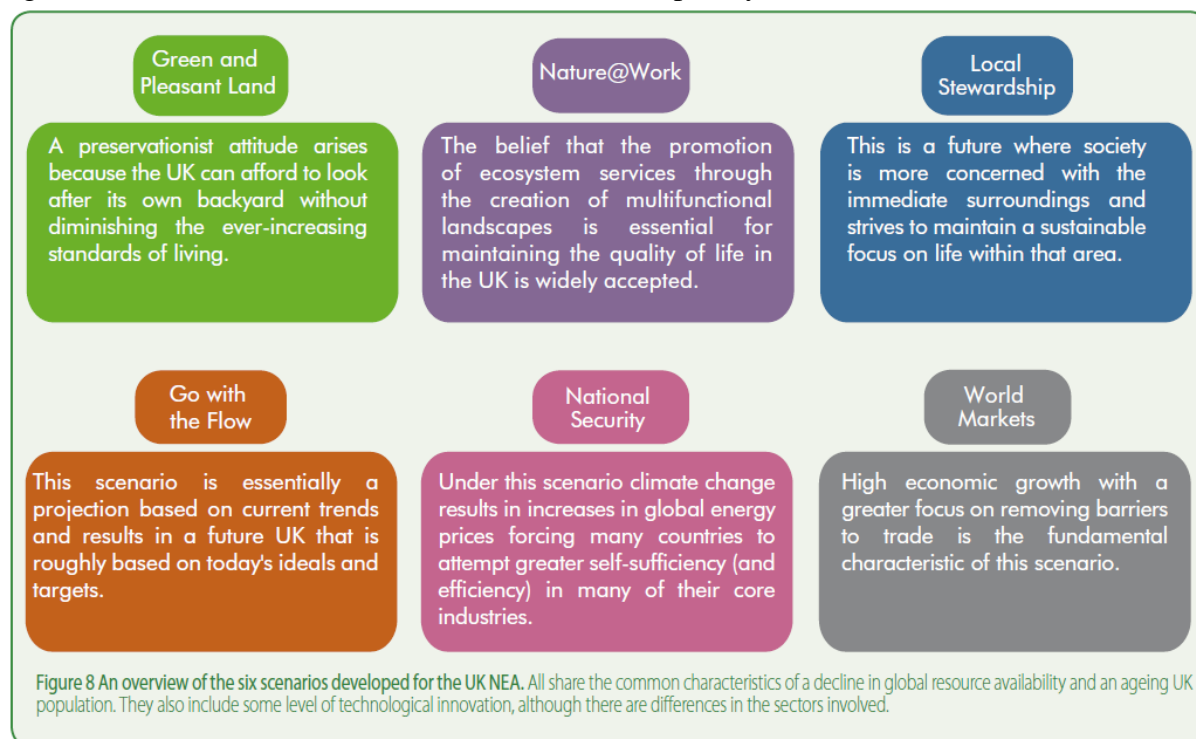
In order to understand what the future might hold, a range of plausible scenarios was developed by the UK NEA, some of which emphasise environmental awareness and ecological sustainability, while others stress national self-sufficiency or economic growth and the removal of trade barriers. Rather than considering four plausible futures generated simply from two dichotomous axes (e.g. a scale axis - local to global, and an environmental motivational axis - pro-active to reactive), as used in the MA, the UK NEA used a morphological approach to exploring a range of scenarios. The method involves constructing a matrix where the columns of the matrix are the direct and indirect drivers, while the rows set out different potential states for each driver (UK NEA, 2011a).

Six storylines employing very different policy priorities were developed:

- Green and Pleasant Land, where a preservationist attitude to UK ecosystems was taken;
- Nature@Work where ecosystem services are promoted through the creation of multifunctional landscapes;
- Local Stewardship, where society strives to be sustainable within its immediate surroundings;
- Go with the Flow, where current trends are assumed to continue, and in which current principles and practices are not radically altered;
- National Security, where there is reliance on greater self-sufficiency and efficiencies; and
- World Markets, where the goal is economic growth and the elimination of trade barriers (UK NEA, 2011a).

Expert judgment and current scientific evidence, where available, was used to link the drivers of change in each storyline to changes in land use and ecosystem services (UK NEA, 2011a).

Figure 14.3: An overview of the six scenarios developed by the UK NEA



Source: UK NEA, 2011a

15. Policy questions

Portugal Millennium Ecosystem Assessment

The ptMA based the analysis of information undertaken in the assessment on the needs and response options for each user group. Users identified priority user needs and prepared a number of questions to be addressed by the ptMA (Pereira et al., 2003). Examples of these questions are listed below per user group. Users also highlighted the importance of assessing the impact of several pieces of legislation on ecosystem services, including the Common Agricultural Policy, the Nitrate Directive and Natura 2000 Protected Areas Network.

Table 15.1: Examples of questions identified by the ptMA user groups

<p>National Confederation of Agricultural Cooperatives and Credit of Portugal, CONFAGRI:</p> <ul style="list-style-type: none"> - How can global priorities be conciliated with national, regional and local priorities? - How do different ecosystem management policies affect farmers and who pays the costs associated with the goods and services from ecosystems? - How can the benefits and costs provided by ecosystem services of agriculture and forest be measured in an efficient way? - In which way the political and legislative instruments (particularly the CAP and the Nitrates Directive) have influenced and could influence the economic activities (agriculture and forest)? - What options and agricultural practices have helped agro-services to support food production and security? - What is the role played by agriculture in wetlands?
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<ul style="list-style-type: none"> - What is the impact of agriculture in areas of the Natura 2000 Network? - What is the efficiency of the water use by agriculture? In which way could it be improved? - How to optimize local and national benefits to populations from agriculture and forest and to reduce the vulnerability of these sectors? - What are the impacts on the soil, water, security, food quality and quantity and human well-being of the different types of agriculture (traditional; biological; transgenic) alone and in coexistence? Which are their costs and benefits? - Could it be possible to assure the non-propagation of GMOs to lands that do not adopt that kind of agriculture?
<p>Institute for the Conservation of Nature, ICN:</p> <ul style="list-style-type: none"> - What is the importance of the ecosystems in each of the services and viceversa? - What is the importance of each of the possible uses (services) of the water domain for biodiversity? And in the long term maintenance of the water resource itself? - What are the effects of indiscriminate licensing (fulfillment of the law but without an integrated management of the entire basin) on each of the services of the river basin? - What are the quantitative effects of the reduction and/or fragmentation of priority habitats on biodiversity and endangered species conservation? - And on the economy of the Portuguese population on a short, medium and large term?
<p>Institute of Water, INAG:</p> <ul style="list-style-type: none"> - What are the natural processes and characteristics that support the integrity of aquatic ecosystems (ex.: magnitude and temporal variability of drainage flows, nutrient cycles)? - What is the relationship between the characteristics of the river basin and the functioning and structure of aquatic ecosystems? - How to apply the approaches, methods and instruments of integrated assessments of aquatic ecosystems? - Which criteria and evaluation methods can be used to evaluate the efficiency of nature conservation and water resources policies on environment protection, including cost-benefit analysis? - What is the economic value of the losses of ecosystem productivity associated with the degradation of the aquatic environment? - Which criteria can be used for the economic valuation of wetlands, in particular on the perspective of the water resources management? - What is the methodology to define targets of ecological quality for modified or artificial water bodies such as dams? - How can the estuarine and coastal sedimentology be used to analyze the recycling processes of specific chemical pollutants? - What methods can be used to forecast the effects of climate change on the structure and functioning of aquatic ecosystems, namely coastal lagoons and estuaries? - What are the implications of the hydrological regime on the maintenance of the physical structure of the environment and on the composition of communities? - How to differentiate between natural and human induced variability of the properties of aquatic ecosystems? - What methodology can be used to determine the reference conditions of aquatic systems, both in terms of physical-chemical characteristics and of the biological component? - What tools are available to quantify significant pressures and impacts on aquatic ecosystems, in the context of defining management priorities? - How can the environmental and resource costs be evaluated on the context of establishing

<p>a policy of water prices?</p> <ul style="list-style-type: none"> - How to apply existing methods to evaluate environmental costs? - What approaches are available to integrate uncertainty in the decision process on the scope of water resources management? - What criteria can be used to evaluate the economic impact of the management measures of the water sector on the other economy sectors?
<p>LPN – League for the Protection of Nature:</p> <ul style="list-style-type: none"> - What is the value of two options: development of environmental tourism certification and rural and nature tourism vs. the increase of the quality of the mass tourism, based on large accommodation and sport infrastructures (hotels, marinas, golf fields)? - What is the value of areas in the National Protected Areas System and in Natura 2000 Network for leisure activities of rural and nature tourism? - What would imply for Portugal the investment on environmental quality of the touristic enterprises and the enforcement of the Land Use Plans on those enterprises? - What are the services currently provided by marine coastal zones in terms of biodiversity and fishing resources? - What are the implications for ecosystems and their users of the application of fishing restrictions in marine zones of great importance to biodiversity and the recovery of fish stocks? - What benefits does the Natura 2000 Network bring for biodiversity in Portugal? - In which way the conversion of arable cultures to extensive livestock production could affect ecosystems? - What will be the ecosystem consequences of the application of the principle of the recovery of the total costs (including environmental costs) of the use of the resource “water”? - How the environmental costs of the use of the resource “water” will be calculated?
<p>Ministry of Agriculture, Rural Development and Fisheries:</p> <ul style="list-style-type: none"> - What has been the evolution of the services of the main ecosystems and of the respective drivers? - What is the economic value of the services provided by ecosystems? - What are the effects of the evolution of agricultural and forest ecosystems on other ecosystems? - In terms of the landscape service, what are the principal ecosystems that should be maintained in the national territory, what is their characterization and what monitoring indicators should be used? - In terms of the biodiversity service, what are the principal ecosystems for the preservation of the wild and domestic biodiversity (habitats and wild species, autochthonous races, regional plant species), what is their characterization and what monitoring indicators should be used?
<p>Ministry of Public Works, Transportation and Housing:</p> <ul style="list-style-type: none"> - What knowledge exists about the most significant services provided by ecosystems that are affected by roadways and railways? - How can ecosystems be evaluated and how to internalize the impacts of infrastructures on ecosystems in taxes aiming to finance conservation of those infrastructures? - What criteria should be considered in the economic valuation of habitats affected by the implementation of linear infrastructures?

Source: Pereira et al., 2003

Millennium Ecosystem Assessment of Spain

The EME tries to answer the following questions:

1. How is biodiversity changing in Spain?
2. Which are the main direct drivers of species loss?
3. Which is the status and trends of the different ecosystem types in Spain in relation to the services they provide to society?
4. Which are the main direct drivers of change of ecosystems and its services in Spain?
5. How do changes of ecosystem services affect well-being of Spanish population?
6. What are the causes of natural capital deterioration in Spain?
7. How effective have been the measures to tackle the degradation of ecosystem services in Spain?
8. How can we communicate to the Spanish population the importance of ecosystem services for their well-being?
9. With which strategies and actions can we initiate a transition process to a socioecological sustainability of Spain?
10. How can we manage the flow of Spanish ecosystem services to ensure the well-being of Spanish population?

UK National Ecosystem Assessment

The key questions addressed in the UK NEA are the following:

1. What are the status and trends of the UK's ecosystems and the services they provide to society?
2. What are the drivers causing changes in the UK's ecosystems and their services?
3. How do ecosystem services affect human well-being, who and where are the beneficiaries, and how does this affect how they are valued and managed?
4. Which vital UK provisioning services are not provided by UK ecosystems?
5. What is the current public understanding of ecosystem services and the benefits they provide?
6. Why should we incorporate the economic values of ecosystem services into decision making?
7. How might ecosystems and their services change in the UK under plausible future scenarios?
8. What are the economic implications of different plausible futures?
9. How can we secure and improve the continued delivery of ecosystem services?
10. How have we advanced our understanding of the influence of ecosystem services on human well-being and what are the knowledge constraints on more informed decision making?

Comparison of the policy questions addressed in the MAES and in the three NEAs

In relation to the policy questions addressed by the three NEAs, the ptMA based the analysis of the information undertaken in the assessment on the list of questions, needs and response options identified by each user groups. Therefore the list of questions is significantly longer than in the EME and the UK NEA and some of the questions are duplicated or overlap between the user groups. The EME and the UK NEA address 10 policy questions each. The

EME has specific questions dealing with biodiversity trends and drivers of species loss. The UK NEA is the only assessment that has a specific question about ecosystem services not provided by UK ecosystems. Even if some of the MAES policy questions are not stated in the same terms in the ptMA and the EME questions, the topics might be addressed to a certain extent by other questions. The UK NEA and the MAES policy questions closely correspond to each other.

Table 15.2: Comparison of the policy questions addressed in the MAES and in the three NEAs

MAES policy questions	ptMA	EME	UK NEA
Q1: What are the current state and trends of the EU's ecosystems and the services they provide to society? What are emerging trends and projected future state of the EU's ecosystems and the services they provide to society? How is this currently affecting human well-being and what are the projected, future effects to society?	Yes	Yes	Yes
Q2: What are the key drivers causing changes in the EU's ecosystems and their services?	Yes	Yes	Yes
Q3: How does the EU depend on ecosystem services that are provided outside the EU?			Yes
Q4: How can we secure and improve the continued and sustainable delivery of ecosystem services?	Yes	Yes	Yes
Q5: How do ecosystem services affect human well-being, who and where are the beneficiaries, and how does this affect how they are valued and managed?	Yes	Yes	Yes
Q6: What is the current public understanding of ecosystem services and the benefits they provide (some key questions could usefully be included in the 2013 Eurobarometer on Biodiversity)?		Yes	Yes
Q7: How should we incorporate the economic and non-economic values of ecosystem services into decision making and what are the benefits of doing so (question to be addressed 2020)? And what kind of information (e.g. what kind of values) is relevant to influence decision-making?	Yes		Yes
Q8: How might ecosystems and their services change in the EU under plausible future scenarios - What would be needed in terms of review/revision of financing instruments?	Yes	Yes	Yes
Q9: What are the economic, social (e.g. employment) and environmental implications of different plausible futures? What policies are needed to achieve desirable future states?	Yes	Yes	Yes
Q10: How have we advanced our understanding of the links between ecosystems, ecosystem functions and ecosystem services? More broadly, what is the influence of ecosystem services on long-term human well-being and what are the knowledge constraints on more informed decision making (question to be addressed to the European Commission (DG RTD and Joint Research Centre) and research community in the context of EU mechanism, KNEU15, and SPIRAL16).	Yes	Yes	Yes

16. Governance

Portugal Millennium Ecosystem Assessment

The ptMA is organized in four groups: the steering committee, the advisory board, the research team and the group of users. The steering committee coordinates all the technical work of the assessment, as well as all the logistic aspects, including preparation of the meetings, and the interaction with the users and the public at large. The steering committee also manages the assessment budget. The advisory board's duties are: to advise the steering committee on the conduction of the Portugal Assessment; to coordinate the review process of the State of the Assessment Report and the Assessment Book. The board is composed by representatives from the research team, by scientists not involved in the research team, by representatives from the users group and by stakeholders not represented in the users group (Pereira et al., 2004).

The assessment was carried out by a research team and by a group of users which are both the primary receivers of the information to be produced and the stakeholders of the ecosystems to be assessed. The research team is composed by over sixty scientists from several fields, including economics, sociology, biology and forest science. The users represent different sectors of the society, including national and local government, non-governmental organizations, agriculture and industry (Pereira et al., 2004):

- Paper Industry Association (CELPA)
- National Confederation of Portuguese Agricultural Cooperatives and Credit, CCRL (CONFAGRI)
- Portuguese Focal Point of the Convention to Combat Desertification, CNCD
- Institute for the Conservation of Nature (ICN)
- Institute of Water (INAG)
- League for the Protection of Nature (LPN)
- Ministry of Agriculture, Rural Development and Fisheries (MADRP)
- Ministry of Public Works, Transports and Housing (MOPHT)
- ExtEnSity Project - local user
- National Park of Peneda-Geres (PNPG) - local user.

Millennium Ecosystem Assessment of Spain

About 60 scientists from different ecological science and social disciplines working in more than 20 research centers and universities have worked under the same conceptual and methodological framework to provide scientific information about the consequences that the changes on Spanish biodiversity and ecosystems are having on the well-being of the Spanish population.

The EME has a General Coordination Team, a Technical Unit and a Communication Unit. Linked to the Technical unit there is an International Advisory Committee and to the Communication Unit a User Group including decision-makers, business, public administrations, NGOs and civil society. The analysis of information was done through thematic and interdisciplinary Working Groups which addressed ecosystems and direct drivers; indirect drivers; biodiversity, services and human well-being; and integration. This was linked via workshops and seminars to the sources of information: network of researchers; national and international data bases and network of projects (EME, 2011).

UK National Ecosystem Assessment

The UK NEA was carried out between mid-2009 and early 2011 as part of the Living With Environmental Change Partnership. It involved over 500 natural scientists, economists, social scientists and other stakeholders from government, academic, NGO and private sector institutions (UK NEA, 2011a).

The UK NEA includes various groups and bodies as part of its governance structure: Co-Chairs of the Expert Panel; a diverse group of academics consisting of natural scientists, economists and social scientists formed the 27-member Expert Panel; the involvement of a wide range of public, private and third sector decision-makers and stakeholders through a User Group; the 300-plus authors involved, managed by a group of Coordinating Lead Authors (largely natural scientists, but including economists and social scientists), were drawn from more than 50 academic institutions, together with representatives from over 15 government agencies, more than 10 NGOs and 11 private sector institutions; each chapter was peer-reviewed by a number of external reviewers; together, the organizations that commissioned the UK NEA - Defra (England), the Devolved Administrations of Northern Ireland, Scotland and Wales (with CCW), NERC and ESRC - formed the Client Group, which provided continual oversight and guidance on the whole process; coordination was carried out by an independent Secretariat based at the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) (UK NEA 2011b).

17. Conclusions

From the analysis of the three NEAs we can conclude that methodologies for the assessment of biodiversity, ecosystems and ecosystem services are significantly different and some harmonization is needed in order to allow comparisons. The selection of ecosystems and ecosystem services in the three assessments was based on the specific characteristics of the country, data availability and user needs and does not follow a common classification.

Regarding ecosystems, information on the characteristics and description of the ecosystems is provided, including data on surface and surface change and geographical distribution. However, the conservation status and trends of ecosystems is assessed in a heterogeneous way for the different ecosystems and across the three NEAs. Information about the status and trends of the provision of ecosystem services by the different ecosystem types is in general provided in the form of a summary matrix including colour codes and arrows, which helps to have an overview and compare the situation across the three assessments. Maps, graphs and tabular data on specific ecosystem services are also provided in different ways across the assessments.

In relation to biodiversity, the three assessments dedicate specific chapters to biodiversity which provide information on the status and trends, main drivers of change and conservation strategies and measures. It is noteworthy that only the UK NEA clearly mentions the use, in some cases, of reporting data from the Habitats Directive. Both the EME and the UK NEA refer to the criteria of the Water Framework Directive as one of the elements to assess the status of freshwater ecosystems. In addition no clear links are provided between the status of biodiversity and the status of ecosystems and ecosystem services.

The way in which biodiversity is considered in relation to ecosystem services is also different across the three NEAs. The EME does not consider biodiversity as an ecosystem service per se, since it underpins all the other services. The ptMA and the UK NEA consider biodiversity as an ecosystem service and assess it like the other ecosystem services. The UK NEA makes the distinction between biodiversity underpinning natural processes and biodiversity in the form of landscapes, seascapes, habitats and wild species.

The three assessments provide detailed analysis of the drivers of change on biodiversity, ecosystems, and ecosystem services. They also include summary tables, which help to compare the situation across the three assessments. However, specific information on the different drivers is more difficult to compare due to the use of different type of indicators, data and units.

The three assessments provide information at the national scale, but also at case study scale, where more detailed information is available in relation to user needs, ecosystem services flows and beneficiaries.

Links with human well-being are connected to the MA in the three assessments. In relation to scenarios, the ptMA and the EME are based on the MA with some adaptations to the national context, whilst the UK NEA takes a different approach based on a matrix with direct and indirect drivers and states for each driver.

Regarding the valuation of ecosystem services the three assessments conclude that more work and research needs to be carried out, mainly in relation to non-market and non-monetary values of ecosystem services.

In relation to the policy questions addressed by the three NEAs, the ptMA provides a long list of questions identified by the different user groups, whilst the EME and the UK NEA provide 10 policy questions. Many of the topics addressed in the 10 MAES policy questions are covered by the ptMA and the EME questions, even if they are stated in a different way. The UK NEA and the MAES policy questions closely correspond to each other.

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