Estimating the Overall Economic Value of the Benefits provided by the Natura 2000 Network

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Final REPORT

by

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(Separate electronic report)

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Main report

1 INTRODUCTION

1.1 Aims, objectives and tasks of the study

This report presents the results of a study by the Institute for European Environmental Policy (IEEP) with GHK, Ecologic Institute, Metroeconomica and EFTEC, to support the European Commission in further developing a methodological framework for assessing the overall economic value of the benefits provided by the Natura 2000 network, carrying out a first assessment of the value of the network, and recommending a way forward for future assessments to support the awareness of the economic co-benefits of Natura 2000 sites and network (see Box 1.1 and Section 2).

Box 1.1: The Natura 2000 network

The pillars of Europe's legislation on nature conservation and biodiversity are Council Directive 2009/147/EC on the conservation of wild birds (Birds Directive) adopted in 1979 and Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive) adopted in 1992. Together, both Directives form the most ambitious and large scale initiative undertaken to conserve Europe's biodiversity, with the implementation of a network of designated special sites - Natura 2000 - lying at their heart.
The establishment of Natura 2000 is at an advanced stage – the nearly completed terrestrial network consists of roughly 26,000 sites and covers almost 18 per cent of the EU territory. It includes terrestrial Sites of Community Importance and Special Areas of Conservation (SCIs/SACs), with an area of 59 million ha, and terrestrial Special Protected Areas (SPAs) with an area of 49 million ha (Natura 2000 Barometer, 2010). For further discussion see Chapter 2.

While the prime focus on the Natura 2000 protected area network is on the conservation and restoration of biodiversity, there has also been an increasing interest in and recognition of the socio-economic benefits of biodiversity (MA, 2005; TEEB 2010, 2011) and of protected areas specifically (Kettunen et al 2009, Stolton et al 2010, Gantioler 2010, Kettunen et al 2011). The recognition and demonstration of the benefits can influence stakeholders' attitudes and support for the Natura 2000 network, attract funding for conservation measures and other investments in and around sites, inform land-use (change) decisions, and help in the integration of protected areas in regional development planning and practice.

The recognition and demonstration of the socio-economic significance of Natura 2000 historically focused primarily on the direct and indirect employment supported by Natura 2000 sites (ten Brink 2002, National Trust, 2006; Hernandez & Sainteny, 2008), and its rural development benefits. Since the Millennium Assessment (MA) and encouragement by The Economics of Ecosystems and Biodiversity (TEEB) initiative (see www.teebweb.org), this approach has been increasingly complemented by the assessment of the wider set of ecosystem services from protected areas. This ecosystem services framework has been adopted within this study - see Box 1.2 for definitions and Chapter 3 for wider discussion of the methodological framework.

Box 1.2 Biodiversity, Ecosystems, and Ecosystem Services

Biological diversity means 'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems' (UN, 1993). The term covers every form of life on Earth (plants, animals, fungi and micro-organisms), the diversity of communities that they form and the habitats in which they live. It encompasses three levels: ecosystem diversity (i.e. variety of ecosystems); species diversity (i.e. variety of different species); and genetic diversity (i.e. variety of genes within species).

Ecosystem means 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit' (UN, 1993). Every ecosystem is characterised by complex relationships between living (biotic) and non-living (abiotic) components (resources), sunlight, air, water, minerals and nutrients: the quantity (e.g. biomass, productivity), quality and diversity of species (e.g. richness, rarity) all play an important role. The functioning of an ecosystem often hinges on certain species or groups of species that perform key functions e.g. pollination, grazing, predation, nitrogen fixing.
*

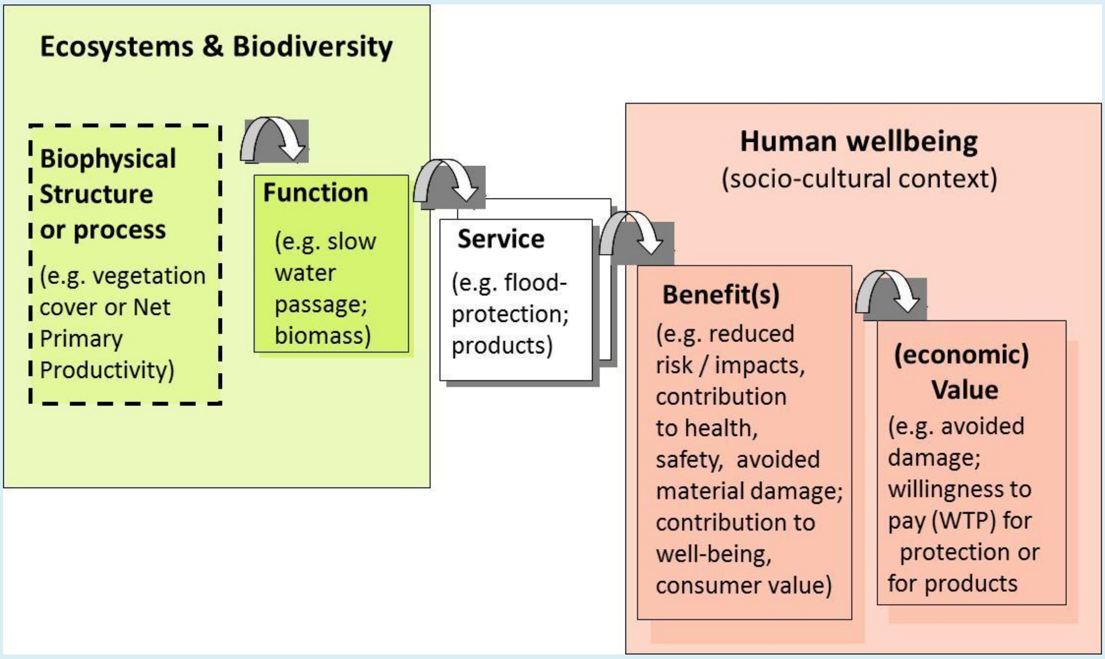
Ecosystem services refer to the flow of benefits that people obtain from ecosystems (MA, 2005a). These include:

- *provisioning services* (e.g. food, fibre, fuel, water);
- *regulating services* (benefits from ecosystem processes that regulate e.g. climate, floods, disease, waste and water quality);
- *cultural services* (e.g. recreation, tourism, and aesthetic, spiritual and ethical values);
- *supporting services* necessary for the production of all other.

To be more explicit, benefits of protected areas include the supply of tangible resources such as water and sustainably produced crops and timber (the 'provisioning services' noted above), and processes that, regulate water and air quality, prevent natural hazards such as flooding and soil erosion, and mitigate climate change through storing and sequestering carbon (the 'regulating services' noted above) (Dudley & Stolton, 2003; Brown *et al,* 2006; Campbell *et al,* 2008). Protected areas also provide 'cultural services', for example by supporting recreation and tourism, and maintaining cultural identity and sense of place (Butcher Partners, 2005; Eagles & Hillel, 2008). These services are underpinned by the role that sites play in supporting the preservation of basic ecological processes (e.g. nutrient cycling), fundamental in maintaining the overall functioning of natural systems (the 'supporting services' noted above). Healthy and well-functioning ecosystems sustained within protected areas can increase not only the range of ecosystem services, but also the resilience of ecosystems to resist and adapt to disturbances (e.g. climate change) also beyond the site level (Stolton *et al,* 2008; Dudley *et al,* 2010).

Many factors influence ecosystem resilience and the likely extent and rate of changes to ecosystem services. Examples include species abundance, level of biomass, quality and structure of natural habitats, and level of genetic diversity. Some services are directly linked to species' detailed composition and diversity (e.g. pollination, many cultural services). Others, like flood regulation, depend on the role of physical structures and processes at the ecosystem scale (for more detailed scientific discussion, see TEEB Foundations, 2010) - see Figure 1.1.

Figure 1.1: Contribution of Ecosystems and Biodiversity to Human Wellbeing



Source: TEEB 2011 and references within; figure adapted from Haines-Young and Potschin (2009) and Maltby (2009)) , Gantioler et al 2011 forthcoming

This report aims to offer an additional evidence base to complement the existing literature, a synthesis of knowledge on the value of protected areas, as well as tools for continuing the improvement of awareness of the many benefits of the Natura 2000 network – for biodiversity, for society and for the economy. An economic evaluation, while only one way of assessing and demonstrating the importance of Natura 2000, has the potential to further support the case for protecting habitats and species - adding the economic dimension to the arguments made on grounds of ecology, intrinsic values of sites and species, and arguments made on the grounds of human, societal and cultural benefits made using other metrics than economic value. On a practical level, some stakeholders may be more responsive to economic evidence than to other metrics and using the metrics of economics may improve the awareness of some policy makers, funders, programme manager and authorities, inside and outside of the biodiversity sphere, of the wider merits of the Natura 2000 network in the EU.

The work included three main tasks:

Task 1) Set out an **economic evaluation approach** to be applied to the quantifiable benefits across the Natura 2000 network, by:

- further **refining the definition of a common typology of benefits** linked to Natura 2000 (developed by Gantioler et al. 2010) and presenting a possible way forward to develop a standardised framework for assessing the value of Natura 2000;
- **suggesting a valuation framework** within which an analysis of benefits should be completed, based on characteristics of the Natura 2000 network;
- **describing the policy context** according to which Natura 2000 sites should be classified (policy-on/policy off scenarios, baseline) before starting to gross and scale up monetary values from a study area to a policy area;
- providing a better **understanding of the spatial provision of benefits** linked to Natura 2000 for a successful scaling and grossing up, and for formulating relevant policies.

This task was based on a review of existing literature and data on the benefits of Natura 2000 and their value, which was used to inform an analysis of alternative approaches to estimating the overall value of benefits, and the key methodological issues to be addressed. In this study we have applied the ecosystem services approach as well as the 'total economic value' (TEV) framework (see Chapter 3) for assessing the economic benefits of protected areas, while recognising that a range of other non-economic methods are also valuable in assessing benefits (e.g. qualitative methods such as Citizens' Juries - see TEEB 2010) and that any overall appreciation of the value of nature needs to combine insights into the qualitative, spatial and quantitative benefits as well as their monetary value. Ultimately, an appreciation of the importance of protected areas would include many criteria and use a range of tools and metrics. The aim of this study has been to gather, combine and analyse existing evidence of economic metrics, in order to present new insights.

Task 2) Apply different approaches to **develop overall, well justified, estimates of the economic benefits** connected with the whole Natura 2000 network.

A range of tools and approaches have been tested – some proving to be 'experimental' (i.e. interesting, but not entirely robust), while other approaches, given the current evidence base, can lead to valuable 'indicative values' (i.e. ball-park values to demonstrate importance). Some are currently more robust than others. The approaches and results are presented in chapters 3 to 6. In all cases there is significant room for improving the approaches and the underlying data.

One approach to valuing the benefits of the network is to assess and aggregate the value of individual ecosystem services it provides. As discussed in later sections, the benefits related to some of the services provided by Natura 2000 are more amenable to EU aggregation than others. Carbon sequestration, and tourism and recreation[1] are the most promising services for economic valuation, given data availability and the nature of the services, though even here there are sources of uncertainties that should not be overlooked (such as the carbon prices to be used in the former and means of differentiating gross and net benefits for the latter). Water provision and regulation, natural hazards regulation and fish provision are also key services that can be demonstrated to offer major benefits, but the fundamental importance of local conditions in determining value makes deriving EU wide total Natura 2000 value estimates using benefit transfer approaches difficult given the current evidence base. Many other services tend to be much less covered in the existing literature and database (see TEEB 2010). For these, the study has aimed to provide useful insights into local estimates and on how to calculate overall values in future analysis, once data become more abundant and robust. Alternative approaches, which do not rely on the valuation of individual services, are also explored – these are based on assessments of the overall value of the benefits of Natura 2000 at the territorial, habitat and/or site level. These offer a useful set of 'indicative' values; again there is a need for major improvement in the evidence base (i.e. move to at least 200 quality base studies) to be able to derive results that start to be truly 'robust'.

Task 3) **Provide recommendations** assessing the progress achieved, identifying further challenges and formulating follow up steps for the Natura 2000 benefits recognition process.

Analysis of the limitations of existing evidence, and the implications for future research, are presented throughout, and summarised in the 'road map' for valuation in the final chapter.

To date, work on benefits of Natura 2000 in Europe has focused mainly on local cases, complemented by a few regional and national studies. While there have been a range of EU wide studies on the benefits of Natura 2000 and the development of a valuation framework (Gantioler et al 2010, Kettunen et al 2009, ten Brink et al 2001), none so far has attempted to provide aggregate monetary values on the socio-economic benefits of Natura 2000 for the EU as a whole. A key value added of this study has therefore been to obtain overall estimates at the EU level (values, numbers of people benefitting) of the benefits of Natura 2000 to the extent currently feasible and to clarify how to improve the benefits assessments to be able to get an increasingly full and robust appreciation of the benefits in the future.

The methodological approach benefited from the involvement of a panel of three peer reviewers, who provided detailed comments and discussion during the methodological development phase, and on the draft final report.

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[1] For tourism and recreation see Bio et al (2011) '*Estimating the economic value of the benefits provided by the tourism / recreation and employment supported by Natura 2000*'

1.2 Structure of the report

Chapter 2 presents the important background on Natura 2000 network, its benefits and the assessments attempted in previous studies.

Chapter 3 presents the overall methodological approach we have applied to estimate the benefits of Natura 2000 network. This introduces the evidence available, and our approach to using it to assess the overall benefits of the network. Key methodological issues related to the benefits assessment, and the approach to addressing them, are discussed.

Chapter 4 provides an overall estimate of the benefits of Natura 2000 network at the EU level, based on the transfer of existing data from Natura 2000 sites.

Chapter 5 provides an assessment of the individual ecosystem services delivered by Natura 2000 network, and their value -focusing primarily on the terrestrial sites

Chapter 6 focuses specifically on the marine environment, with particular focus on food provision related to Marine Protected Areas (MPAs), though also looking at six other ecosystem services.

Chapter 7 summarises the key results and presents the road map for way forward on valuation of Natura 2000 network.

Further information is also provided in Annexes:

Annex 1 includes information on land cover of the Natura 2000 network.

Annex 2 shows carbon sequestration data and the range of steps supporting the assessment of the carbon values.

Annexes 3 and 4 provide further insights on the methodologies used in this study for carbon and for marine.

Annex 5 includes details from selected literature review.

1.3 Definition of key terms: value and benefits of protected areas

While terms are defined in each chapter it is useful to discuss up front what is meant by '**value**' as this is core to the assessment and the meaning of the results. The following terms are used throughout the report to describe and distinguish between the different values associated with the Natura 2000 network:

• Value of Natura 2000 network: a combination of biodiversity value and socio-economic benefits. The biodiversity value is presented in chapter 2, and the socio-economic benefits are used throughout the rest of the report.

• Biodiversity value: role of Natura 2000 network in protecting biodiversity (ie. species and habitats of EU importance) and securing well functioning ecosystems for all species. This is sometimes known as the 'intrinsic value' – see chapter 2.

- Benefits of Natura 2000: socio-economic importance of the Natura 2000 network - the benefits / ecosystem services that support human welfare, whether via the economy or via wellbeing directly.
- Ecosystem services related benefits (actual or potential): Ecosystem service is a generally used as an anthropocentric concept, defined by the presence of beneficiaries/users. Consequently, by definition, a biophysical function / process performed by Natura 2000 sites (eg. water purification) is defined as an actual ecosystem service only when someone is benefiting from it – whether now or potentially in the future.
- Value of benefits associated with Natura 2000 network: estimated economic value of benefits / ecosystem services provided by Natura 2000.

As will be seen in chapter 3 there are a range of methods to ascertain value, and the values derived themselves can be of different types (actually money, avoided costs, potential costs, and welfare values), what they relate to (e.g. for GDP and national accounts, or just welfare benefits) and also very different implications (notably for funding of protected areas) – see Chapter 3 and 7.

2 BACKGROUND: THE BENEFITS OF NATURA 2000 AND THEIR ASSESSMENT

Key Messages

- The prime focus on the Natura 2000 protected area network is on the conservation of the unique and endangered biodiversity in Europe; this includes rare habitats (e.g. cold water coral reefs), species (from keystone species to iconic charismatic species such as the Iberian Lynx) and genetic diversity (e.g. number of endemic species).
- The network comprises 26,000 sites and covers almost 18 per cent of the EU territory. It includes terrestrial SCIs/SACs (approved Sites of Community Importance and Special Areas of Conservation under the Habitat Directive), with an area of 59 million ha (0.59 million km^2), and terrestrial SPAs (Special Protected Areas under the Birds Directive) with an area of 49 million ha (0.49 million km^2). It also includes a growing marine protected area (MPA) network – now at 14.5 million ha[2]: 10 million ha^2 classify as SPAs and 13 million ha^2 as SCIs (note there is a significant number of sites that are both SCI and SPAs). The network is a core element of the wider green infrastructure, which together form a great part of our living natural capital.
- In addition to its biodiversity benefits, the Natura 2000 network provides a range of co-benefits to society and the economy via the flow of ecosystem services (provisioning, regulating, cultural and supporting services); they support policy objectives beyond biodiversity, including climate change mitigation and adaptation, water quality and provision, food provision, jobs and livelihoods, cost savings, science and education, social cohesion and identity.
- The Natura 2000 network, while almost complete at the terrestrial level, has yet to be finalised for marine protected areas, and much of the network (both terrestrial and marine) is still not yet reaching favourable conservation status. More needs to be done to improve the ecological status of the network. A healthier Natura 2000 network will also lead to a higher level of benefits provision to society and the economy as well as increase in the network's resilience to environmental pressures including climate change.
- It is important to assess the benefits of the network and the potential increase in benefits from improving the conservation status (e.g. via restoration), and also the avoided loss of services from avoiding the degradation of the network. This will help to communicate the need for (and benefits of) funding (e.g. public investment), need for instruments to reward benefits provision (e.g. payments for ecosystem services, direct investment, transfers to local sites), help address stakeholder (mis)perceptions on the importance and socio-economic role of the sites, and help integrate the sites into the wider ecological-social-economic fabric of the regions.
- While there is a major new interest in understanding the socio-economic values of the Natura 2000 network and there is a growing range of studies on this, there remains important knowledge gaps that merit being addressed. There is a need for an increased number of more evenly geographically distributed studies on the value of Natura 2000 sites to help inform decision making and ensure due governance of this natural capital.

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2 IP/11/1376: Press Release: Environment: Major expansion of Europe's protected natural areas available via http://europa.eu/rapid/

2.1 The EU Nature Directives and Natura 2000 network – aims and status

2.1.1 The main objectives of the EU Nature Directives

The EU has a well-developed biodiversity conservation policy framework, which has been built up in response to international initiatives such as the Convention on Biological Diversity (CBD) and Bern Convention, and successive EU Environmental Action Programmes. At the heart of the EU's conservation policy framework are the Birds Directive[3] and Habitats Directive[4], which form the main legal framework for the protection of nature and biodiversity in the EU.

The principal aim of the Birds Directive (Article 2) is to ensure that *Member States shall take the requisite measures to maintain the population of the species referred to in Article 1*[5] *at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level.* As such, according to Article 3 they shall take measures to *preserve, maintain or re-establish a sufficient diversity and area of habitats* for all species of wild birds covered by the Directive.

As stated in Article 2(1) the overall aim of the Habitats Directive '*shall be to contribute towards ensuring bio-diversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies*.' Article 2(2) iterates that '*measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest*.'

The general principles and criteria that define Favourable Conservation Status (FCS) are outlined in Article 1 (and summarised in the Box below). In layman's terms, '*FCS can be described as a situation where a habitat type or species is prospering (in both quality and extent/population) and with good prospects to do so in future as well'*[6].

Box 2.1: The definitions of favourable conservation status according to the Habitats Directive

Article 1(e) 'conservation status of a natural habitat means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory referred to in Article 2.

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3 Council Directive 2009/147/EC on the conservation of wild birds (codified version of Directive 79/409/EEC)

4 Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora

5 All species of naturally occurring birds in the wild state in the European territory of the Member States to which the Treaty applies.

6 Assessment, monitoring and reporting of conservation status – Preparing the 2001-2007 report under Article 17 of the Habitats Directive (DocHab-04-03/03 rev 3).

The conservation status of a natural habitat will be taken as 'favourable' when:
- its natural range and areas it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable as defined in (i).'

Article 1(i) 'conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory referred to in Article 2;

The conservation status will be taken as 'favourable' when:
- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.'

To achieve their objectives both Directives require two main types of activities. Firstly, the designation, implementation and management of sites that are particularly important for conserving and restoring EU biodiversity, and secondly, the strict protection of listed species as well as their breeding sites and resting places, wherever they occur. The establishment, protection and management of a coherent network of areas designed to protect the habitats and species targeted by the Directives is known as 'Natura 2000 network'.

2.1.2 The Natura 2000 network

The Natura 2000 network comprises of **Sites of Community Importance (SCIs)**, which are proposed by Member States and assessed by the Commission and European Topic Centre on Nature Conservation according to the needs of nine biogeographical regions[7] (see chapter 2.1.1), in line with the requirements of the Habitat Directive. Once approved as an SCI, they must be designated as **Special Areas of Conservation (SACs)** by Member States under Article 4 of the Habitats Directive (for habitats and species of Community interest). SACs are combined under Article 3 of the Habitats Directive, with the intention of forming 'a coherent ecological network' referred to as the Natura 2000 network. The term 'coherence' is of key importance as the aim of the Directives is not to implement a number of protected sites which are ecological 'islands' that can survive on their own, but as elements of a broader ecological network, including buffer zones or biological corridors, with numerous functional links amongst sites.

Similarly, under the Birds Directive Member States are requested to select the most suitable sites and designate them directly as **Special Protection Areas (SPAs).** Article 4(3) of the Birds Directive refers to the need for SPAs to '*form a coherent whole*

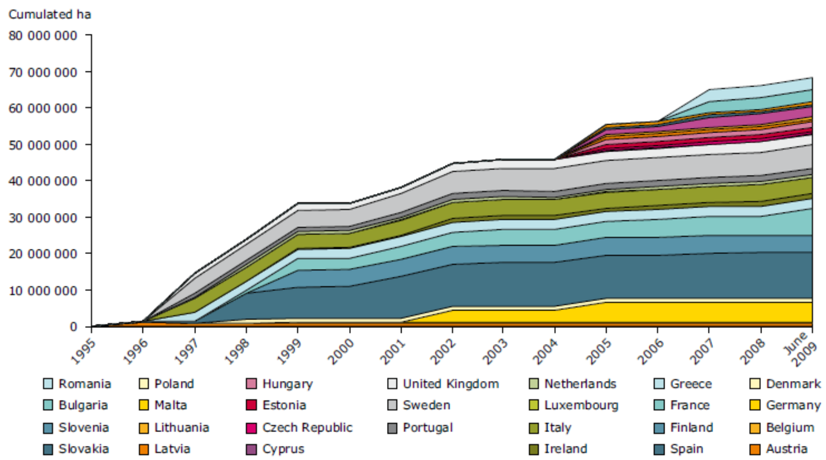
[7] http://ec.europa.eu/environment/nature/natura2000/sites_hab/biogeog_regions/index_en.htm

which meets the protection requirements of these species in the geographical sea and land area where this Directive applies.'

The Habitats Directive also includes specific measures to maintain or restore the coherence of the Natura 2000 network, in particular Articles 3(3) and 10. Although Article 10 provisions are considered to be discretionary for Member States, Commission guidance, produced for DG Environment by IEEP, indicates that in principle Article 10 measures should be taken whenever Member States regard them as necessary to achieve the overall objectives of the Directives (see above), especially for the maintenance or restoration of the species and habitats at FCS (Kettunen et al., 2007). The establishment of Natura 2000 is at an advanced stage (see Figure 2.1) – the nearly completed terrestrial network consists of roughly 26,000 sites and covers almost 18 per cent of the EU land territory. A detailed overview is presented in Annex 1 of this report.

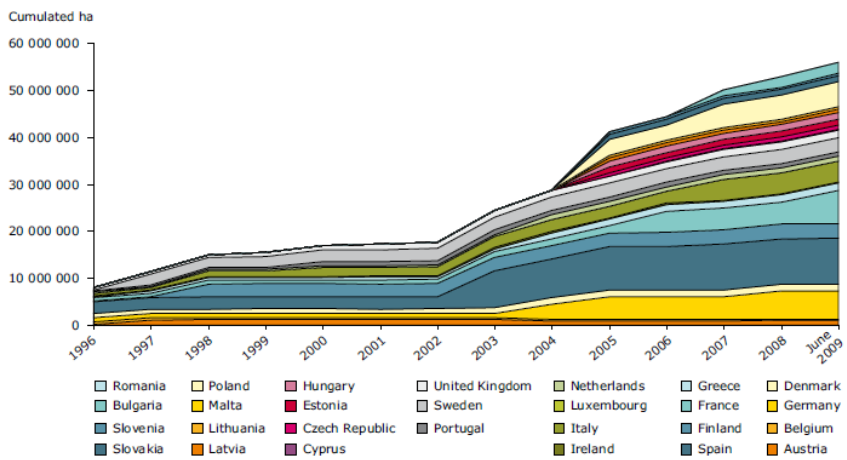
Figure 2.1: Cumulative surface area of sites under the Habitats & Birds Directives

a) Cumulative area coverage of Habitats Directive (SCIs) over time



Source: Natura 2000 EUNIS database (www.eea.europa.eu/data-and-maps/data/natura-2000-eunis-database).

b) Cumulative area coverage of Birds Directive (SPA) over time



- Some 22 419 terrestrial sites are designated as Sites of Community Importance including 1 391 marine sites.
- In all, 5 242 sites are designated as Special Protection Areas including 619 marine sites.

Source: Natura 2000 EUNIS database.

Table 2.1: Areas of the Natura 2000 network

Part A: Special Protection Areas - *update May 2010*

	MS Area (km2)	**Total Number of SPAs**	Total Area (km2) of SPAs	**Terrestrial Area (km2) of SPAs**	**% Total national areas**	**Number of marine sites**	**Marine Area (km2)**	**MS**
AT	83.859	96	9.869	9.869	11,8%			**AT**
BE	30.528	234	3.282	2.967	9,7%	4	315	**BE**
BG	110.91	114	23.217	22.678	20,4%	14	539	**BG**
CY(1)	5.736	29	1.593	1.484	25,9%	3	109	**CY(1)**
CZ	78.866	39	9.684	9.684	12,3%			**CZ**
DE	357.031	738	59.784	43.729	12,2%	15	16.055	**DE**
DK	43.093	113	14.718	2.538	5,9%	59	12.18	**DK**
EE	45.226	66	12.592	6.09	13,5%	27	6.502	**EE**
ES	504.782	599	105.032	103.998	20,6%	33	1.034	**ES**
FI	338.145	468	30.838	25.271	7,5%	66	5.567	**FI**
FR	549.192	382	78.476	43.562	7,9%	73	34.914	**FR**
GR(4)	131.94	202	29.534	27.586	20,9%	120	1.947	**GR(4)**
HU	93.03	55	13.512	13.512	14,5%			**HU**
IE	70.28	132	3.013	2.08	3,0%	71	933	**IE**
IT	301.333	597	43.777	41.053	13,6%	45	2.724	**IT**
LT	65.301	88	6.449	6.278	9,6%	1	171	**LT**
LU	2.597	13	145	145	5,6%			**LU**
LV	64.589	95	6.999	6.479	10,0%	4	520	**LV**
MT(2)	316	13	16	16	5,1%			**MT(2)**
NL	41.526	77	10.125	5.23	12,6%	6	4.895	**NL**
PL	312.685	141	55.228	48.738	15,6%	4	6.49	**PL**
PT	91.99	59	10.438	9.816	10,7%	10	622	**PT**
RO(3)	238.345	109	0	0	0,0%	1	0	**RO(3)**
SE	414.864	531	29.873	25.855	6,2%	108	4.018	**SE**
SI	20.273	27	4.656	4.653	23,0%	1	3	**SI**
SK	48.845	38	12.236	12.236	25,1%			**SK**
UK	244.82	260	18.401	15.276	6,2%	35	3.125	**UK**
EU	**4.290.102**	**5.315**	**593.486**	**490.824**	**11,4%**	**700**	**102.663**	**EU**

(1) The area of the MS and the % corresponds to the area of Cyprus where the Community acquis applies at present, according to protocol 10 of the Accession Treaty of Cyprus

(2) Several marine sites, but no information on marine areas provided in the database

(3) No surface areas provided in the Romanian database

(4) Marine area calculated with GIS due to lack of information in SDF

Source: http://ec.europa.eu/environment/nature/natura2000/barometer/docs/SPA_EU27.pdf

Part B: Sites Of Community Importance - *update May 2010*

	MS Area (km2)	Total Number of SCIs	Total Area (km2) of SCIs	Terrestrial Area (km2) of SCIs	% Total national areas	Number of marine sites	Marine Area (km2)	MS
AT	83.859	168	8.978	8.978	10,7%			**AT**
BE	30.528	280	3.269	3.071	10,1%	2	198	**BE**
BG	110.91	228	33.43	32.838	29,6%	14	592	**BG**
CY(1)	5.736	40	883	754	13,1%	6	129	**CY(1)**
CZ	78.866	1.082	7.854	7.854	10,0%			**CZ**
DE	357.031	4.622	54.342	34.574	9,7%	53	19.768	**DE**
DK	43.093	261	19.319	3.174	7,4%	125	16.145	**DK**
EE	45.226	531	11.321	7.569	16,7%	46	3.752	**EE**
ES	504.782	1.448	131.434	123.508	24,5%	97	7.926	**ES**
FI	338.145	1.715	48.552	43.092	12,7%	98	5.46	**FI**
FR	549.192	1.367	73.556	46.718	8,5%	133	26.838	**FR**
GR(2)	131.94	241	28.076	21.472	16,3%	134	6.604	**GR(2)**
HU	93.03	467	13.973	13.973	15,0%			**HU**
IE	70.28	424	13.56	7.551	10,7%	96	6.009	**IE**
IT	301.333	2.288	45.309	43.055	14,3%	162	2.254	**IT**
LT	65.301	382	9.254	9.083	13,9%	2	171	**LT**
LU	2.597	48	399	399	15,4%			**LU**
LV	64.589	324	7.856	7.294	11,3%	6	562	**LV**
MT	316	28	50	42	13,3%	1	8	**MT**
NL	41.526	146	14.342	3.485	8,4%	14	10.857	**NL**
PL	312.685	823	38.003	34.403	11,0%	6	3.6	**PL**
PT	91.99	96	16.788	16.013	17,4%	25	775	**PT**
RO	238.345	273	32.833	31.48	13,2%	6	1.353	**RO**
SE	414.864	3.983	64.467	56.955	13,7%	334	7.512	**SE**
SI	20.273	259	6.36	6.36	31,4%	3	0	**SI**
SK	48.845	382	5.739	5.739	11,7%			**SK**
UK	244.82	623	29.066	16.657	6,8%	49	12.409	**UK**
EU	**4.290.102**	**22.529**	**719.015**	**586.092**	**13,7%**	**1412**	**132.923**	**EU**

(1) The area of the MS and the % corresponds to the area of Cyprus where the Community acquis applies at present, according to protocol 10 of the Accession Treaty of Cyprus

(2) Marine area calculated with GIS due to lack of information in SDF

Source: http://ec.europa.eu/environment/nature/natura2000/barometer/docs/SCI_EU27.pdf

For the terrestrial sites, the focus will now increasingly shift to effective protection, management and restoration. Related key priorities will be the formal designation by Member States, the setting of conservation objectives for all sites to maximise their contribution to the achievement of favourable conservation status and the putting in place of effective management measures. Though significant additional marine areas have been added to the network in recent years, the key focus in this regard will be on finalising the list of marine Natura 2000 sites and subsequently the shift to effective protection and management (see Box 2.2 for conservation measures). The coming period will be critical for making Natura 2000 fully operational.

Box 2.2: Conservation measures for Natura 2000 sites

The requirements for conservation management of habitats under the Birds Directive are rather general and vaguely defined. Article 3(3b) is of most relevance, but this merely states that the preservation, maintenance and re-establishment of biotopes and habitats shall include amongst other primary measures the '*upkeep and management in accordance with the ecological needs of habitats inside and outside the protected zones*'.

Conservation management measures that must be taken by Members States in SACs to maintain FCS are given in Article 6(1) of the Habitats Directive. This states that *'[f]or Special Areas of Conservation, Member States shall establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans, and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites*'.

Thus Article 6(1) outlines a general conservation regime which must be established by Members States. However, as noted in a European Commission report on Natura 2000 site management (European Commission, 2005a), it is left entirely up to Member States (in accordance with the principles of subsidiarity[8]) to decide upon which measures are appropriate. Furthermore, neither the Birds nor the Habitats Directives define the meaning of 'ecological requirements', and their identification is the responsibility of Members States. However, the European Commission's guidance on Article 6 of the Habitats Directive (European Commission, 2000) notes that ecological requirements should include all the abiotic and biotic requirements needed to ensure FCS (*e.g.* air, water, soil and vegetation). Requirements need to be defined from scientific knowledge for each habitat and species according to the conditions at each site.

The broad types of practical conservation measures that are taken to provide the ecological requirements of habitats and species within Natura sites and across the network as a whole include:

- Hydrological management (e.g. maintenance of high water levels in wetlands);
- Grazing management (e.g. maintenance of low intensity seasonal grazing, using traditional breeds);
- Vegetation planting (e.g. planting of trees to replace losses, such as from logging, disease or fire);
- Vegetation management (e.g. scrub removal on a undergrazed grassland);
- Burning management (e.g. infrequent managed burning to halt ecological succession and reduce risk of less frequent but larger and more damaging fires);
- Invasive species control (e.g. removal of invasive plants, predators, and competitors);
- Predator control (e.g. reductions in artificially raised predator numbers);
- Substrate / soil protection (e.g. measures to stabilise sand dunes from coastal erosion);

[8] The principle of 'subsidiarity' (agreed at the European Council, Edinburgh, UK December 1992), is that measures should only be taken at EU level if it is more effective at treating a problem than measures at national, regional or local level.

- Pollution control / mitigation (e.g. creation of buffer strips alongside sensitive habitats to protect against pesticide spray drift);
- Disturbance management measures (e.g. fencing to protect ground-nesting birds from trampling by visitors).

2.1.1 The biodiversity value of the Natura 2000 network

Natura 2000 offers protection to an ever richer range of European flora and fauna and wildlife habitats, including over 1,000 rare and threatened animal and plant species and over 200 habitat types across the 27 Member States[9], representing Europe's most valuable habitats and wildlife. As such, the European Union recognised its particular responsibility in conserving and also restoring not just those that are considered endangered or vulnerable, but also a wide range of species and habitats that are generally rare, restricted in range or endemic, or very representative habitats of a particular region. As noted in the introduction, it is useful to classify this as 'biodiversity value' – which is not anthropocentric and includes intrinsic value. This value does not need to be measured in economic terms. This compares with the socio-economic benefits, which is anthropocentric (of which we and future generations are the beneficiaries) and stem from the flow of ecosystem goods and services. This, as noted in chapter 3, can be measured in economic terms, as well as in biophysical or indeed other terms (e.g. stakeholder or community preference).

The European Union is characterised by a wide variety of climatic, topographic and geologic conditions which has a profound influence on the diversity of its wild flora and fauna. Overall currently nine biogeographical regions according to similarities in those conditions are present in the European Union: the Alpine, Atlantic, Continental, Black Sea, Boreal, Mediterranean, Macaronesian, Steppic and Pannonian. As a result and despite the continent's small size, it hosts a diverse range of habitats, ranging from forests to open grasslands, rocky habitats and caves to Mediterranean scrub. Table 2.2 provides an overview of the number of habitat types covered and their share of the EU's terrestrial part of the Natura 2000 network.

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9 http://ec.europa.eu/environment/nature/info/pubs/docs/nat2000/factsheet_en.pdf

Table 2.2: Number of habitat types and habitat share of Natura 2000 land cover

Habitat	Number of habitat types covered by Natura 2000	Area in percentages as declared by Member States
Coastal and halophytic habitats	28	16.5%
Coast sand dunes and inland dunes	21	1.6%
Freshwater habitats	19	6.8%
Temperate heath and scrub	12	12.6%
Sclerophyllous scrub	13	4.4%
Natural and semi-natural grasslands	31	12.7%
Raised bogs, mires and fens	12	8.6%
Rocky habitats and caves	14	4.5%
Forests	81	32.3%
Total	231	100%

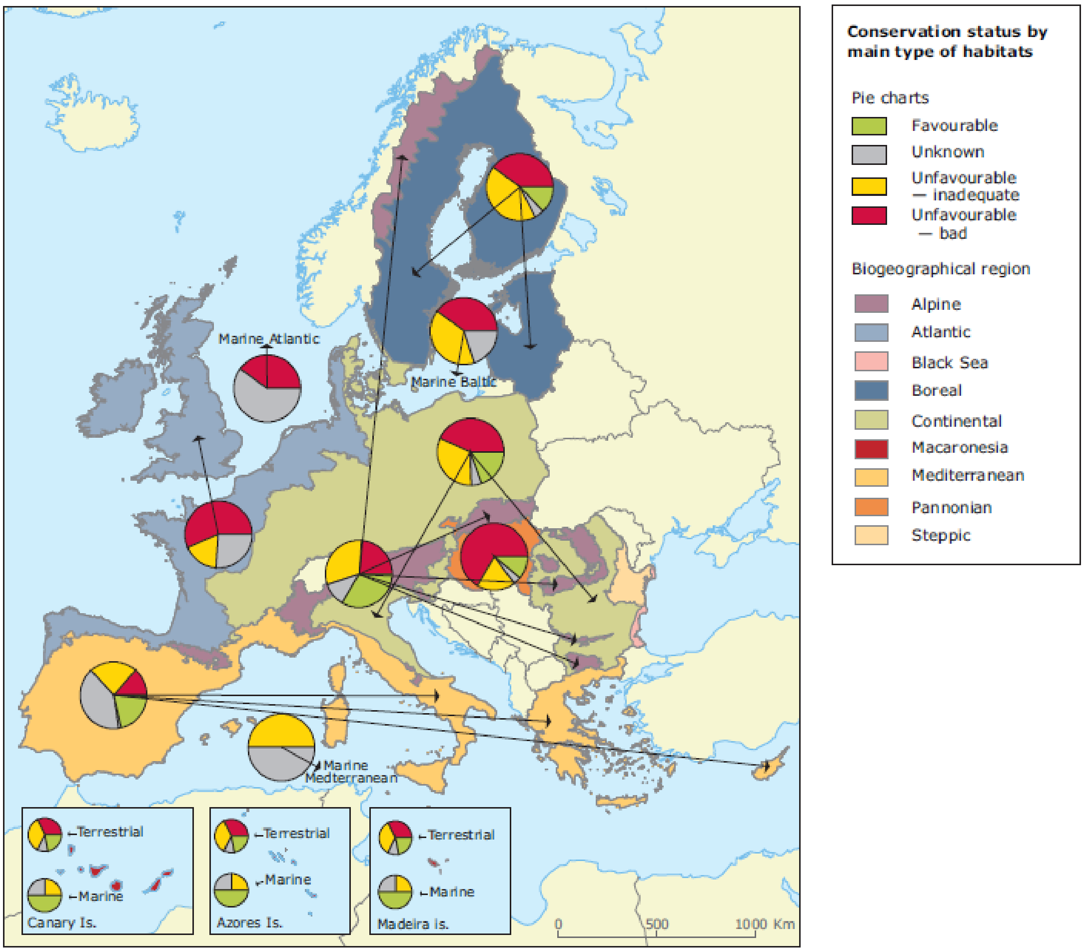
Source: adapted from Mücher et al. 2009, EC 2008

The table above shows that forests not only provide the largest number of Natura 2000 habitat types, but that they also account for 32 per cent of the EU's terrestrial part of the network. However, half of these habitat types are restricted to one or two Member States, for example beech forests in the Italian Apennines or the lush laurel forests on the Canary Islands, Azores and Madeira (EC, 2008). Only a handful of more 'common' forest listed by the Habitats Directive, such as alluvial forests, oak woods and beech forests are present in several countries. However, 67 out of 195 bird species listed in Annex I of the Birds Directive are forest-related, including globally threatened species such as imperial eagle (*Aquila heliaca*), the lesser kestrel (*Falco naumanii*) or the long-toed pigeon (*Columba trocaz*) (EEA, 2008). 26 out of 54 mammal species listed in Annex II of the Habitats Directive, are linked to forest habitats, including priority and flagship species such as the wolf (*Canis lupus* — only some European populations), the brown bear (*Ursus arctos* — only some European populations), the Iberian lynx (*Lynx pardinus*), and the bison (wisent) (*Bison bonasus*) (EEA, 2008).

Also grasslands form a large number of habitat types, ranging from wet and dry grasslands, hay meadows and alpine pastures to arid steppes and wooded pastures (EC, 2008). Dry Natura 2000 grasslands, for example, can host rare examples of orchids such as *Himantoglossum caprinum* and attracts butterflies like the large blue *Maculinea arion* and the scarce large blue *Maculinea teleius*. And also rocky habitats offer shelter to plants such as the ancient king (*Saxifraga florulenta*). And not to mention freshwater habitats such as rivers and lakes, home to critical amphibians such as the yellow-bellied toad (*Bombina variegata*) or reptiles such as the European pond terrapin (*Emys orbicularis*).

The above only provided a short glance at the biodiversity values delivered by the Natura 2000 network. Recent assessments have shown that biodiversity is yet far from being conserved or even restored. Under Article 17 of the Habitats Directive, Member States are obliged to report every six years on their progress in implementing the Directive and the status of habitats and species of Community interest. The systematic assessment covering the reporting period from 2001 to 2006[10] concluded that only 17 per cent of the 701 Annex I habitats were found to be in 'favourable' condition, though this is quite variable across the regions (see Figure 2.2 for map of level of achievement of favourable conservation status for habitats).

Figure 2.2: The conservation status of habitats in the EU's biogeographic regions



Note: How to read the map: in the Mediterranean biogeographical region (see Box 2.1 for an explanation of biogeograhical regions) about 21 % of habitats have a favourable conservation status but 37 % have an unfavourable (bad/inadequate) status.

Source: ETC/BD, 2008; SEBI 2010 Indicator 05.

Source: SOER 2010

The results display regional differences with regard to status. None of the habitat assessments from the Atlantic region (covering UK, Ireland and the Atlantic coasts from Spain to Denmark) were marked 'favourable' (despite occasionally achieving 'favourable' status at a national level). Of nine habitat groups broadly encompassing the habitat types in the Habitats Directive, only three had more than 20 per cent in 'favourable' status, namely rocky habitats, sclerophyllous scrub (i.e. evergreen

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10 COM(2009) 358 final. Composite Report on the Conservation Status of Habitat Types and Species as required under Article 17 of the Habitats Directive. Brussels

shrubs of arid Mediterranean regions) and forest habitats. Those habitats under the greatest pressure were dunes; bogs, fens and mires; grasslands and coastal habitats. The fact that for the EU as a whole, only 17 per cent of the species assessments carried out were considered 'favourable', underlines that significant efforts are still needed in investing in conservation measures and management of the existing network. The Boreal, Marcaronesian (i.e. Atlantic islands off the coast of North Africa) and Alpine regions fare best while the high proportion of 'unknown' in the Mediterranean and Atlantic regions make comparisons difficult. Some species, which have been the subject of conservation measures, such as wolf, Eurasian Lynx, brown bear, otter and beaver have shown signs of recovery but the report notes that these and other species remain a long way from achieving healthy, sustainable populations.

2.2 Existing evidence of the benefits and ecosystem services of the Natura 2000 network

In addition to their crucial role in maintaining Europe's biodiversity, Natura 2000 sites can also provide a range of benefits to society and the economy (Gantioler et al, 2010, Kettunen et al 2009). These benefits often result from **ecosystem services** and include the provision of a number of tangible resources (e.g. water, sustainably produced crops and timber – each provisioning services under the Millennium Ecosystem Assessment nomenclature) and beneficial processes provided and/or maintained by well-functioning ecosystems (MA, 2005) - which lead to regulating services (e.g. climate regulation) and cultural services (e.g. recreation and identity). In addition to the provision of ecosystem services, the network is also important for the intrinsic value of habitats and species it protects, which is an important motivation for the policy (Gantioler et al.2010, Kettunen et al. 2009). The investment in conservation measures and management of the sites as well as the services from the sites also lead to wider benefits – such as job creation and increased locational quality that attract investment.

The variety of ecosystem services potentially provided by the Natura 2000 network (both directly and indirectly) is extensive. For example, Natura 2000 sites often conserve habitat types that provide critically important regulating services, such as water purification and retention (e.g., wetlands), carbon storage (e.g. peat bogs) and protection from erosion and avalanches (e.g. forested mountain areas). The sites also support populations of many other species besides those for which they were designated as a protected area, many of which may be of socio-economic value, e.g. pollinating insects, game animals and fish. Natura 2000 areas are also known to provide a number of ecosystem services related to recreation, education and tourism (cultural services). In several cases Natura sites are furthermore recognised as an important part of local cultural heritage and identity (also cultural services). In addition, the network can provide a range of wider socio-economic benefits (e.g. employment, support of local and regional economy) that cannot be attributed to one single ecosystem service, but rather are influenced by a range of services or relate to on site management activities (Gantioler et al. 2010, Kettunen et al. 2009).

To date, monetary valuation studies of the benefits of Natura 2000 habitat and species conservation are limited in number, scope and approach, making overall evaluations difficult to achieve. An earlier study on the *'Costs and Socio-Economic Benefits associated with the Natura 2000 Network' (Gantioler et al, 2010)* found that gaps in the evidence base made it difficult to present an overall assessment of benefits. However, based on existing evidence and stakeholder recommendations, the authors described a typology of benefits and a standard valuation framework to facilitate assessment of the overall monetary value of Natura 2000 in future. This typology built upon the classification of ecosystem services presented in the MA, repackaged to better address the objectives of Natura 2000, and coupled with a representation of wider socio-economic benefits (e.g. local job creation) and 'additional' benefits associated with the network (e.g. increased ecological resilience, benefits beyond borders).

The standard valuation framework used was based around the structure of Total Economic Value (TEV), tailored to fit the objectives of the network (see Section 3). Gantioler et al identified the need for further primary valuation work, but also underlined that there is considerable scope to assess the benefits of Natura 2000 by transferring existing evidence of the benefits of different sites, habitats and ecosystem services. These two are not fully alternative routes as an increase in primary valuation is critically important for improving the results obtainable by benefits assessment. In addition, the study suggested clearly distinguishing between market value (MV) and indicative value, the latter consisting of consumer surplus and cost-based approaches, when presenting the total economic value of ecosystem services. This approach offers a way to differentiate between values representing 'real money' (market value), 'potential to be real money' (becoming real if markets are set up) and broader 'welfare benefits' (reflecting social perception of benefits).

Another earlier study, led by IEEP in collaboration with WWF and RSPB, developed a '*Toolkit for Practitioners'*, for *'Assessing the Socio-Economic Benefits of Natura 2000' (Kettunen et al, 2009)*. The Toolkit traced out a staged approach which Natura 2000 site managers and other conservationists may follow to assess the benefits generated by their site, and detailed available methodologies for evaluating specific ecosystem services in qualitative, quantitative and monetary terms. This created one input for the current study, and also underlined the importance of having benefits presented in different forms, part due to them being 'fit-for-purpose' (e.g. quantitative benefits of avoided health impacts can be sufficiency convincing), part due to method and data limitations.

As regards the added value of the current study, a key step forward here undertaken is to further look at how to assess the aggregate network benefits and not only the site specific ones. This requires additional reflection as regards scaling up, benefit transfer, and how to address issues of interaction between sites (competition or positive synergy or simple complementarity/additionality) - see Chapter 3. This is complemented by insights gained from a first assessment of the Natura 2000 network's benefits (to the extent current possible given methods, data and resources) and exploration of where additional research is needed and developing a road map for valuation to ensure that an improved appreciation of the value of Natura 2000 can be obtained - see Chapters 4 to 7.

Overall national assessments of the benefits delivered by the network are scarce. However, national studies in the Netherlands (Kuik et al, 2006) and Scotland (Jacobs, 2004) have provided overall estimates of the value of these benefits, while a larger number of studies have examined the value of services delivered by individual Natura 2000 sites. For the site based studies this is explored further in Chapter 4 (and Annex A5[11]) for terrestrial sites and in Chapter 6 for marine sites. In addition, there is a growing literature on specific ecosystem services valuation – Table 2.3 overleaf presents each of the ecosystem services, and examples of assessments, where possible from EU Natura 2000 sites. Chapters 5 presents the assessments for a range of specific ecosystem services. The methodology employed and methodological issues encountered are presented in Chapter 3.

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[11] Table A5.1 in the Annex provides an overview of existing estimates of the value of the benefits of Natura 2000 sites, collated through the literature review undertaken for this study and previous studies (Gantioler et al. 2010, Kettunen et al. 2009). The values identified are expressed on a per hectare per annum basis, and converted into current prices (2011 euro) using the Harmonised Indices of Consumer Prices from Eurostat[11].

Table 2.3: Examples of ecosystem services

Ecosystem service	Ecosystem Service description	Illustrative example
	Provisioning Services	
Food	Natura 2000 can play a significant role by providing fish, directly supporting sustainable agricultural production, such as through organic farming, and indirectly supporting out-of-the-site agricultural production (i.e. through wild pollination, erosion control, water cycling etc.). Moreover, some Natura 2000 sites also provide various wild products, such as mushrooms, berries or game.	Being the first major farming for conservation project in Ireland, The BurrenLIFE Project seems to offer a good 'value-for-money' solution with minimum estimated economic return of 235%. (Rensburg et al,. 2009)
Water quantity	Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow of water. Vegetation and forests influence the quantity of water available locally.	The benefits of freshwater provided by the Pico da Vara/Ribeira do Guilherme Natura 2000 park in Portugal are valued approximately €600,000 per year or €99 per hectare. Cruz and Benedicto (2009)
Raw materials	Ecosystems provide a great diversity of raw materials needed for instance for construction and fuel including wood, biofuels and plant oils that are directly derived from wild and cultivated plant species. There are also important Ornamental resources - Sustainably produced/harvested ornamental wild plants, wood for handcraft, seashells etc. Also ornamental fish.	Non-timber forest products such as rubber, latex, rattan and plant oils are very important in trade and subsistence – the annual global trade in such products is estimated to amount to US$11 billion (Roe et al. 2002).
Natural medicines - Biochemicals & pharmaceuticals	Biodiverse ecosystems provide many plants used as traditional medicines as well as providing raw materials for the pharmaceutical industry. All ecosystems are a potential source of medicinal resources.	80% of the world`s people are still dependent on traditional herbal medicine (WHO 2002), while the sale of medicines derived from natural materials amounts to US$57 billion per year (Kaimowitz 2005).

Genetic/species diversity maintenance	Genetic diversity (the variety of genes between, and within, species populations) distinguishes different breeds or races from each other, providing the basis for locally well-adapted cultivars and a gene pool for developing commercial crops and livestock. Some habitats have an exceptionally high number of species which makes them more genetically diverse than others and are known as 'biodiversity hotspots'. In Europe, Mediterranean Basin with its particularly diverse flora is considered such a hotspot.	Crop Wild Relatives (CWR) are the wild ancestors of crop plants and other species closely related to crops. Hopkins and Maxted (2011) observed that they are likely to play a significant role in securing 21st century food security, because of their potential use in plant breeding to produce crops which withstand adverse impacts of climate change, increasing scarcity of nutrients, water and other inputs, and new pests and diseases.
Regulating services		
Air quality regulation	Trees or other plants also play an important role in regulating air quality by removing pollutants from the atmosphere. Many protected areas located in proximity to highly polluted areas might offer particularly high benefits.	The results of a study (Powe, 2002) have found net pollution absorption by trees in the UK to have reduced the number of deaths brought forward by air pollution by between 65-89 deaths and between 45-62 hospital admissions, with the net reduction in costs estimated to range somewhere between £222,308 and £11,213,276.
Climate/climate change regulation	Ecosystems regulate the global climate by storing and sequestering greenhouse gases. As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues. In this way forest ecosystems are carbon stores. Trees also provide shade whilst forests influence rainfall and water availability both locally and regionally.	In Mecklenburg-Vorpommern (Germany) an area of 29,764 ha (equivalent to about 10% of the area of drained peatlands in Mecklenburg-Vorpommern), has been restored between 2000 and 2008. This means that emissions of about 300,000 tCO_2-equivalents every year are avoided (with an average of 10.4 tCO_2-equivalents per hectare). When assuming a marginal cost of damage caused by carbon emissions of 70 € per tCO_2, the effort to restore peatlands avoids damage from carbon emissions of up to 21.7 million € every year, on average 728 € per hectare of restored peatlands. (TEEB Case study by Förster 2011 and the references within[12])
Moderation of extreme events	Ecosystems and living organisms create buffers against natural disasters, thereby preventing or reducing damage from extreme weather events or natural hazards including floods, storms, avalanches and landslides.	In the Swiss Alps, healthy forests are a major component of disaster prevention. 17 per cent of Swiss forests are managed to protect against avalanches, landslides and rock falls. These services are valued at EUR 1.6 – 2.8 billion per year (ISDR, 2004, Dudley et al., 2010).

[12] http://www.eea.europa.eu/atlas/teeb/peatland-restoration-for-carbon-sequestration-germany-1

Water regulation	Certain ecosystems, such as wetlands or sand dunes, can influence the timing and magnitude of water runoff, regulate and mitigate floods and provide support to recharging of ground water resources.	In Kalkense Meersen Natura 2000 site, in Belgium, it has been estimated that restoration of the original river landscape can bring flood mitigation benefits between EUR 640,000 – 1,654,286 per annum (Arcadis Belgium et al., 2011).
Water purification & waste management	Ecosystems play a vital role in providing numerous cities with drinking water, as they ensure the flow, storage and purification of water. Furthermore, ecosystems such as wetlands filter effluents. Through the biological activity of microorganisms in the soil, most waste is broken down. Thereby pathogens (disease causing microbes) are eliminated, and the level of nutrients and pollution is reduced.	The city of Vienna obtains almost all of its drinking water from mountain springs originating in the Lower Austrian-Styrian high alpine zones. In December 2001, it was the first city in the world to protect its drinking water for future generations under Constitutional Law (Vienna Waterworks 2011).
Erosion control	Soil erosion is a key factor in the process of land degradation, desertification and hydroelectric capacity. Vegetation cover provides a vital regulating service by preventing soil erosion. Soil fertility is essential for plant growth and agriculture and well-functioning ecosystems supply soil with nutrients required to support plant growth.	A study by Ruijgrok et al. (2006) estimated that the value of erosion control in pristine scrubland areas in Europe and in Belgian grasslands was €44.5/ha, at 2008 prices (as in Braat et al, 2008).
Pollination	Insects and wind pollinate plants which is essential for the development of fruits, vegetables and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats. Protected areas play a key role in harbouring wild pollinators which, if located in close proximity to agricultural fields, can help to increase yield and quality of many crops.	Using the methods of Gallai et al. (2009), the United Kingdom's National Ecosystem Assessment estimated the economic value of biotic pollination as a contribution to crop market value in 2007 at EUR 629 million (England: EUR 532 million, Northern Ireland: EUR 28 million, Scotland: EUR 69 million, Wales: unknown) (UK NEA, 2011)
Biological control	Ecosystems are important for regulating pests and vector borne diseases that attack plants, animals and people. Healthy ecosystems can effectively regulate pests and diseases through the activities of predators and parasites. Birds, bats, flies, wasps, frogs and fungi all act as natural controls.	Globally, more than 40 per cent of food production is being lost to insect pests, plant pathogens, and weeds, despite the application of more than 3 billion kilograms of pesticides to crops, plus other means of control (Pimentel 2008).

Disease regulation of human health Regulation of vectors for pathogens	A number of species, such as birds and insects, are known to be vectors of human diseases (e.g. malaria, dengue fever, Lyme disease etc.). In a natural state the functioning of ecosystems keeps the populations of these species under control.	Asian tiger mosquito (Aedes albopictus) in Italy poses a health risk as it is a vector for Dengue and Chikunguna fever and it also has painful stings. Costs related to preventing negative health impacts (e.g. eradication program and communication) amounts to 1.1 million EUR / year (Kettunen et al. 2008 and the sources within).
Cultural & social services		
Landscape & amenity values	People around the world derive aesthetic pleasure from natural over built environment. In particular, people value a specific or exceptional view (landscape values) and appreciate the beauty of nature (amenity values).	In Denmark, houses in natural environments, when compared to similar houses elsewhere, sell for a 25 percent higher price (Dissing, 2002). This is particularly true where they are located within 30-45 minutes of an urban centre (e.g. Danish Lille Vildmose site) (Bostedt et al., 1991).
Ecotourism & recreation	Ecosystems and biodiversity play an important role for many kinds of tourism which in turn provides considerable economic benefits and is a vital source of income for many countries. Cultural and eco-tourism can also educate people about the importance of biological diversity. Walking and playing sports in green space is a good form of physical exercise and helps people to relax.	'Non-market benefits of the Scottish Natura 2000 sites related to recreation were estimated by asking visitors how much they would be willing to pay for using the Natura 2000 sites for recreational activities which resulted in an estimate of around £1.5 million per year related to use values. (Jacobs report to Scottish Executive, 2005)'
Cultural values and inspirational services, e.g. education, art and research	Language, knowledge and the natural environment have been intimately related throughout human history. Biodiversity, ecosystems and natural landscapes have been the source of inspiration for much of our art, culture and increasingly for science.	The Bialowieza Forest, a Natura 2000 site, is the focus of extensive scientific research. Bialowieza village has three scientific institutes and two education centres. The national park runs a Museum and Bison Reserve with highly educated staff and a good level of nature education on offer.' Pabian and Jaroszewicz (2009)

Sources: Building on TEEB 2011b, TEEB 2010, MA 2005; Kettunen et al 2009; Balmford et al 2008; TEEB Foundations 2010a

3 METHODOLOGY FOR ESTIMATING THE OVERALL VALUE OF BENEFITS

Key Messages

The assessment of the value of the benefits of Natura 2000 is based on combining the ecosystem services framework of the MA as well as the Total Economic Value (TEV) categorisation of use and non-use values. This framework captures only the value of Natura 2000 from an anthropocentric viewpoint – i.e. the benefits that sites provide to support human wellbeing. Biodiversity also has an intrinsic value that is independent of human thoughts and values (i.e. its biodiversity value). However, given the very different nature of these two values and the particular need to assess and communicate the economic value of benefits to reach the non-biodiversity community, the assessment aimed at providing economic insights and evidence to complement the biodiversity value of and rationale for the network, as well as the wider moral rationale of non-anthropocentric benefits. The assessment also recognises that non-monetary assessments of the importance of Natura 2000 are also necessary, and the results of this assessment should be seen as complementary to these, rather than competing with them.

The valuation challenge

- Assessing the value of Natura 2000 is a non-trivial exercise for site level assessments; doing an assessment for the network is yet more ambitious.
- **Different tools exist for different benefits types**: some build on ***market prices*** (e.g. food); others use ***avoided costs*** (e.g. avoided costs of water treatment, i.e. avoided 'replacement costs' and avoided costs of flood damage); ***revealed preference*** methods can be used to assess other values (e.g. travel cost for recreational valuation) and ***stated preference methods*** can be used to assess a wide range of benefits (and are especially useful in valuing cultural services, though are generally far less good for regulating services, given that the public is less familiar with biodiversity functions than in benefits/value for them). Each methods pose different challenges, which can affect the valuation estimates; for certain issues, more than one method can/should be used to facilitate comparison.
- Site specific studies – while they are increasingly being undertaken – are still relatively few (around 25 studies and 35 values have been found and used in this current study) and to develop EU wide estimates significant use of **'benefit transfer'** (increasingly known as "**value transfer**") techniques is needed. Here the values of one site are 'transferred' to another. Benefit transfer needs to take due account of site/country/habitat differences and make appropriate adjustments, where possible (e.g. to take account of differences in income per capita). The broader the base of studies from which values can be taken, the more likely benefit transfer will be a robust technique.
- **Presenting results in context:** The use of different tools and benefit transfer approaches adds uncertainties to the results, which should be presented as ranges. Transparency is needed as regards assumptions and approaches used, and the results need to be viewed in this context. Some results will offer valuable illustrative 'ball park' estimates, others will be 'experimental'; a range of methods have the potential to offer robust results, but whether this is so now depends greatly on the available base data on site values.

Key methodological issues

- **A key issue relates to the distinction between the gross benefits of Natura 2000 sites**

(and their ecosystems and biodiversity) and the incremental benefits of the Natura 2000 designation (and its associated conservation/management measures). The former will be larger than the latter. The extent of the difference will depend on the pressures facing the site and the conservation measures taken. While not the focus of this study, a comparison of benefits and costs (e.g. of management), should be clear whether comparing 'like with like', or not, and be explicit as to the meaning of the comparison.

- Furthermore, the benefits from one site may come at the expense of another site (e.g. displacement of tourism from one site to another) or other destination (e.g. displacement of tourism from a museum to a Natura 2000 area). There might also be positive synergies where promoting the provision of ecosystem services at one site might lead to benefits at another. Furthermore, promoting connectivity of the network can improve resilience and safeguard (in places increase of) the provision of services from a range of individual sites. Assessment of the benefits at the regional, national and EU levels will need to take both substitutability and synergy issues into account.
- **Opportunity costs and trade-offs of services within Natura 2000** - Particularly in assessing the net benefits of Natura 2000 designation, it is also important to recognise that Natura 2000 status may lead to a reduction of the delivery of certain services, such as food provision – e.g. if Natura 2000 designation reduces agricultural production by promoting more extensive management practices; the allocation of compensation or incentives such as Payment for Ecosystem Services (PES) can help address trade-offs and help avoid or resolve conflicts. On the other hand, it can positively impact the provision of goods outside a site (and indeed, over time, on the site itself) by supporting services such as biological control and pollination and thus affect the future provision of goods. The loss of such services can also result in the need for costly human-made solutions further affecting the net gains.
- **Spatial variations in benefits and values** – To be robust and credible, estimates of the economic value of Natura 2000 need to be based on an understanding of variations between and beyond sites, the services they deliver, and spatial variations in the value of these services (e.g. whether they are local, nation, global), the 'distance-decay' function of the benefits, the different geographic conditions (rainfall, sunlight), the existence of substitute sources of services (e.g. rivers, aquifers for ESS water supply), population proximity and socio-economic characteristics. Successful application of benefit transfer methods depends on an understanding of the characteristics and services of both the study site (that for which a value is available) and the policy site (that to which benefits are being transferred) – which includes both the biophysical (i.e. functions and services) and the socio-economic (beneficiaries).
- **Non-linearity and thresholds** - Service values are not a simple linear function of the area of an ecosystem. Non-linearity may occur as a result of threshold effects, interrelations between sites and across ecosystem services, and because the value we place on a resource increases as it gets scarcer.
- **Aggregation and scaling-up** - Upscaling gives rise to some important methodological challenges, such as how to interpret extraordinarily high benefit estimates for particular sites, and how to fill in gaps in available evidence. Similarly, adding up benefits that flow over time creates a challenge in how best to aggregate these values; which discount rate to use influences the answer, what the value represents and related ethical issues.
- **Avoiding double counting** - In aggregating benefits, care needs to be taken to avoid double counting, which is a risk where one benefit estimate potentially overlaps with another (e.g. pollination services should not be counted both in pollination and in food

provision).

- **'Ecological knock-on or ecological multiplier effect'** - It also needs to be emphasised that many of the complex interactions between ecosystems and the services they provide are not yet well understood. The avoided deterioration or conservation and restoration measures undertaken due to designation might have multiplying effects across services which are not yet recognised and valued (e.g. potential non-linearity between supporting services and other services).

The above methodological issues and limitations underline that valuations need to be done with care, using a transparent approach and being honest as to where current data and tools can give robust, indicative and illustrative answers that are order-of-magnitude correct, and where analysis is only experimental.

The following chapter presents the overall methodological approach applied by the authors. It outlines the current discussions on biodiversity valuation relevant for this study and provides insights into the methodological decisions taken.

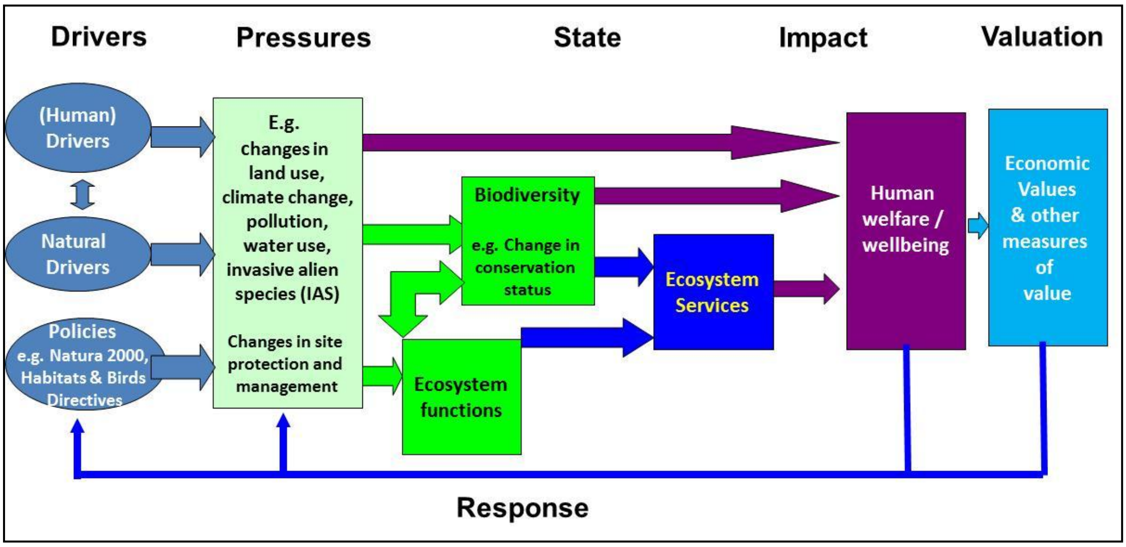
This particularly refers to the following key issues.

1. General methodological framework (see chapter 3.1)
2. Valuation methodologies (see 3.2)
3. Aggregation approaches (see 3.3)
4. Policy scenarios (see 3.4)
5. Spatial variations (see 3.5)
6. Non-linearity and thresholds (see 3.6)
7. Aggregation and scaling up (see 3.7)
8. Variations in estimation methods (see 3.8)
9. Avoiding double counting (see 3.9)
10. Trade-offs and positive synergies (see 3.10)
11. Discounting (see 3.11)

3.1 Methodological Framework

An **ecosystem services approach** forms a basis for assessing the benefits delivered by the network, and to examine their value. By protecting Natura 2000 sites and requiring conservation action, the network should enhance the functioning of ecosystems, which in turn deliver benefits to society and the economy (Figure 3.1).

Figure 3.1: Benefits of Natura 2000

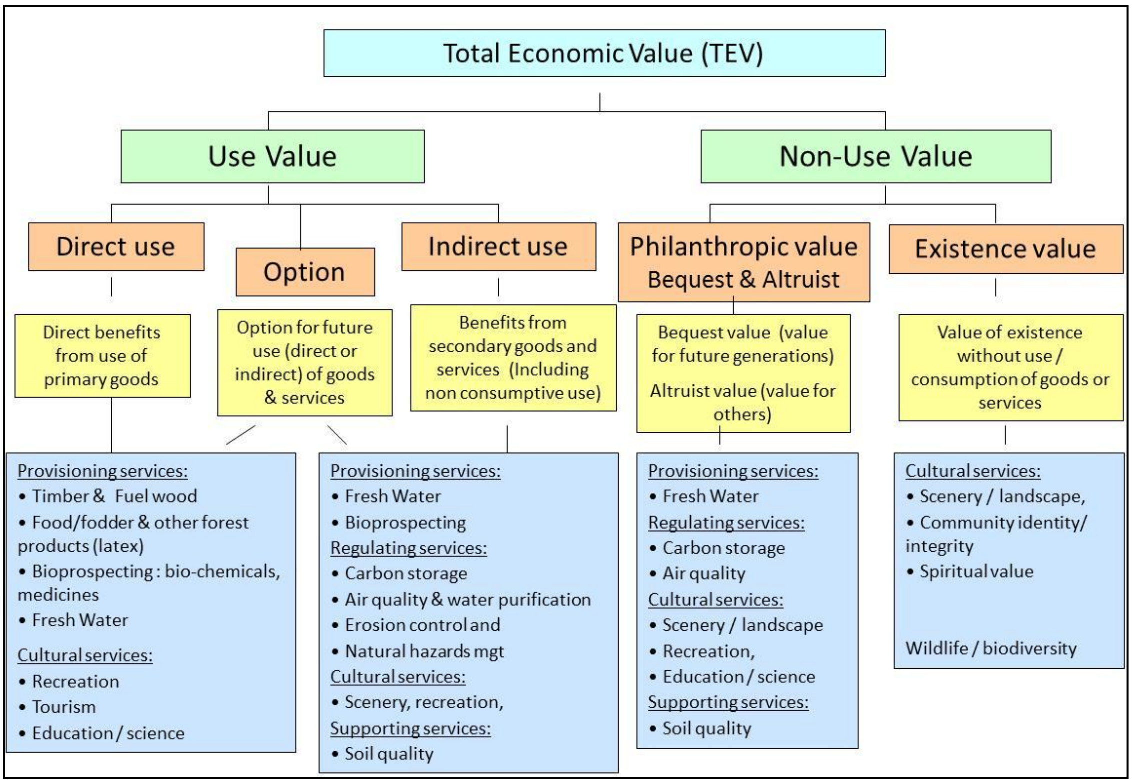


Source: Adapted from Braat and ten Brink et al (2008)

The Millennium Ecosystem Assessment (MA) (2005) provided a framework for categorising, assessing and valuing the services delivered by ecosystems. According to this framework, sites can deliver a range of provisioning, regulating and cultural services that enhance human welfare. These are underpinned by supporting services, which benefit people indirectly, and it is recommended at this stage not to value them separately to avoid double counting.

To examine the overall value of the multiple benefits delivered by Natura 2000 sites, we employ a **Total Economic Value** framework. An illustration of this framework is given in Figure 3.2. For Natura 2000 sites, values result from direct use or management (for example in the provision of food, fibre, fresh water and genetic resources, as well as cultural uses such as recreation) as well as their indirect use (not attributable to few specific management measures or direct use of the site - for example in regulating air, water and climate). In addition, people derive non-use values from the existence of sites and their protection for future generations, which have been defined as nature benefits. There can be an element of ‘intrinsic value’ in the existence value, but this remains a (generally small) anthropocentric element. The full intrinsic value, or biodiversity value, is a value that is not anthropocentric, but which reflects biodiversity for itself. This is more a moral issue, than economic, even if the term ‘value’ is used.

Figure 3.2: The Total Economic Value (TEV) framework in the context of Natura 2000

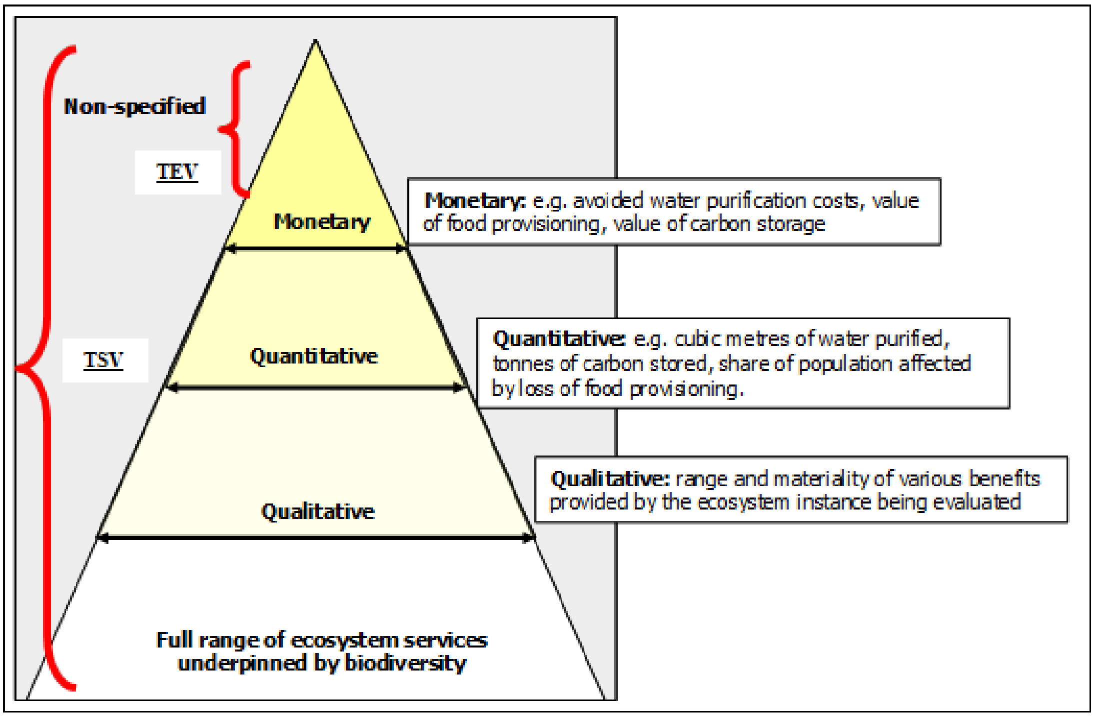


Source: White et al, 2011, adapted from Kettunen et al (2009), adapted from Pearce & Moran 1994

The TEV framework often leads to the interpretation that all values have been considered; it, however, does not include (in practice) those values which are difficult to monetise and (from a conceptual perspective) those formally outside of monetisation (i.e. full intrinsic value). In the assessment of territorial ecosystem services carried out for England (O' Gorman and Bann, 2008) as well as in TEEB (2009), the authors refer to Total System Value (TSV), which implies that economic approaches need to be complemented by other methods to estimate TSV (see figure below).

The total value of the Natura 2000 network (TSV) can be represented by a combination of monetary values, quantitative numbers and qualitative insights (and un-knowns), with generally less information and insight being available at the monetary level (TEV), and a broader view at qualitative level. This is illustrated in the 'benefits pyramid' below.

Figure 3.3: The benefits pyramid and Total Economic Value versus Total System Value



Source: Gantioler et al. 2010, adapted from TEEB 2009

Because resources are not available for original valuation studies of Natura 2000 sites, this assignment involves the development and application of benefit transfer methodologies, using existing valuation evidence of the benefits of Natura 2000 sites as a basis for estimating the benefits of the network as a whole.

Benefit transfer (see Box 3.1) involves the application of values obtained in one context (the 'study site') to estimate the value of benefits in another context (the 'policy site') (EEA 2010). It provides a cost-effective means of deriving overall value estimates, where there are gaps in evidence, and where there are insufficient resources to conduct original valuation studies. However, benefit transfer needs to be applied with great caution, taking care to ensure that the values used are robust, relevant and applicable to the policy site.

Box 3.1: Benefits or value transfer

'Benefit or value transfer' is a method of estimating economic values in the study location (e.g. a site in the Netherlands) by using values already developed in other studies (e.g. from a site in the UK). It is a pragmatic way of dealing with information gaps given resource (time and money) constraints that prevent an original study being undertaken for the site of interest. This is important as there are rarely enough resources available to conduct a primary (or site-specific) valuation study for every site, ecosystem, service or benefits/cost being assessed.

Benefit transfer is not a new concept and can be considered a practical solution to resource constraints. The basic rationale is that there may be sufficient commonalities in different areas to allow values from one area to be transferred to another. However, this needs to be done with care as values can vary widely depending on local specificities.

The conditions which determine whether benefit transfer can provide valid and reliable estimates include:

- the commodity, issue or service being valued is very similar at the site where the estimates were made and the site where they are applied;
- the populations affected have very similar characteristics, and;
- the original estimates being transferred must themselves be considered to be reliable.

There is some scope to factor in differences (e.g. income, environmental conditions) when making the transfer and a range of tools are available (TEEB Foundations, 2010; EEA, 2010) including the following:

- Unit benefit transfer – e.g. multiplying a mean unit value (per household or per hectare) from a similar site by the quantity of the good/ service at the site being assessed.
- Adjusted unit benefit transfer – as above, but adjusting for site characteristics (e.g. income, population levels / beneficiaries, or other factors that affect ecosystem functions (e.g. insolation, precipitation levels).
- Value function transfer – e.g. use a value or demand 'function' from a set of sites (e.g. for travel cost) where the unit values are estimated as a function of population, average income etc. and apply it, with to the new site, with the values of the explanatory variables of that site.
- Meta-analytic value function transfer: where a value function is developed from multiple site values (and their parameters). Carrying out a meta-analysis, following certain statistical principals to construct the value function, allows a more flexible and representative value function to be developed that can builds on and respond to a wider set of site characteristics and valuation methods.

It should be noted that some of the values used for a benefit transfer may change over time. For instance, carbon prices are expected to rise over time, reflecting a tightening of policy ambitions, which in turn reflect a need for actions and the increasing appreciation of likely damage from non-action (note that the marginal damage costs can be the basis of carbon prices; others carbon prices focus on the cost of action; yet others on market prices, for example within the EU-ETS).

WTP will also generally increase in line with income (here measured by GDP/capita in purchasing power parity (PPP)[13] terms – which can be calculated nationally, or better yet at a regional or local level). An assumption of linear relationship between WTP and income can be considered defensible and pragmatic, and was *de facto* used for most of the services in this project. A 'linear relationship' here means that e.g. a 10 per cent increase in income per capita is taken to imply a constant per cent increase in WTP; this could be 10 per cent if, in economic terms, the 'elasticity' WTP is taken to be one. Future country analyses may wish to use different rates for scenarios and sensitivity analysis, and can build on either meta-studies that can help provide elasticities (changes of demand related to income or price, and changes in demand lead to changes in value) etc. In practice elasticities will be below one, even considerably below 1 (e.g. 0.5) and sensitivities and ranges will be valuable to help present the uncertainly transparently.

[13] Purchasing power parity between two countries, A and B, is the ratio of the number of units of country A's currency needed to purchase in country A the same quantity of a specific good or service as one unit of country B's currency will purchase in country B (World Bank, 2008b)

Note that cross country benefit transfers are not needed if there is sufficient domestic data; at this stage this is not yet the case for Natura 2000.

See chapter 4 and 5 for approaches used in this project, as well as the recommendation in Chapter 6 as regards research needs for a widened set of base studies so as to reduce the uncertainty in benefit transfer.

Source: building on White et al, 2011 in TEEB 2011, TEEB 2010 and EEA 2010. Other useful references include Navrud and Ready (2007)

A variety of different estimates of the benefits provided by the Natura 2000 network are available. However, the evidence is fragmented, relating to a minority of sites, regions and services, and employing a variety of different valuation methods and assumptions.

Because of the gaps in the evidence, providing an overall assessment of the value of the benefits of Natura 2000 requires scaling up from a relatively limited evidence base, employing a number of assumptions. There is no one correct way of undertaking such an analysis, and we have tested a series of different approaches to arrive at a range of different benefits estimates.

The approach builds on the evidence on the value of benefits delivered by different sites, habitats and services available in the literature, as well as on the team's experience in benefit assessment.

3.2 Introduction to different approaches to value estimation

The different services delivered by Natura 2000 benefit society in a variety of ways, and can be captured using different valuation methods (See also Annex 4, as well as TEEB, 2011 chapter 4; and TEEB, 2010). For example:

- **Market prices** can be used to measure the value of those services provided by Natura 2000 sites that have direct market value, including provision of food and timber. They can also potentially be applied to some regulating services (e.g. to value reductions in damage to property caused by flooding).
- **Avoided costs** can be used to assess the value of some regulating services. Examples include avoided costs of water treatment (due to water purification services) or avoided expenditures on flood defences (due to water regulation services). A distinction can be made between the use of 'replacement costs' as a method and avoided damages (e.g. expected damage function approach). These needs to be used with caution as they use costs as a proxy for benefits, and in the former there are different replacement cost options with different prices (e.g. replace natural water purification with pre-treatment will give a different answer, than using bottled water as a substitute).

- **Revealed preference methods** are based on directly observing the individual choices related to the ecosystem services being valued that take place in already existing markets. For instance, **the travel cost method** is used to value recreational visits to sites, by taking account of the travel time and expense incurred by visitors
- **Stated preference methods** are capable of valuing a wide range of ecosystem services. They involve directly asking members of the public about their willingness to pay to secure an environmental change and the services it delivers. They are the only means of estimating existence values (the benefits that people derive from simply knowing that biodiversity is protected). They include the contingent valuation method (CVM) and the choice experiment method (CEM).
- **Economic impact assessment and multipliers:** understanding how the money associated with the decision to visit the site is spread across beneficiaries directly (e.g. site entrance fees, shop, possible hotel stays, restaurant, travel, etc.), how it subsequently flows through the economy as one sectors purchases the outputs of another (e.g. hotel paying for purchase of food and drink, laundry services etc.) and creates added value and supports jobs at each stage. An input output model is a helpful tool to clarify the interactions and identify not just direct employment but also indirect and induced employment (see Nunes et al, 2011; GHK et al, 2007)

The table below summarises the role of these different valuation methods in assessing the value of different services delivered by the network (see also Chapter 4 for which tools were used in which studies that formed the basis of the site based scaling up assessments).

Table 3.1 Applicability of Methods for Valuing Different Ecosystem Services

Ecosystem Service	Market Prices	Avoided Costs	Travel Cost	Stated preference methods
Provisioning Services:				
Food	**			*
Fibre and Fuel	**			*
Genetic resources	**			*
Fresh Water	**	**		*
Regulating Services:				
Air quality	*	*		**
Climate regulation	**	**		*
Water regulation	**	**		*
Erosion control	**	**		*
Water purification and waste treatment	**	**		*
Disease regulation	**	**		*
Pest regulation	**	**		*
Pollination	**	*		*

Natural hazard regulation	**	**		**
Cultural Services:				
Recreation and ecotourism	*		**	**
Spiritual, religious and existence values				**
Aesthetic and landscape values			*	**

*Source: Adapted from GHK et al. (2010) * relate to level of applicability of the valuation method. ** highly applicable; * applicable to some extent; - not applicable*

Many of the studies of the benefits of Natura 2000 do not involve original valuation work but use **benefit transfer** (see chapter 3.1) to assess the value of services delivered by Natura 2000 sites (see also Box 3.2 on value, prices and costs).

The current study has compiled and analysed evidence of the value of the different services delivered by the network based on a variety of these different valuation methods, including existing evidence using benefit transfer techniques.

Box 3.2: Values, Prices and Costs

A lot of confusion can arise from the use of the related but different terms of 'value', 'price' and 'cost'. They mean different things, though are sometimes taken to be equivalent when communicating key messages. Also, it is sometime overlooked that different models and methodologies lead to results presented in different terms (values, prices, or costs), and these may not be comparable. It is important to underline that:

- **Something of value does not need to have a cost or a price in the market; but**
- **Estimating an economic value does not mean putting a price tag on the environment**
- **Demonstrating that something has value, however, does not mean that it can be bought or sold and hence commoditised.**
- **Exploring the economic value is one of many ways of assessing the role and importance of nature. To develop a full picture a mix of tools and measures should be used.**

There are a range of methods to ascertain value, and the values themselves can be of different types – from real market values that can feature in companies' 'bottom lines', national accounts and GDP, to values representing wellbeing, which are meaningful at a social level, but invisible to the cash economy. To be more precise:

- **Some values are reflected in 'real money' transactions:** 'cash-in-hand', i.e. that can be seen in bank accounts and national accounts – e.g. spending on products (sustainable forestry or agriculture production in Natura 2000), measured using market price`s (taking subsidies into account) and tourism spend in sites or related to visits (although these expenses have not been included in the benefits estimates, as they reflect a consequence of rather than a measure of the values that people derive from visits to the sites).
- **'Real value' – avoided real costs:** e.g. the value of water purification is real money in the sense of avoided real costs (e.g. to water company or drink company) and can influence companies' profitability and hence GDP, but is not (currently) visible in accounts nor is

the focus of market transactions – apart from where the water purification service benefits is captured via a payment for ecosystem service (PES) scheme.

- For carbon storage, there is not yet a market that pays for carbon storage in protected areas, so the values assessed are real in terms of avoided cost of damage, but not yet real in terms of 'money in pockets', or directly noticeable in GDP statistics.
- For flood control, again generally there are no PES schemes to make the value real in accounts and market transactions. The value perceived is typically the value of avoided costs – avoided damage to assets and loss of wellbeing, and the benefits go to those holding the assets that do not get damaged, or those whose wellbeing is not compromised.
- On recreation, benefits are real but these are **welfare benefits** (i.e. type of 'consumer surplus') and not real in cash terms, with the exception of paid recreation, the often considerable sums that flow to equipment and goods for recreation, and transport and related time costs. The value to the beneficiary can be estimated at least partly through 'revealed preference techniques' (e.g. travel cost method). The value people ascribe to nature is partly reflected also in house prices (these tend to be higher near nature) and assessable via 'hedonic pricing methods'.
- Individuals also value (in the psychological sense) nature – e.g. landscape, charismatic species – and the value can be assessed directly via 'stated preference methods' – though this does not pick up the value to future generations or the wider intrinsic value of nature.

3.3 Assessing Overall Benefits - Alternative Methods

The study explored a range of different methods to assess the overall value of the benefits of Natura 2000 sites and to aggregate them to assess the overall benefits of the network :

1. *Ecosystem service based* – This approach involves overall assessment of the value of the individual services that Natura 2000 delivers - attempting to quantify service delivery for each type of service and aggregate across the network. This has been found to be more feasible for some services (carbon and recreation, for example) than others (pollination, natural hazards, water purification) given the site specificity of services and data availability. The feasibility of estimating values for different services is discussed in more detail in Section 5. Different methods were used for different services.

2. *Territorial based* – Estimates are available of the value of benefits delivered by Natura 2000 in different EU regions, such as the Netherlands and Scotland. The scope to extrapolate from these estimates to assess the possible scale of benefits across the network as a whole was explored.

3. *Site based* – A variety of studies provide estimates of the overall value of services and benefits delivered by particular sites. These can be used as a basis for assessing the overall value of benefits delivered by all sites across the network.

4. *Habitat-based* – Data is available on the areas of different habitats protected by the network. By reviewing estimates of the value of ecosystem services provided by different habitat groups (e.g. forests), estimates can be made of the overall level of benefits provided by those groups at EU level. This could also include a land use approach in order to particularly inform policy developments in a certain area (e.g. agricultural land).

A summary of these different methods and their strengths and weaknesses is provided in Table 3.2.

Table 3.2: Methods for Benefits Estimation and their Strengths and Weaknesses

Method	Description	Strengths	Weaknesses
Ecosystem Service Based	This approach focuses on the contribution of Natura 2000to the delivery of individual ecosystem services, seeking to quantify and value each service.	Consistency of approach for valuing each individual service. By focusing on particular services, may provide relatively robust lower bound estimates of value of benefits.	Geographic variations in service delivery make estimation at network level difficult. Only certain services can be valued so likely to underestimate benefits of the network.
Territorial Based	A limited number of estimates are available for the value of benefits in different regions (notably Netherlands and Scotland). These can be scaled up to estimate benefits at EU level.	Simplicity. Should provide a reasonably comprehensive estimate of benefits.	Involves extrapolating from a small number of studies. Does not account for wide variations in benefits and values between MS. Amalgamates estimates produced using different methods. Difficulty of accounting for large variations in existing benefits estimates.
Site Based	Benefits estimates are available for a number of different Natura 2000 sites. These can be scaled up to estimate the benefits at network level.	Draws on data from a relatively large number of studies. Recognises and has the potential to account for the different characteristics of sites and the nature and value of services they deliver.	Difficulty of accounting for wide variations in estimates between sites Amalgamates estimates produced using different methods. Difficulty of knowing how available estimates relate to overall characteristics of network and providing a robust basis for upscaling.
Habitat Based	Site based estimates can be used to estimate per hectare values for individual habitats, which are then combined with data on extent of habitats at network level, to provide EU wide estimates.	Provides a logical basis for upscaling, as similar habitats are likely to deliver similar types of services across the network (though many services vary significantly by location). Data are available on area of individual Natura 2000	Variations in service delivery can be expected within habitats, according to location. Difficulty of accounting for wide range of benefits estimates for certain habitats. Lack of estimates of benefits of some habitats. Amalgamates estimates produced using different

	habitats, providing a basis for upscaling.	methods.

There are some overlaps between these approaches – for example analysis of the value of ecosystem services draws on site and habitat-based evidence. The available evidence can therefore be used in different ways without duplication of effort.

Since the value of most of the benefits and services delivered by Natura 2000 can be expected to vary in line with the area of the network, the current study has in most cases employed an area-based approach to upscaling, estimating the value of services per hectare and multiplying these by the area of the network. It should be noted that there are alternative means of upscaling benefits estimates, some of which have been used for particular services. For example, recreational benefits vary widely per hectare between sites, and have been estimated based on the total numbers of users, while benefit estimates based on willingness to pay are normally estimated on a per person or per household basis and upscaled by population. While the most appropriate aggregation approach is employed in assessing the value of some of individual ecosystem services, overall estimates of the value of multiple services (site-based and habitat-based estimates) have been estimated on an area basis (see Section 4).

Where per hectare values have been used, different methods have been employed to upscale these, including simple scaling up from 'average per site values' (no weighting for income), weighting site based values by GDP/capita, and estimating average values for different habitats and scaling these up accordingly. Furthermore it would conceptually be possible to scale up and integrate the 'spatial dimension' (by spatial discounting – e.g. for 'distance decay' functions of benefits – as known for recreation and tourism benefits from sites, as well as water purification and supply), but this is not possible at this stage given data limitations (it would require more spatially explicit modelling and overlaying of the distance decay function with population groups so as to determine who are the beneficiaries and at what likely value given distance from the site).

The above four approaches were developed and tested in the initial methodological phase of the work. From this, it emerged that:

- The 'territorial approach' currently is unlikely to provide robust or useful benefit estimates, given the paucity of available evidence at the national and regional scale, and was therefore dropped. In the future, with greater regional and biogeographic data, there could be benefits of pursing the approach, however - see chapter 7.
- The 'ecosystem services' approach provides the most systematic and reliable approach to examine the benefits of Natura 2000 in detail. However, a lack of

evidence of many of the relevant services makes a comprehensive assessment impossible. This approach could therefore be used only to assess the value of some of the key services delivered by the network, while recognising these do not provide a basis for a comprehensive assessment.

- The ‘site-based’ and ‘habitat-based’ approaches, while subject to certain methodological limitations, provide a basis for attempting a preliminary overall estimate of the value of the benefits delivered by the network; however, they don’t provide detailed information on ecosystem values, and therefore should be seen as a general ‘average’ value.

Based on the above, the ecosystem services approach was adopted as the framework for the assessment, with specific focus in particular on the following key services within the ecosystem service approach analysis including carbon storage and sequestration, water purification and provision; marine provisioning services (fish) and wider ESS benefits; and natural hazards management as well as offering some insights on the value of pollination, agricultural production, and others (see chapters 5 and 6).

The following sections highlight the key methodological issues involved in estimating the benefits of the network, and discuss how they have been addressed through the study.

3.4 The policy scenarios: gross and additional benefits of Natura 2000

In principle, there is a need to distinguish as far as possible between the additional value that designation brings by protecting and enhancing service delivery and the benefits which we would expect to be delivered by the sites even if they were not designated as Natura 2000 – the ‘additionality’. Some ecosystem services would be expected to continue, whether or not a site is formally designated. According to TEEB (2011), a protected area’s marginal ecosystem service value can therefore be divided into two components:

- the added value of designation:
  - value of protected area status (e.g. increased ecotourism interest);
  - value of subsequent avoided degradation due to measures on and off site – e.g. to meet favourable conservation status objectives;
  - increased value due to management and investment;
- the value of services maintained even without designation (i.e. the counterfactual in the absence of the Natura 2000 policy).

In this current study, it has only been possible, given data and time constraints, to look at the incremental benefits for part of carbon storage. In other areas the gross benefits from the ecosystems under Natura 2000 are looked at and not the additional benefits of designation and conservation measures. The additional benefits of conservation measures is covered, at the site level, in the Arcadis et al 2011 study being done in parallel to this study.

A further issue is that Natura 2000, as currently implemented, is not meeting its full potential or providing the level of benefits that would be delivered if all sites were maintained in favourable condition. As outlined in the background chapter of this report, it is estimated that only 17% of the Natura 2000 area is currently in favourable conservation status, with many sites constrained by a shortage of resources for due management. It is likely that the current benefits of Natura 2000, as currently measured and valued, would generally be enhanced if more sites achieved favourable conservation status, particularly in relation to the increased resistance/resilience of ecosystems (see Box 3.3), though there may be changes in the marginal benefits (e.g. potentially falling if a range of sites offer a similar services that addresses demand or create the benefit).

Box 3.3 Ecosystems resilience

Resilience has been defined as *'the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.'*[14]

In essence, resilience of an ecosystem lies in its ability to withstand external pressures, while at the same time sustaining the same functionality and in the end the services it provides. Due to the fact that often ecosystems are known to behave non-linearly (i.e. exhibiting abrupt changes, thresholds), the resilience plays a crucial role in decreasing the vulnerability of ecosystems to perturbations (e.g. climate change) and therefore sustaining the provision of associated benefits to human. From an economic point of view, resilience is type of 'natural insurance', which ensures continuing provision of a range of ecosystems services to human (TEEB, 2010).

There are several ecosystem characteristics which are thought to have significant impacts on ecosystem resilience. In general, an increase in ecosystem's species richness, amount of functional groups or (sub) populations is thought to have a positive influence on resilience. On the contrary, a lack of habitat's connectivity, decrease in its size or an increased amount of environmental pressures is believed to influence the resilience negatively. **Nevertheless, in general terms, it can be said that resilience of an ecosystem increases with improved connectivity and coherence of an ecosystem.** Conservation measured under a policy-on scenario can be expected to increase a number of factors supporting resilience and therefore improve resilience, and associated insurance value. This, however, is too complex to integrate in the current analysis.

14 IPCC Fourth Assessment Report, glossary http://www.ipcc.ch/publications_and_data/ar4/syr/en/annexessglossary-r-z.html

In practice, insufficient data precludes a full analysis of the net benefits of Natura 2000, taking account of the changes in the value of benefits brought about by the policy itself.

Given the above, our approach was to:

1. Focus in the first instance on the overall gross benefits delivered by Natura 2000 sites. This will highlight the benefits of the network in its current form. This is the most feasible approach and provides a clear message to target audiences; and
2. Illustrate the implications of alternative policy scenarios for the value of the benefits delivered by the network for an important ecosystem services such as carbon sequestration. This is important in understanding the net benefits of the current policy relative to the costs, and the likely changes in benefits under alternative policy scenarios.

At each stage of the analysis attention was paid to the effects on benefits of alternative policy scenarios relating to protection and condition of Natura 2000 sites. Where necessary this has relied on qualitative insights as well as quantitative indicators (e.g. % of sites protected by other designations, % achieving favourable conservation status and the implications of this for service delivery).

Box 3.2: Scenarios for examining net benefits

Different scenarios could be considered when examining the net benefits of Natura 2000 and how designation changes the economic values of the ecosystem services provided. These scenarios could be:

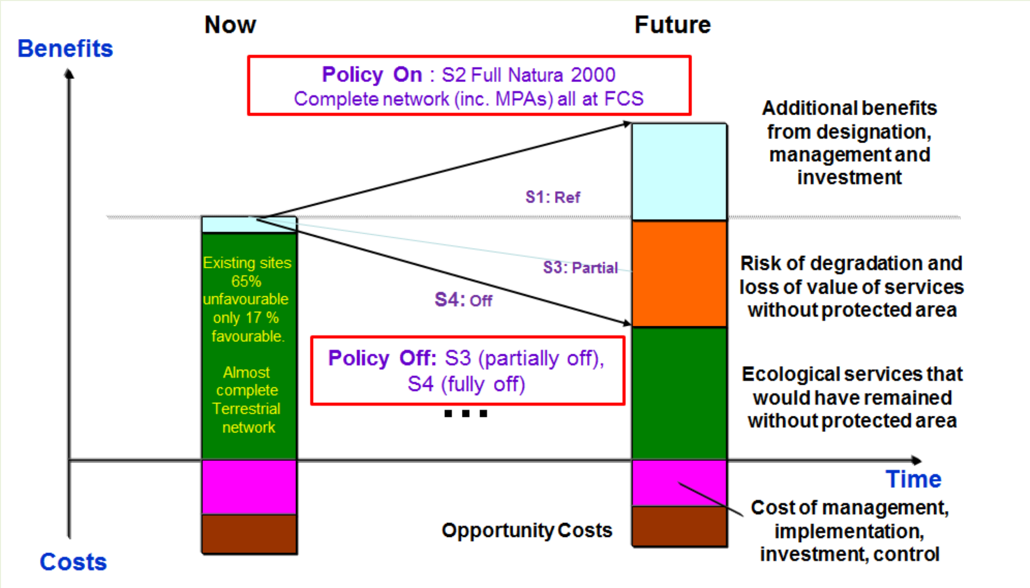
S1: Reference Point: A 'current Natura 2000' scenario: the gross benefits currently provided by the network.

S2: A 'full Natura 2000' scenario: the benefits that the network would be expected to deliver if all sites were fully funded and appropriately managed to achieve favourable conservation status over time.

S3: A 'partially restored' scenario: this would refer to a scenario where the favourable conservation status of the Natura 2000 network is only partially achieved (e.g. 50% in favourable conservation status).

S4: A 'partial conservation' scenario: this explores the benefits that sites might be expected to provide if Natura 2000 status was removed but other designations (e.g. national protected areas) remained in place. This would be expected to yield benefits somewhere between those provided by the current Natura 2000 scenario and the 'no conservation scenario' – i.e. some loss of benefits through reduced protection and management, especially in parts of the EU where national conservation policies are less developed and less well resourced, and lack of connectivity as many national approaches have not been conceived as a network.

S5: A 'no conservation' scenario: the effect of the removal of all conservation designations from Natura 2000 sites. This may involve, for example, a gradual loss of sites and/or their conservation interest due to development as well as inappropriate management, as well as a potential increase in agricultural activities (provisioning services) that would otherwise not have been allowed (captured by opportunity costs)



SOURCE: adapted from Kettunen et al 2011 in ten Brink 2011

The above conceptual framework, while attractive from the points of doing a complete analysis, is not the policy decision that we are currently facing – namely stay at current levels of funding or increase funding to ensure the full set of conservation objectives can be met (i.e. the light blue box). It would of course help to know what the value of the otherwise lost services (i.e. the orange box), but this is non trivial as we need a baseline / counterfactual to the policy on scenario.

Our approach has been to estimate the gross benefits of Natura 2000 sites (i.e. the green and light blue bar on the left) and to provide an assessment of the likely changes in the scale of these benefits under the alternative policy scenarios – for carbon sequestration, the only service readily amenable to such an analysis. The figure above is therefore more a conceptual framework for future analysis.

Note that evidence of the effect of policy scenarios on the value of benefits is available from some individual studies and has been examined in contract 072, 'Recognising Natura 2000 Benefits and demonstrating the economic benefits of conservation measures' (Arcadis et al 2011). A recent study by GHK and IEEP examining the benefits of Sites of Special Scientific Interest (UK protected areas network) in England and Wales examined the added value of national designations as well as considering the additional benefits conferred by Natura 2000 status.

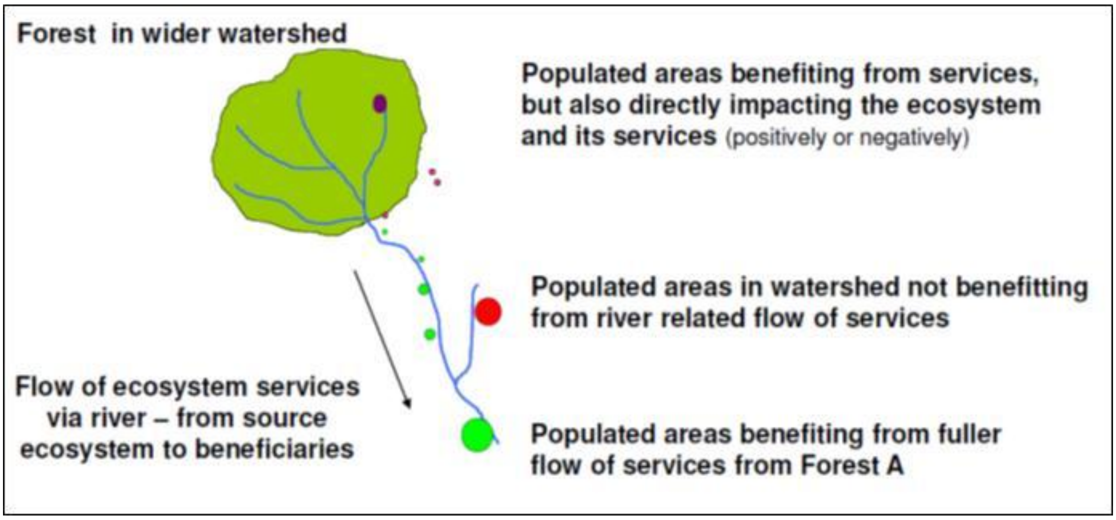
3.5 Spatial variations in benefits and values

To be robust and credible, estimates of the economic value of Natura 2000 need to be based not just on an understanding of existing evidence of benefits and values of particular sites, but also an understanding of the network itself, the services and benefits delivered by different sites, habitats and regions, and the spatial variations in these. Any scaling-up from site-based data needs to be well informed. Successful application of benefit transfer methods depends on an understanding of the characteristics and services of both the study site (that for which a value is available) and the policy site (that to which benefits are being transferred).

This is particularly true for services which are often site-specific and vary widely between sites, such as water regulation, air quality regulation and hazard prevention. For instance, for the water provision and purification services it is important to consider the location of sites relative to centres of population and the effects that this has on the provision and value of services. A similar approach is needed for flood management. The issue of spatial variation is a fundamental issue and it is better not to attempt benefit transfer and scaling up exercise if there is not enough underlying data and understanding of similarities/differences between sites and their links to economics and social systems. Otherwise it may lead to figures that may risk to make no sense, and potentially undermining other results that are more robust.

An illustration of the spatial relationship of ecosystems is provided in the figure below, showing the different relations for population areas in the vicinity of a partially forested watershed.

Figure 3.4: Understanding the spatial relationship of ecosystem services provision and beneficiaries – Example: Partially forested watershed



Source: Adapted from Balmford et al (2008)

Key factors that affect ecosystem service delivery, and hence the benefits of different sites, include:

- The habitats and ecosystems protected;
- The conservation status of the site;
- The aesthetic qualities of the landscape and the species and habitats it supports;
- The locations of sites relative to population (affecting, for example, recreation and air quality management);
- The location relative to natural resources (e.g. water resources);

- The land use and economic activities on the site and adjacent areas (e.g. agriculture, forestry, fisheries etc.);
- The quality and productivity of soils.

Note also the spatial relation between sites for a given beneficiary of a service can also be important. If there are several sites storing, purifying and supplying water, not all necessarily offer a de facto direct benefit to a population area, if another site already does the job. There may therefore be a biophysical function which has the potential to deliver ecosystem services, but does not actually provide (additional) benefits (or delivers services of limited value). This however does not mean that the service does not have any value due to future opportunities on benefits provision that might arise (e.g. due to impacts of climate change). It can be important (from the services perspective) having a portfolio of habitats providing similar services in case one of the habitats becomes degraded (e.g., risk of fire in a forest), so that the 'redundant' habitat becomes now of primary importance (similar issues as for 'redundant species' that step in to perform the role that others played and hence keep the ecosystem functions going and services flowing (insurance value). This is discussed further in the section below on aggregation.

Spatial variations in these different attributes need to be understood in order to inform an assessment of the benefits of the network as a whole. Our approach – as well as reviewing evidence of the value of benefits for particular sites and services – has sought to examine the relevance of available estimates to the network as a whole, considering the degree to which individual estimates can be scaled up to network level and the extent to which adjustments are needed to account for differences in the services delivered by different sites.

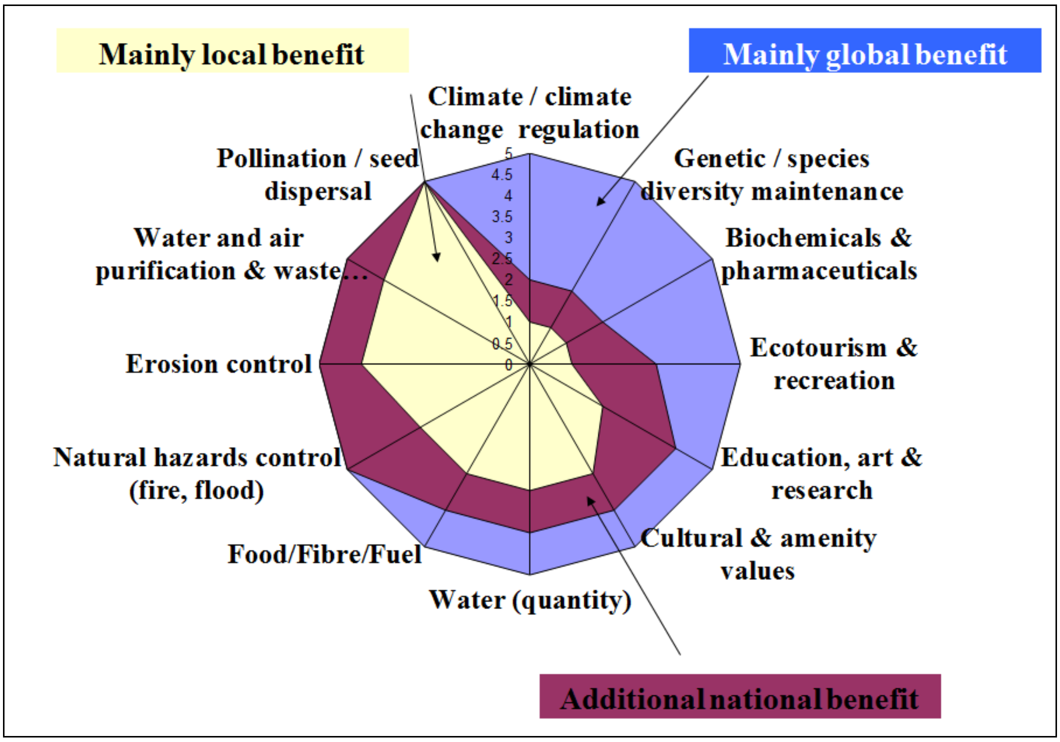
Scaling up of benefit estimates needs to take account of the characteristics of the Natura 2000 network as a whole, including:

- The number and size of sites, and the size distribution;
- The distribution of sites between Member States;
- The area of different habitats and land uses;
- The location of sites relative to human population and economic activities;
- The location of sites relative to natural resources;
- The interconnections between sites and the wider green /ecological infrastructure (as this can enhance benefits flows);
- The conservation status of sites and how this varies by country and habitat;
- The socio-economic conditions of the surrounding area, which affect the ability and willingness to pay for the services provided.

Note also that some benefits calculated for a given site may focus on an issue of global importance (e.g. willingness to pay for the conservation of a particular species) – see also Figure 3.5. If several sites all aim at the same objective, this could potentially lead to the total benefits from the Natura 2000 network being less than the sum of its parts for that particular service. That said, the insurance value (above mentioned portfolio point) of having replica sites delivering the same service can also be important. With increases in the risk of degradation of any of its parts, the greater the insurance value. In other words, the greater the strength of the drivers affecting the risk of conservation status of each site (the parts), e.g., human sprawl, the closer the sum of the parts becomes to the real value estimate of the aggregate network in terms of its role in preserving an endangered species in the EU as well as services provision.

Understanding the many benefits of Natura 2000 also implied understanding the benefits to the wide range of beneficiaries, from local, national, cross-border, EU and to global beneficiaries (see Figure). For example carbon storage is a global benefit from local action while seed dispersal and pollination has a local function and generally local benefits. As noted earlier, there can be a 'distance-decay' effect of the benefits – for example, the value of recreation, tourism, pollination each fall as the distance from the site increases.

Figure 3.5: Benefits of benefits over different geographic scales



Source: ten Brink et al (2011)

Spatial maps (e.g. from EEA, JRC) and other useful insights on spatial provision of benefits from available literature sources/databases have been taken into account in assessing the distribution of different ecosystem services. This helps identify, when possible and relevant, the main beneficiaries of the services provided and their geographical location. This was considered a key aspect of socio-economic assessments of Natura 2000 in earlier studies (Gantioler et al. 2010).

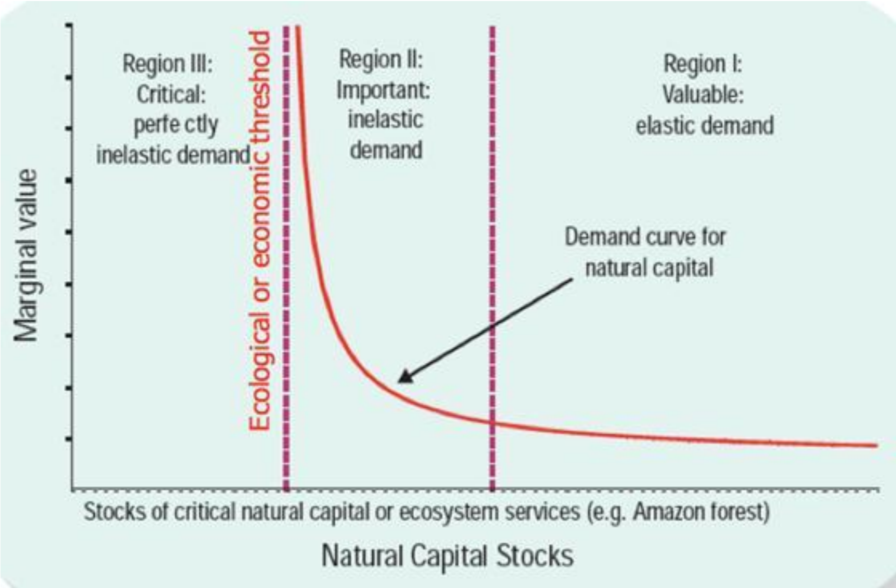
Another issue relates to variations in the value of benefits between different parts of Europe. As well as differences in the levels of service delivery, such variations can reflect differences in socio-economic conditions and preferences. For example, certain services may be more highly valued in some regions than others, while differences in income levels may affect the amount that people are able and willing to pay for them. Some of these variations can be accounted for by adjusting benefits estimates to reflect differences in income levels, for example.

3.6 Non-linearity and thresholds

There are many cases in which service values are not a simple linear function of the area of an ecosystem. Examples include coastal flood protection and the recreational values of ecosystems (see for example Barbier et al, 2007; Koch et al, 2009). The figure below shows how the relationship between the ecosystem services (quantity and/or quality) and their value can be non-linear in that the responsiveness of demand for services changes around ecological and economic limits. Non-linearities can arise not only from biophysical changes (e.g. collapse of fish stock, eutrophication events, habitat areas falling below the level needed for a species), but also from socio-economic changes (e.g. economic crisis – which can lead to dramatic falls in willingness and ability to pay).

Non-linearities and threshold effects have implications within individual studies, and in particular for attempts to transfer values across studies, for grossing-up across spatial scales, or for constructing meta-analysis functions. More generally, they may suggest the need to move to safe minimum standards or precautionary approaches when dealing with decisions about critical natural capital (See TEEB 2010, chapter 5). This may imply setting limits to the applicability of cost-benefit methods where catastrophic changes are a risk.

Figure 3.6: The demand curve for natural capital



Source: (Farley, 2008)

Scale is of course important here, and should be reflected in the non-linearity of values. If we are discussing the whole forest resource of a nation, we might expect quite strong non-linearity, whereas at the individual woodland scale any thresholds faced are likely to be purely local. There is therefore a potential problem associated with the use of transfers from a single study to many separate instances of the same resource or impact - which collectively have an impact larger than the sum of the parts.

This may be particularly important when considering values associated with networks of sites such as Natura 2000, where the value of the whole may be indeed expected to be greater than the sum of the parts, given the interrelations between habitats/sites and across ecosystem services.

The impacts of irreversible decisions on the value of benefits should also be taken into account. Often, the decision to develop or convert land is, practically speaking, irreversible; even where restoration may be technically possible it may involve very high costs and/or long delays.

In practice it has not been possible in a study of this nature to take account of changes in the marginal value of the ecosystems protected. The benefits estimates have therefore employed a linear approach to assess the benefits of Natura 2000 at the network scale – i.e. the benefits of the network are estimated by upscaling site based estimates to the EU level, assuming a constant value per hectare (or an adjusted per hectare value taking account of relevant factors – e.g. GDP/capita[15]). It

[15] As noted elsewhere in this report other factors could also be added in such as precipitation levels, rarity/abundance of sites - and indeed the issue of scarcity/abundance of sites, which may change over time depending on the range of policies and pressures. While not needed for the actual analysis in this study, it could potentially be addressed by using different elasticities. Also for wider non-linearities it may well be necessary to complement the valuation approach, with risk analysis.

is noted, however, that this is likely to under-estimate the value of the benefits of the network, since, if Natura 2000 sites and the services that they provide were progressively lost, the value of those remaining would progressively increase (as they are rarer).

3.7 Aggregation and scaling-up

In testing different approaches to benefits assessment, it is important to clearly specify the approach used to transfer benefit estimates from the available evidence base and to scale them up to the network as a whole.

This requires examination of the representativeness of the benefits estimates used and their transferability across the network as a whole, which also needs to take into account the relative scarcity or abundance of sites and their relation to the demand for the service, as not all benefits are additive and there can be 'competition' between sites (see Box 3.3). Transferring site specific estimates to the wider network could, without very careful interpretation and analysis, give potentially misleading results. This highlights the importance of informed use of benefit transfer, backed by an understanding not just of the values being used, but also of the capacity of the wider network to deliver similar levels of benefits.

Box 3.3: Ecosystem services and interaction between sites for different services.

The value of a site depends not just on its natural features, but also on interactions with other sites (competition or positive synergy or simple complementarity/additionality), and on the scarcity or abundance of supply (of sites or services) and the relation to demand for the service.

Simple complementarity: for example, the *carbon stored or sequestered* in one site is not affected by how much is stored or sequestered in another and the values of the carbon stored in different sites can be added (the change in the supply of service does not in this case affect the marginal price of carbon). The same generally goes for most provisioning services assuming that there is enough demand. As soon as the supply is greater than the demand then there can be competition and price effects. If there are a number of protected areas providing water, then the marginal unit value of the service (and price of the water provided) will be lower (whether this is so for the cost naturally depends on the pass through of costs to price). Water purification as well as other regulatory functions is generally complementary, again in the context of sufficient demand.

Competition and synergies: Eventual *bio-prospecting or biomimicry* gains from genes, species or ecosystems in one site might be in pure competition with another if and where it has the same element of biodiversity that can be used to inspire biomimicry or develop bio-prospecting related products. For tourism and recreation, this can be in pure or partial competition (people go to one site rather than another); and indeed also as a ***positive synergy*** - if they go to one they may also go to another or if they may go to one they may not go to another more sensitive with positive effects on other services. Which is the case depends on the sites and the visitors.

A further example of ***positive synergy*** could arguably be that of different sites together (and with wider green infrastructure) providing flood control or other natural hazards management (e.g. where hydrological functioning depends on more than one site alone). This may also be true for biocontrol (e.g. where biopredatory species viability is supported by there being two sites, and connectivity between them). In the extreme this positive synergy might be '***necessary synergy***' if a site on its own cannot offer the service.

For Natura 2000, given the above issues of supply and demand, the marginal values of the services would be expected to be higher as the areas become more scarce (in absolute terms, and indeed relative to demand), and the economic values for a range of services fall as the supply relative to demand falls.

Note also that over time the values will be expected to change – firstly improvement in conservation status is likely to lead to greater service provision (as healthy ecosystems generally provide more services) and secondly over time the greater income and hence potential willingness to pay from a richer growing population will lead to increases in the unit values for a range of services (e.g. tourism, water; higher value assets at risk from flooding and climate change). The latter point does not affect the calculations in chapter 4 as these are for a snapshot – the now – and not the future. Analysis that projects into the future should have unit prices of services change reflecting the driving factors – in a richer more populous world with more economic assets at risk, values can be expected to rise.

Benefit transfer and scaling up gives rise to some important methodological challenges, such as how to interpret extraordinarily high benefit estimates for particular sites, and how to fill in gaps in available evidence.

The study has identified unit values per hectare that can be used to assess the overall benefits of the network, and scaled these up on an area basis to estimate the overall benefits of the network as a whole. The different methodological approaches tested a range of different methods for upscaling benefit estimates. These include:

- Mean value of benefits per hectare – taking a simple mean from available benefits estimates and upscaling this to the EU level;
- Mean value of benefits per hectare, excluding outliers – omitting exceptionally high benefits estimates for individual sites, which are likely to be unrepresentative and will unduly skew the benefits estimates if included;
- Median value of benefits per hectare – where several benefits estimates are available, the median may provide a more representative value than the mean, particularly if the latter is biased by one or more exceptional estimates;
- GDP adjusted benefits per hectare – as differences in national income per head can be expected to influence the value of benefits, and many of the available estimates relate to the more affluent Member States, adjusting values by GDP per capita may provide more representative estimates (note the GDP/capita can be on national basis, but arguably better to do so at regional or local level, depending on information availability. Care is needed where beneficiaries are from a mix of geographic scales)

- Stratifying benefits estimates – there are good reasons to expect that the available benefits estimates will not relate to a representative cross section of Natura 2000 sites. For example, studies may have tended to focus on sites which are more valuable or which deliver particular benefits that are more easily quantified. This issue could potentially be addressed by grouping benefits estimates according to different site characteristics (e.g. by habitat or according to whether sites can be expected to deliver services of low, medium or high value because of their location, characteristics and profile). However, the scope to do this was found to be limited, because of the difficulty of defining robust typologies that could be related to the Natura 2000 network as a whole.

3.8 Variations in benefit estimation methods

The benefits estimation draws on a variety of available studies, covering a diverse range of sites, with different services and values. This creates some problems and challenges, given the different approaches, services covered, estimation methods and assumptions used by the various source studies. Combining a diversity of values obtained in this way may raise concerns about the consistency of the approach. As far as possible, consistent and standardised approaches to assessment of benefits should be used, although the scope to do this is limited by the available evidence (Gantioler et al. 2010).

Within this study, consistent approaches have been used to estimate the value of individual ecosystem services, identifying appropriate units of measurement and unit values and applying these at the EU scale. Inevitably, however, the other approaches to benefits estimation (territorial, site-based and habitat based approaches) need to draw on different studies using different methodological approaches, in order to obtain a sufficient sample of benefits estimates on which to base the valuation. Caution is therefore needed in interpreting these estimates, recognising that they amalgamate a variety of methods and values.

It was also necessary to check the reliability and robustness of the benefits estimates employed, and to ensure as far as possible that erroneous estimates are not made through the transfer of flawed benefits estimates. Experience from studies on the Cost of Policy Inaction (COPI) (Braat and ten Brink et al, 2008) and other studies suggests that focusing only on refereed academic papers is restrictive and does not guarantee that the values used are robust and policy relevant. The study has therefore sought to exercise judgement regarding the choice of estimates to be used. All sources are here clearly referenced, in order to provide a transparent assessment.

3.9 Avoiding double counting

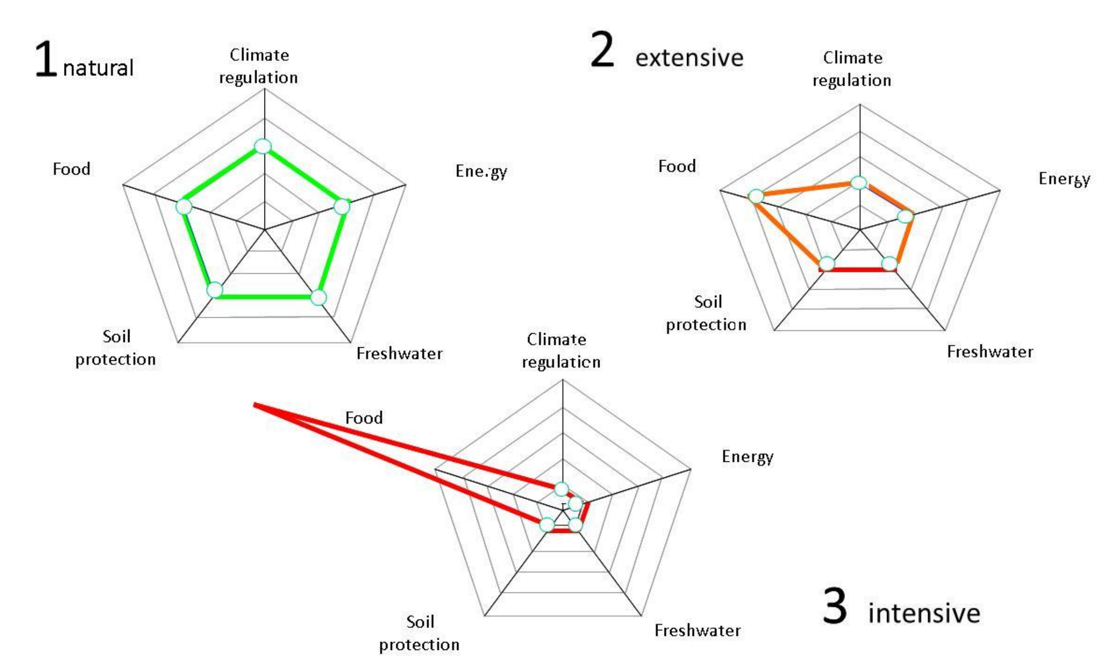
In aggregating benefits it is important to avoid double counting, which is a risk where one benefit estimate potentially overlaps with another.

For example, care is needed in summing estimates of the values of different ecosystem services if some estimates potentially cover more than one service. While stated preference studies may be necessary to fully capture the non-use values of sites, a respondent's willingness to pay may also be influenced by knowledge or perceptions of other benefits and services that the site may deliver, including for example regulating services. Careful understanding of the scope of different estimates, and the potential overlaps between them, is therefore needed before summing them. – for example pollination and value of agricultural output should not be added given that the value of the agricultural output may already integrate the pollination value.

3.10 Trade-offs and opportunity costs

Particularly in assessing the net benefits of Natura 2000 designation, it is also important to recognise that Natura 2000 status may bring trade-offs, reducing the delivery of certain services. For example, food provision may decline if Natura 2000 designation reduces agricultural production by promoting more extensive management practices. See Figure below.

Figure 3.7: Land use choices and trade-offs of ecosystem service provision



Source: Ben ten Brink (MNP) presentation at the Workshop: The Economics of the Global Loss of Biological Diversity 5-6 March 2008, Brussels, Belgium.

At the same time, it needs to be considered that what might seem like a considerable trade-off in the first place, might either be smaller or even non-existing depending on the timeline and the cost factors taken into account. For example, the spider diagram above shows that we might gain substantially on food provision via intensive forms of land management, though losing out on other ecosystem services (and of course biodiversity values). However, the loss or decrease of other services (e.g. biological control, pollination, supporting services) will likely affect the provision of food in the long run, and even if human made forms of substitutions are developed those are likely to be more costly, reducing the net benefits gained.

The assessment of the gross benefits of Natura 2000 sites focuses on the overall value of the different services they provide. However, when examining the implications of alternative policy scenarios, the net effects of Natura 2000 on service delivery need to be considered. It is recognised that, in the absence of designation, the value of some services (e.g. food and timber) would be expected to increase with no designation, at least in the short term. This current study is not seeking to do a cost-benefit exercise of Natura 2000, but simply to present the range of economic (values of) benefits to complement the biodiversity ones to help enrich understanding and the debate. The issues of opportunity costs is, however, still a real issue (see Kaphengst *et al*, 2011). Note that it is often not 'opportunities lost', but 'opportunities changed' – as will be shown in chapter 5 there still is significant agricultural output from Natura 2000 sites.

3.11 Discounting and time value of services

The estimates in this study focus on the benefits that Natura 2000 provide to society now – creating a snap shot of current values. To illustrate and explore the incremental benefits of Natura, the study also looked at the value of a policy on scenario over the period to 2020 for carbon storage. This was the only service amenable to a time profile and analysis of (additional benefits of) policy action within the study.

In the general case where 'todays' values' are assessed, no discounting is needed, and in the carbon storage case, the results focus in on 2010, as well as the annual change over the period to 2020 and the benefits in 2020. No net present value of the flow of benefits has been calculated. There are two issues of importance here – the developing values of services over time and the issue of discounting.

Values per hectare can be expected to change over time for the following reasons:

- Demography: more people, greater demand, higher value;
- Income and education : the greater the income and education, usually leads to a higher value for certain services;
- Site ecological health: improving ecological status (which is likely, with some exceptions, as a result of positive management practices) will lead to greater provision of services;

- Climate change: the greater the risk of climate change and actual/likely damage from climate change over time, the higher the carbon price and hence the higher the value of climate regulating services;
- Rarity: the existence of rare endemic species/habitats (e.g. very particular to the region) will lead to higher values.
- Availability/abundance of similar sites in the region: Where there are many sites, the marginal value of a given site will be smaller (given that there are substitutes); the loss or degradation of sites elsewhere will make the provision of services from the study site more critical, and enhance their value.
- Preference/social norms: there may be changes in habits, interests and values that can change the ecosystem service value over time (e.g. preference towards or away from nature tourism).

For discounting, traditionally a 4 per cent real discount rate has been used (in analysis supporting public policy) to discount the future flow of benefits. This naturally leads to future benefits being regarded, from the viewpoint of today's decisions, as being relatively less valuable than a similar level of benefit delivered today. This approach to discounting is being challenged given, inter alia, the moral implications of discounting (See Box 3.4, and for more extensive discussion see TEEB 2010)

Box 3.4: Discount Rates

The choice of the discount rate

Discounting is important to the analysis of long-term projects. For instance, a hundred year project, yielding benefits of €22,000 on completion (i.e. in 2111), is worth around €8,000 today at a 1 per cent discount rate but only €1 at a 10 per cent real discount rate. In general, a lower discount rate will favour ecosystem services as they are expected to continue into the far future and this increases the weighting placed on them. However, this is not always the case as a low discount rate will also favour any project with large upfront costs and benefits further in the future, including for example road building, which could adversely impact on biodiversity and ecosystem services. Practice varies considerably. An OECD survey of its Member Countries found that the social discount rate used was usually around 4 to 5 per cent but varied from 3 per cent in Denmark to 10 per cent in Australia. Some countries allowed for declining rates (usually after 30 years). In practice, what is most surprising is how infrequently the benefits of ecosystem services are recognized, quantified and monetized. This – rather than the choice of discount rate – may well be the biggest analytical bias against the preservation of ecosystem services.

Some argue that the social discount rate should be lower. The Stern Review on the Economics of Climate Change argued for a discount rate lower than any of those used currently used by a government, though this is challenged by a number of economists (see TEEB Foundations, 2010 chapter 6).

Source: TEEB in TEEB 2011 chapter 4 – building on OECD (2006a)

4 OVERALL ASSESSMENT OF THE BENEFITS OF NATURA 2000 – PART 1: territorial, site-based and habitat-based approaches

Key Messages

A first assessment of the Natural 2000 network's economic co-benefits

A first estimate for the value of the Natura 2000 network – scaling up from existing site based studies (35 values from 21 studies) – suggests that the current value of benefits of the (terrestrial) network would be between **200 and 300 billion EUR/year.** Four assessments were done– two site based scaling up (one simple and another adjusted for GDP/capita) assessments , one building on habitats and a fourth, scaling up from (national) territory results to the EU. The territorial approach was rejected on the grounds of insufficient data. The other each produced values in the above range.

What the numbers tell us:

- This value relates to a range of services from the protected area network, and should be seen as 'gross benefits'
- It represents an indicative estimate.
- They are expected to be a conservative estimate as the base studies themselves only cover a subset of ecosystem services and a subset of the TEV elements.

What the numbers do not tell us:

- It should not been seen as benefits of the Natura 2000 designation and associated conservation measures as such.
- It is also not a net benefit calculation as it does not take into account opportunity costs.
- This a first estimate is expected to be fine tuned in the future when additional data become available and as methodologies evolve (see last chapter); the values should not be taken as fully robust or precise, but rather as indicative first estimates, fit for purpose for illustrating the benefits flowing of Natura 2000.

Further investment in site studies is needed – both for the own merits of demonstrating benefits for the local to national to EU stakeholders - and also to improve the evidence base to allow a more sophisticated understanding of the benefits (see further below).

4.1 Introduction

This section presents overall estimates of the value of the benefits delivered by the Natura 2000 network, based on aggregation of site-based and habitat-based data.

4.2 Site-based estimates of Natura 2000 benefits

4.2.1 Overview of approach

Various studies are available of the benefits provided by different Natura 2000 sites. These studies indicate that different sites deliver different benefits and that estimates of the value of these vary widely – this may reflect the value of the benefits themselves as well as the degree to which they can be valued comprehensively and accurately.

Compiling data at the site level provides a basis for scaling up across the network as a whole. Site based estimates can be pooled to give a range of per hectare values for sites. While different studies may focus on different services and benefits, reflecting the different characteristics and locations of sites and the services they deliver, this is not necessarily a problem if the individual studies are robust and provide a relatively complete and consistent approach to benefits estimation.

Advantages of this approach are that it enables a relatively large number of existing benefits estimates to be employed, and that it recognises the natural variations in sites and their characteristics and values. As for the territorial approach, a key disadvantage is that it combines values from a range of different studies employing different methods and assumptions, whose consistency may therefore be questioned. Furthermore, scaling up from the site to the network level presents methodological issues and challenges, given the variability of site based estimates.

4.2.2 Available Benefits Estimates

An extensive review was undertaken of studies assessing the value of services delivered by Natura 2000 sites. The analysis focused on studies that:

1. **Cover a wider range of ecosystem services** provided by the sites in question, in order to enable a reasonably complete assessment of benefits. While data constraints often preclude comprehensive analysis of the value of ecosystem services, studies that focused on one or two services only were excluded from the assessment. Since most values identified covered certain services only, they are likely to provide a conservative estimate of the benefits of the network;
2. **Provide estimates of the annual per hectare value of benefits**, or enable such an estimate to be derived. Estimating benefits on a per hectare per annum basis provides a standardised basis for the analysis and upscaling of values.

3. **Relate to terrestrial and coastal sites only** – the benefits of marine sites are considered separately below.

The review provided 34 different estimates of the value of the benefits of Natura 2000 sites, from 20 different studies. A summary of suitable estimates is given in Table 4.1. All values have been estimated on a per hectare per annum basis, where necessary by estimating the annualised values where the source material expressed these as capitalised sums, and have been converted to euro at 2011 prices.

Table 4.1: Summary of valuation studies, by site`

Site	Ecosystem services / types of benefit	Site value per ha per year (€, 2011 prices)	Reference
Pond Complex of Central-Limburg, Belgium	Provisioning services, tourism and recreation	1,406	Desmyttere and Dries (2002)
Scheldt estuary, Belgium	Regulating and provisioning ES (various)	3,990	Ruijgrok, E.C.M. (2007)
Skjern River restoration, Denmark	Biodiversity/ existence values, recreation, water purification and regulation, fibre production	1,218	Dubgaard et al (2002)
Protected forests in eastern Finland	Non market values measured through contingent valuation	403	Kniivila et al (2002)
La Crau, France	Non-market benefits (public WTP) + hay production	229	Hernandez and Sainteny (2008)
Donana, Spain	Range of ecosystem services, estimated through CVM	375	Martin-Lopez et al (2007)
Sites protected for Large Blue butterfly, Landau, Germany	Range of services and values including non-use values	6,932	Watzold et al. (2008)
Burren, Ireland	Cultural services: tourism and recreation; Broader socio-economic benefits: beneficial externalities of conservation	2,714	Rensburg et al. (2009)
Wadden Sea N2K sites, Netherlands	Wide range of provisioning, regulating and cultural services	3,650	Kuik et al (2006)
River N2K sites, Netherlands	Use and non use values, estimated through hedonic pricing and benefit transfer	5,324	
Lake and marsh N2k sites, Netherlands	Tourism, recreation, non use values including biodiversity	5,944	
Dune N2K sites, Netherlands	Flood protection, recreation, non use values	13,198	
High fen and sandy soil N2K sites, Netherlands	Recreation, non use values	1,274	
Stream valley and hills N2K sites, Netherlands	Provisioning, amenity, recreation, non-use values measured through stated and revealed preference methods	4,974	
Białowieża Forest, Poland	Recreation, amenity and existence, freshwater, range of provisioning services (e.g. food, timber), tourism,	2,799	Pabian and Jaroszewicz (2009)

	pest control.		
Pico da Vara / Ribeira do Guilherme, Azores, Portugal	Water provision, quality & regulation. Recreation and eco-tourism. Landscape and amenity values.	642	Cruz and Benedicto (2009)
Lower Green Corridor, Romania	Provisioning services: fisheries, forestry, animal fodder; Regulating services: nutrient retention; Cultural services: recreation	512	Ebert et al. (2009)
Danube floodplains (7 countries, 60% in Romania)	Provisioning services, recreation, water purification	572	Gren et al (1995)
Maramures Mountains Natural Park, Romania	All ecosystem services	416	Ceroni (2007)
Clyde Valley Woods, Scotland	Recreation and non-use values (based on CVM of visitors and general public	5,665	Jacobs (2004)
Waukenwae and Red Mosse, Scotland	Recreation and non-use values (based on CVM of visitors and general public	14,769	
River Bladnoch, Scotland	Recreation and non-use values (based on CVM of visitors and general public	5,341	
Sands of Forvie, Scotland	Recreation and non-use values (based on CVM of visitors and general public	4,404	
Tips of Corsemaul and Tom Mor, Scotland	Recreation and non-use values (based on CVM of visitors and general public	19,763	
Strathglass Complex, Scotland	Recreation and non-use values (based on CVM of visitors and general public	87	
Lewis and Harris, Scotland	Recreation and non-use values (based on CVM of visitors and general public	155	
Sites of special scientific interest in England and Wales (almost 80% by area are N2K)	Range of 7 key provisioning, regulating and cultural services (gross)	7,926	GHK (2011)
Wallasea Island, England	Range of key ecosystem services	1,447	Eftec (2008)
Derwent Ings , England	Social benefits of N2K site, measured through CVM	1,318	Willis, K.G (1990)
Skipworth Common, England	Social benefits of N2K site, measured through CVM	5,987	
Upper Teasdale, England	Social benefits of N2K site, measured through CVM	1,150	
Alkborough Flats, North Lincolnshire, England	Range of ecosystem services	4,508	Everard, M. (2009)
Humber Estuary, England	Amenity and recreation, carbon	847	Luisetti et al (2010)
Blackwater Estuary, England	Amenity and recreation, carbon, fisheries	4,371	

The per hectare values are derived from estimates of the value of services delivered by each site, divided by the area of the site. It is apparent from Table 4.1 that the available estimates give a wide range of values for the benefits of Natura2000 sites, ranging from just less than €50 per hectare per year to almost €20,000 per hectare per year.

The range of values identified underscores that sites are not uniform, while estimates of the value of the services they deliver also vary according to the methods used and data available.

Variations in value estimates reflect differences in:

- The location and characteristics of different sites (including their condition, scarcity and substitutability);
- The ecosystem services delivered, which vary by habitat and location relative to people and natural resources;
- The value placed on those services by people and by markets;
- The extent to which studies have been able to estimate ecosystem service delivery and its value; and
- The methods used in valuation, and the assumptions used in benefit estimation.
- The role of non-use values which can form a significant share of the total value

Although the available values have a wide geographical spreads, the majority come from North West Europe, particularly the UK and the Netherlands, which raises some concerns about their representativeness of the network as a whole. While it is possible to take account of some variations between Member States when scaling up to the EU as a whole (e.g. by adjusting for variations in GDP), it is likely that the sample of values does not fully account for variations in ecosystem service delivery across the network.

4.2.3 Estimating the benefits for the EU27

Two methods are employed to upscale these estimates to the EU level:

a. Simple upscaling based on mean and median per hectare values for sites;
b. Upscaling of GDP adjusted mean and median per hectare values for sites.

Development of alternative approaches (including a typology of sites and the development of a benefit transfer function) was also explored, and is discussed below, but proved to be unworkable due to limitations in the data available.

a. Simple Up-scaling of Mean and Median Values

The average values of site based estimates in euro per hectare are as follows:

- The arithmetic mean per hectare value of these 35 benefit estimates = €3,950 per hectare
- Median value of these 35 benefit estimates = €2,756 per hectare

The mean value is 40% higher than the median, influenced by some high per hectare values from a small number of studies. These differences appear to reflect real

variations in the per hectare benefits provided by different sites, and not just variations in estimation methods.
These average values can be used to estimate the value of benefits of Natura 2000 across the EU27, multiplying by the overall Natura 2000 area of 91 million hectares [16] (see Table 4.2).

Table 4.2: Estimated benefits at EU27 based on simple upscaling of site based estimates

Basis for upscaling	Value per hectare (€)	Value EU27 (€M)
Mean	3,950	359,874
Median	**2,756**	251,086

This gives overall benefit estimates of between **€251 billion and €360 billion** annually for the EU27.

b. Use of GDP adjusted per hectare values

The value of benefits can be expected to vary according to differences in income levels between Member States, which affect the value of ecosystem services and willingness to pay for them. Each of the site based estimates was adjusted for differences in GDP per capita in Purchasing Power Standards, in order to provide income adjusted estimates of the value of benefits per hectare. The adjustment used Eurostat indices of national GDP per capita, on the basis that Natura 2000 sites provide benefits at the national level, and most studies estimate benefits to the national as well as the local population.

Because the available estimates are concentrated among higher income member states, adjusting them for differences in GDP per capita reduces the overall benefit estimates (Table 4.3).

Table 4.3: Estimated benefits at EU27 based on up-scaling of GDP adjusted site based estimates

	GDP adjusted value per hectare (€)	Value EU27 (€M)
Mean	3,441	313,520

16 Note that in developing the above area and shares, some overlaps between SACs and SPAs may affect the total area, given that the data available at the time of this study did not allow us to quantify those overlaps precisely . The above 91 million ha, however, are already significantly lower than the 131 million ha that would be derived by simply adding the Habitat SCAs and Bird SPAs areas (recall Table 2.1). See also the EEA database for 2010 See http://www.eea.europa.eu/data-and-maps/data/natura-1 .

Median	2,447	222,951

Upscaling using these per hectare values gives overall benefit estimates of between **€223 billion and €314 billion** annually for the Natura 2000 network as a whole.

c. Other possible site-based approaches

As discussed above, there are wide variations in per hectare benefit estimates between sites and studies. The method of upscaling simple per hectare averages to arrive at EU level estimates depends on the assumption that the sample of Natura 2000sites for which estimates are available is representative of the network as a whole.

An alternative approach might involve developing a typology of Natura 2000 sites which helps to explain variations in benefits estimates between them. Sites could potentially be scored and grouped according to their characteristics (e.g. location relative to population, natural resources and infrastructure; rarity of the site and its habitats and species; habitat types; condition of the site; ecosystem services provided; and economic factors such as GDP per head). Such an approach was investigated during the methodological stage of the work. However, its workability was found to be limited by a variety of factors, such as difficulties in measuring key criteria robustly and objectively, and uncertainty about the weight attached to different criteria. Furthermore, limited data regarding the specific location, characteristics and services of Natura 2000 sites makes it difficult to relate such a typology to the population of Natura 2000 sites as a whole.

A more sophisticated approach to benefit transfer would involve the estimation of a benefits function, linking benefits estimates to the characteristics of individual sites and studies. However, this would require a much larger number of benefits estimates than is available.

4.3 Habitat-based estimates of Natura 2000 benefits

4.3.1 Overview of approach

It is also possible to use estimates of the value of services delivered by different habitats as the basis for estimating the value of the benefits of the Natura 2000 network. Because similar habitats can be expected to deliver similar types of ecosystem services, we can expect the value of services to vary by habitat. Data are available for the area of different habitats in the network, and can be used as a basis for up-scaling habitat based values.

This is similar to the site-based method and involves compiling estimates of the value of benefits delivered by different habitats. These may be derived from studies focusing on a particular habitat (e.g. benefits of marine protected areas) or on particular sites dominated by a single habitat. A range of values can be derived for each habitat, and, combined with data for the area of each habitat covered by the network, used to provide estimates at the network scale.

This approach has some advantages in that there is likely to be some consistency in the types and levels of services delivered by a habitat, while good data on the areas of each habitat covered by the network are available. Disadvantages relate to the consistency and reliability of different benefits estimates (as before), the likelihood that data will be unavailable for certain habitats, and the known variations in delivery of some services within habitats. For example, while some services such as climate regulation may be reasonably consistent between different forest sites, the value of others such as water purification will vary significantly according to the location of the forest (for example in relation to pollution sources, water supplies and centres of population). This presents challenges in extrapolating benefit estimates across the habitat as a whole.

Relevant data sources include: data from COPI and TEEB studies on value of services delivered by different habitats; studies of the benefits of Marine Protected Areas; studies of individual sites as above where these have a predominant habitat or values broken down by habitat.

4.3.2 Available Benefits Estimates

The first step is to calculate the mean and median values for each habitat type identified through the literature review. To calculate the habitat values, the site based studies summarised above were grouped by broad habitat types, using to the Habitat Directive Classification. This was not straightforward as the studies reviewed did not use the Natura 2000 habitat classification system in their reports. Judgement was required to associate the habitat included in the studies reviewed with the Natura 2000 classification system. In addition, several of the values identified were based on studies of sites that contained more than one habitat type. When this was the case, the value contained in the study was assigned to the predominant habitat type for the site in question.

The mean and median value for Natura 2000 sites, by hectare, and adjusted for differences in GDP (from 2010 Eurostat figures), were calculated based on the entire range of values identified. The results of these calculations are presented in the table below.

Table 4.4: Natura 2000 habitat values, per hectare

	GDP adjusted, 2011 €/Ha				
Habitat Directive Classification (Natura 2000habitat code)	**Count**	**Min**	**Max**	**Median**	**Mean**
Coastal and Halophytic Habitats (1)	6	743	3,954	3,053	2,651
Coastal Sand Dunes and Inland Dunes (2)	2	3,863	9,849	6,856	6,856

Freshwater Habitats (3)	8	371	4,685	1,231	2,256
Temperate Heath and Scrub (4)	3	1,009	17,336	5,252	7,866
Sclerophyllous Scrub (Matorral) (5)	0	-	-	-	-
Natural and Semi-natural Grassland Formations (6)	5	77	5,875	1,156	1,898
Raised Bogs and Mires and Fens (7)	3	136	12,956	951	4,681
Rocky Habitats and Caves (8)	0	-	-	-	-
Forests (9)	5	**347**	**4,969**	**924**	**2,309**
All habitats	32	77	17,336	1,721	3,323

Source: Grouping of site based estimates, from literature review for this study.

4.3.3 Estimating the benefits for the EU27

These per hectare values can be combined with data for the area of each habitat across the Natura 2000 network to estimate the value of benefits for the network as a whole.

Data on the area of each habitat in the Natura 2000 network was identified in Mücher et al. (2009). This information is used to estimate the total value of the Natura 2000 network, by habitat, based on median, mean and mean excluding outlier values. The results of this analysis are presented in Table 4.5 below.

Table 4.5: Estimated Natura 2000 habitat values

Habitat Directive Classification (Natura 2000 habitat code)	Estimated area (million ha)	Median	Mean
Coastal and Halophytic Habitats (1)	15.0	45,884	39,849
Coastal Sand Dunes and Inland Dunes (2)	1.5	9,993	9,993
Freshwater Habitats (3)	6.2	7,628	13,977
Temperate Heath and Scrub (4)	11.5	60,284	90,285
Sclerophyllous Scrub (Matorral) (5)	4.0	-	-
Natural and Semi-natural Grassland Formations (6)	11.6	13,373	21,964
Raised Bogs and Mires and Fens (7)	7.8	7,450	36,672
Rocky Habitats and Caves (8)	4.1	-	-
Forests (9)	29.4	27,189	67,956
Total (7 habitats)	***83.0***	171,802	280,695
Estimated Total for Natura 2000 Network (9 habitats)	**91**	188,587	308,118

Estimates are made for 7 habitats for which values are available, and scaled up to the Natura 2000 network as a whole.
This method gives estimated values of between **€189 billion** and **€308 billion** per annum, depending on whether the median or mean values are used. The figures are slightly lower than for the site-based estimates, because the most widespread habitats (such as forests) have slightly lower estimated per hectare values than the average.

The way forward

The above first estimates offer order of magnitude value ranges for the gross benefits of the Natura 2000 network. These should be taken as illustrative estimates which can help communicate the economic value of the range of socio-economic co-benefits stemming from the ecosystems covered by the Natura 2000 network.

There is a clear need for further site based studies which are more geographically spread across the EU, that cover a wider range of ecosystem services and are done in a comparable manner which would help create an improved evidence base for future assessments – as well as being immediately useful to demonstrate benefits for the local to national to EU stakeholders . The road map and details for the way forward is presented in Chapter 7.

5 OVERALL ASSESSMENT OF THE BENEFITS OF NATURA 2000: PART 2: ECOSYSTEM SERVICE APPROACH

Key Messages *(see also subsections for additional key messages)*

The approach used in this section of the report involves the assessments of the value of the individual ecosystem services that Natura 2000 delivers - attempting to quantify service delivery for each type of service and aggregate across the network. This has been found to be more feasible for some services (carbon and recreation, for example) than others (pollination, natural hazards, water purification) given the site specificity of services and data availability. The analysis is therefore more quantitative/detailed for some services, more qualitative for others, and potential improvements for future research are noted when relevant.

The Natura 2000 network plays a critical important service of storing carbon and improvements in land management will increase the carbon benefits.

For **Carbon storage** - It is estimated that the Natura 2000 network currently stores around 9.6 billion tonnes of carbon, equivalent to 35 billion tonnes of CO_2, which is estimated to be worth between €607 billion and €1,130 billion (stock value in 2010), depending on the price attached to a ton of carbon.

In the future these carbon values can be increased. A policy scenario (Policy ON), with full protected area coverage (terrestrial PAs + fuller MPAs) and with a move to full favourable conservation status is estimated to generate a gain of at least a total of 1.71-2.86% by 2020 compared to a policy inaction scenario (Policy OFF), where no additional action is taken to conserve the current Natura 2000 sites over the next decade. Overall the increase in carbon storage benefits between 2010 and 2020 amounts to around €793 to €881 billion (lower and upper bound estimates for increase in value of carbon stock), partly due to the improved land management measures and partly due to the increase in the value of carbon itself, which applies to both existing stock in 2010 and gains over the period to 2020 from land management measures.

In addition it is estimated that efforts in terms of enlarging the total area of protected forest habitats (i.e. a version of the Policy ON scenario that leads to **quantity improvement of the Natura 2000 sites**) could generate at least €16 to €23 billion more in immediate benefits than the policy that focuses only on the improvement of on-site quality (for the period to 2020). The enlargement considered in the analysis was a 10 per cent increase in forest-protected areas in all Member States by 2020 with respect to their national forest coverage in 2010.

Money can be saved via working with natural capital, by reducing the cost of **water purification and provisioning:** While it has not been methodologically feasible to develop an EU wide assessment of the benefits of Natura network for water purification and provision, given the site specific nature of the benefits, it is clear from case examples that the Natura 2000 network can lead to cost-effective means of water purification and supply, offering significant savings over man-made substitutes.

Similarly for **natural hazards management**, case examples show that there is potential for significant savings and additional co-benefits from Natura 2000 and wider green infrastructure.

For wild **pollination** it is clear that this offers critically important value in Europe – with estimates suggesting that insect pollination is responsible for value of €14 billion per year in Europe, which is 10% of agricultural productivity related to human food (Gallai et al., 2009). However, the existing data does not allow us to identify which share of this is from Nature 2000 and which share is from wider green infrastructure, nor to estimate its spillover effects over surrounding agricultural areas.

Many Natura 2000 sites include important **agricultural practices**. Farmland covers almost 50% of the EU territory and agro-ecosystems represent 38% the surface of Natura 2000 sites. High Nature value farming can offer significant benefits for biodiversity as well as helping support local breeds, support genetic diversity and hence be part of the insurance value of the agricultural sector, supporting its resilience.

5.1 Overview of the ecosystem service-based valuation of Natura 2000

This chapter summarises the assessment of the benefits of Natura 2000 network for a core set of ecosystem services selected for this study (see also Table 2.3 for an introductory overview of the services covered and some examples). As noted earlier, most studies have focused on site specific values, and this is a first attempt to develop an aggregate value for the Natura 2000 network as a whole. There have naturally been significant challenges in the assessment relating to:

- Gaps in evidence and data (e.g. lack of base studies) regarding many services, making quantification difficult.
- The site specific nature of many services, particularly regulating services, making it difficult to extrapolate from site estimates.
- The range of other methodological challenges noted earlier (see chapter 3 and 4).

As a result, the assessments of different services present different levels of answers. The aim here was to only present aggregate numbers for the network as a whole where sensible, and to note where approaches should only be seen as 'experimental'.

A key part of this work was also to clarify needs for improving future assessment of the values. Therefore, we strived to clearly identify the current weaknesses in data and approaches to develop a road map for better understanding the economic co-benefits of Natura 2000 in the future.
As presented below, for carbon storage the overall value ranges for the carbon stored in protected areas are given. It has also been possible to do a 'policy-on' 'policy-off' analysis – looking at carbon benefits from a range of measures to be supported by the move to favourable conservation status. A policy-on (incremental

effects of implementing Natura 2000) has only really been possible for carbon storage. In other areas the gross benefits are presented.

For most other ecosystem services we present a mix of EU wide context numbers (e.g. the value of pollination, value of losses from natural hazards), experimental assessments and case insights. These still underline the benefits of Natura 2000, but we do not feel that any EU wide estimates are currently sufficiently robust to merit use in any formal documentation

It should be noted that relatively good evidence is available for recreation and tourism services, which are usually associated to significant monetary benefits. Estimates of their value have been made separately under a parallel project (BIO et al, 2011 forthcoming) and hence not included in this technical report (although due reference is made in the synthesis report).

The results are structured as follows:

Chapter 5.2 presents the value of carbon storage – this is included first given the high policy relevance and since that the values assessed are relatively robust.

Chapter 5.3 discusses the benefits related to natural hazards management – expected to become an increasingly important issue with climate change.

Chapter 5.4 focuses on water and explores the values of Natura 2000 for water purification (a regulating services) and water provision (a provisioning services),

Chapters 5.5 and 5.6 focus on food – with 5.5 first presenting insights on pollination, and 5.6 on agricultural production (an important activity across many Natura 2000 sites).

Health related benefits are explored in Chapter 5.7, which focuses on the provisioning services of natural medicines and genetic materials (which also touch upon generic diversity for crops), Chapter 5.8 on air quality and Chapter 5.9 on health impacts. Chapter 5.10 complements this with a brief discussion on biological control, which supports health and of course a range of other services (e.g. agricultural productions).

The Marine environment, focusing primarily on fish provision, is covered in Chapter 6.

As noted above, tourism and recreation are covered in a parallel study.

5.2 Climate regulation: carbon storage

Key Messages

- In general carbon stock density appears to be relatively high across the European Natura 2000 sites. Many of them harbour several ecosystems that are important current storages of carbon and offer significant opportunities for further carbon sequestration, including sites located on forested lands, wetlands, agricultural lands, and marine and coastal ecosystems.

- It is estimated that the Natura 2000 network currently stores around 9.6 billion tonnes of carbon, equivalent to 35 billion tonnes of CO_2, which is estimated to be worth between €607 billion and €1,130 billion (stock value in 2010), depending on the price attached to a ton of carbon. These estimates should be seen as a first indicative assessment of the value of the stock of carbon in the Natura 2000 network, and as a conservative estimate given that part of the network (marine and some terrestrial habitats) could not be fully covered in the analysis.

- Of the different ecosystems, the forest habitats contain the highest carbon value in the network, ranging between €318 and €610 billion in 2010. The second highest carbon value is contained in the dryland (grassland) system, ranging between €106 and €197 billion in 2010, followed by marine and inland water ecosystem, which account for €92 - €171 billion and €84 -157 billion, respectively.

- In the future these carbon values can be increased. A policy scenario (Policy ON), with full protected area coverage (terrestrial PAs + fuller MPAs) and with a move to full favourable conservation status is estimated to generate a gain of at least a total of 1.71-2.86% by 2020 compared to a policy inaction scenario (Policy OFF), where no additional action is taken to conserve the current Natura 2000 sites over the next decade. The increase in carbon sequestration will be due to the increase in the area covered and continued sequestration.

- Overall the increase in carbon storage benefits between 2010 and 2020 amounts to around €793 to €881 billion (lower and upper bound estimates for increase in value of carbon stock), partly due to the improved land management measures and partly due to the increase in the value of carbon itself, which applies to both existing stock in 2010 and gains over the period to 2020 from land management measures. The underlying values of carbon used were €17 to €32 per tonne of CO_2 in 2010 and €39 to €59 per tonne of CO_2 in 2020 (based on DECC, 2009; EC, 2008 and Centre d'Analyse Stratégique, 2009).

- In addition it is estimated that efforts in terms of enlarging the total area of protected forest habitats (i.e. a version of the Policy ON scenario that leads to **quantity improvement of the Natura 2000 sites**) could generate at least €16 to €23 billion more in immediate benefits than the policy that focuses only on the improvement of on-site quality (for the period to 2020). The enlargement considered in the analysis was a 10 per cent increase in forest-protected areas in all Member States by 2020 with respect to their national forest coverage in 2010.

5.2.1 What is the service: Description of the climate regulation service

Regulating services provided by natural habitats and ecosystems include a vast array of benefits, including climate regulation (through carbon sequestration) and others such as water regulation and purification, soil erosion control and so on. In particular, ecosystem based climate regulation refers to the sequestration of carbon from the atmosphere by plant tissue and the capacity of living biomass, litter and soil organic matter in terms of carbon storage in the course of time (IPCC, 2006). In this context, it is important to distinguish between carbon sequestration and carbon storage. The first refers to the process of carbon flow cycling that is captured from the atmosphere by trees and other plants through physical and biological processes, and is usually reported in terms of estimates per year of the tree growth. Instead, carbon storage refers to the amount of CO_2, or carbon equivalent that is stocked by above- and below- ground biomass, dead wood, litter and soil organic carbon[17]. This takes place in forest ecosystems and/or many other ecosystems such as grassland, cropland and peatland, throughout their entire vegetative cycle (Penman, et al. 2003).

In addition, it is useful to distinguish between total carbon stocks (tC), which refer to total carbon stored by ecosystems in a given year, and net changes in carbon stocks, derived from natural carbon sequestration (e.g. increased stock via growth of trees), the expected carbon gains or losses (or annual 'carbon fluxes' in other words) from land-use practices and management, as well as discrete disturbances on managed land (e.g. fires, degradation from pests). Such a distinction can be applied to the calculations made for many ecosystems, including forests, croplands, grasslands, wetlands, and other land uses. The carbon stock is useful for providing us a general picture of ecosystems carbon capacity, whereas the carbon flux is essential to better understand the consequences of land-use changes and land management practices on the existing carbon sinks.

As far as the Natura 2000 habitats are concerned, an estimate of both total carbon stocks and the net changes of carbon associated with a particular habitat type may serve as an important indicator for evaluating the impacts of land-use and management practices in Europe, as these practices may have either immediate or long-term impacts on carbon stocked in ecosystems.

In the Natura 2000 network, many sites harbour several ecosystems that are important current storages of carbon and offer significant opportunities for further carbon sequestration, including sites located on forested lands, wetlands (e.g. peatlands) agricultural lands (especially croplands, grasslands, and range lands), biomass croplands, deserts and degraded lands and boreal wetlands and peatlands (Kettunen, et al., 2009). In particular, forests sequester the largest fraction of the terrestrial ecosystem carbon stocks on the planet, estimated at 1,640 PgC globally (equivalent to 1,640 Giga tons or billion tons of carbon) (Sabine et al., 2004). This suggests that forest ecosystems in the Natura 2000 network are of key importance in retaining already captured carbon and in this way reducing carbon emissions. Moreover, changes in forest ecosystems in terms of

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[17] Above- and below- ground biomass, dead wood, litter and soil organic carbon are known as the 5 Carbon pools.

deforestation, afforestation, fertilization, tree harvesting, and natural disturbance on managed lands can significantly affect the existing carbon sinks and lead to release of CO_2 to the atmosphere (Paustian, 2006). For example, Parry *et al.* (2007) estimate annual global anthropogenic emissions of CO_2 at about 10Gt, of which about 1.5 Gt is from land use change (mostly deforestation, at a rate of about 13 million hectares per year), accounting for some 15% of global CO_2 emissions. In comparison, in non-forest ecosystems (such as cropland, grassland), net biomass carbon stocks are considered to remain roughly constant, although there could be some reduction in stocks over time if land degradation is occurring (Paustian et al., 2006). Land-use and management practices on Natura 2000 sites can influence ecosystems in a way that affects greenhouse gases (GHGs) fluxes[18] over a period of several years to a few decades. This has been taken into account in the conservation measures of Natura 2000 network.

It should be also noted that in addition to terrestrial ecosystems, and their vegetation cover, marine ecosystems (including the marine protected areas) have an essential role in climate regulation via their effect on biogeochemical cycling and the biological 'pump' that moves carbon from the surface ocean and sequesters it in deep waters and sediments (MA 2005). However, our knowledge is rather limited in terms of the carbon capacity contained in the marine protected areas, and in terms of how conservation measures may affect the carbon stocked in the ocean. Therefore, although the objective of this study is to evaluate the role of carbon sequestration services provided by all Natura 2000 habitats as a way of mitigating GHGs in the atmosphere and regulating climate, we will focus particularly on the terrestrial ecosystems. Finally, in order to assist policymaking, we will evaluate the potential impacts of alternative policies and management practices on Natura 2000 sites on the changes of net carbon stocks in the above-and below-ground biomass.

5.2.2 Where are the benefits: spatial distribution of the service of carbon storage

Figure 5.1 shows a globally consistent map of carbon storage in terrestrial ecosystems, produced using globally consistent estimates for above- and below- ground biomass. It is estimated that earth's terrestrial ecosystems store an approximately 2,052 giga tons of carbon in their biomass and soil (Campbell, et al. 2008). Two distinct bands of high carbon density can be noted: in the northern latitudes and the tropics.

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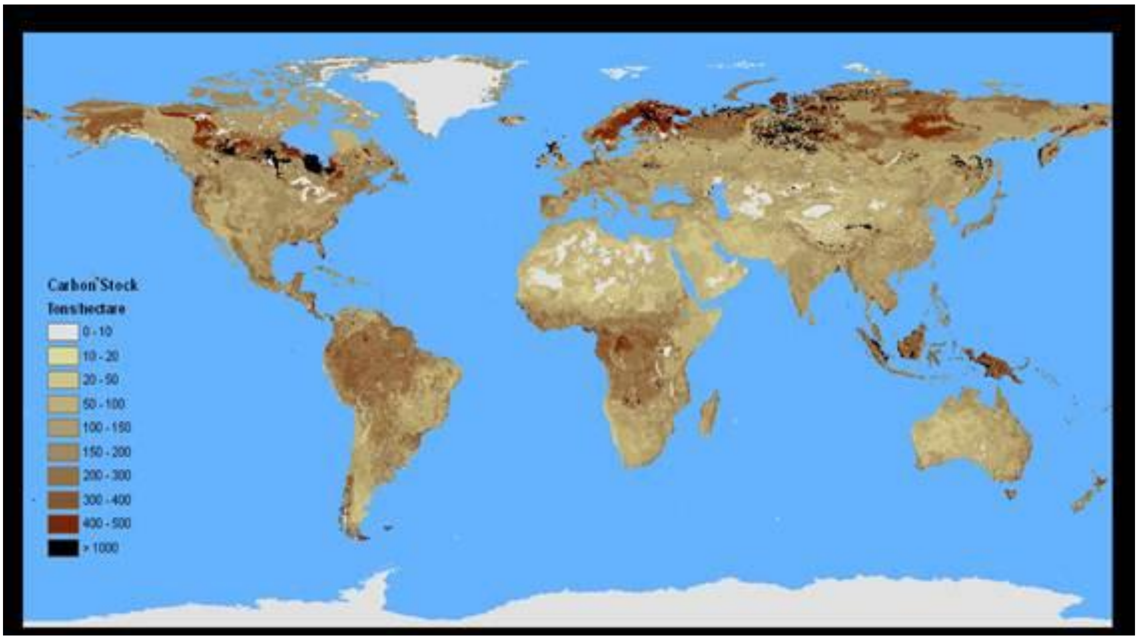
[18] CO2 fluxes between the atmosphere and ecosystems are primarily controlled by uptake through plant photosynthesis and release via respiration, decomposition and combustion of organic matter.

Figure 5.1: Global carbon stock density in terrestrial ecosystems (above and below ground biomass plus soil carbon)



Source: Campbell et al. 2008: pp6

In the context of Europe and the Natura 2000 sites, carbon stock density appears relatively high across Europe. In particular Northern European countries, where boreal forests are predominant, shows much higher carbon storage potential in terms of high carbon density in the soil and biomass (Figure 5.1). This suggests that conservation measures focusing on maintaining the existing carbon storage in, for example, forest ecosystems[19] might turn out to be cost-effective measures[20] to meet the conservation and climate mitigation objectives in those countries. This is particularly clear in the case of forest fires. In other words, by saving the same hectare of forest from burning down, we can gain higher carbon benefits from forests located in the Northern latitudes, as more carbon is prevented from being released to the atmosphere. Moreover, as far as cost is concerned, areas with the lowest costs involved in sequestering carbon are the most cost-effective locations. The map below (Figure 5.2) represents a geographic distribution of the costs involved in sequestering carbon (EUR/ton), calculated by combining the biological potential for carbon sequestration with estimated costs of reforestation (Kettunen, et al., 2009; Benitez et al. 2007). It shows that the costs of establishing forest areas appear to be higher, or in other words lower cost-effectiveness, in central and northern Europe, e.g. Italy, Austria, Scotland, Ireland and also around the Balkan area (as according to the Benitez et al. 2007, Figure 5.2).

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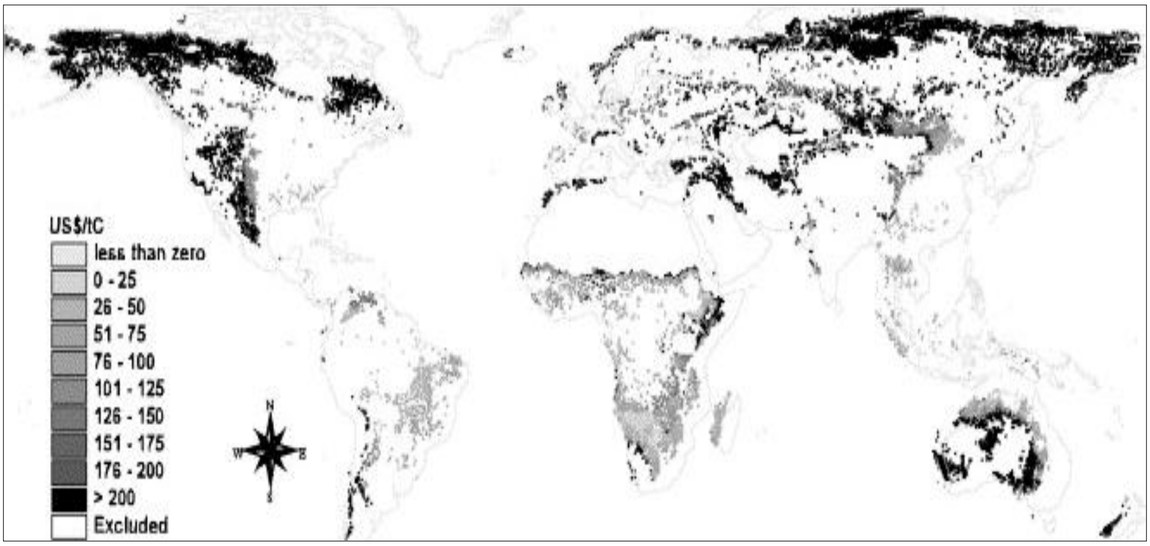
[19] Other ecosystems will also offer significant opportunities for cost-effective carbon storage and conservation measures. A most notable example is peatlands. Another is agricultural lands where change in agricultural practice can also result in cost-effective measures.

[20] Whether they are cost effective will depend on the site characteristics as well as other issues such as opportunity cost.

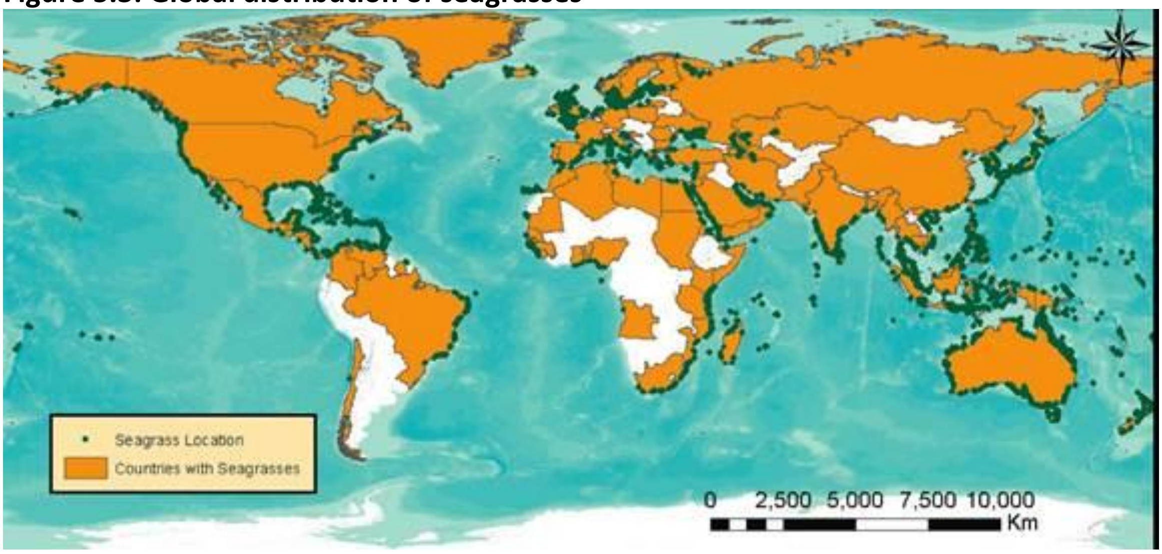
Figure 5.2: Geographical distribution of carbon costs



Source: Benitez et al. 2007

In addition to the terrestrial ecosystems, two types of coastal habitats in Europe appear to possess the greatest GHG mitigation potential, namely seagrass meadows and salt marshes[21]. The amount of carbon held in living biomass is much more variable among the habitat types: seagrasses contain 0.4–18.3 tCO2e per hectare, and salt marshes, on average, a few times higher than that at 12–60 tCO2e/ha (Murray et al. 2011). Figure 5.3 and 5.4 present two maps of the distribution of seagrass and salt marshes across the globe.

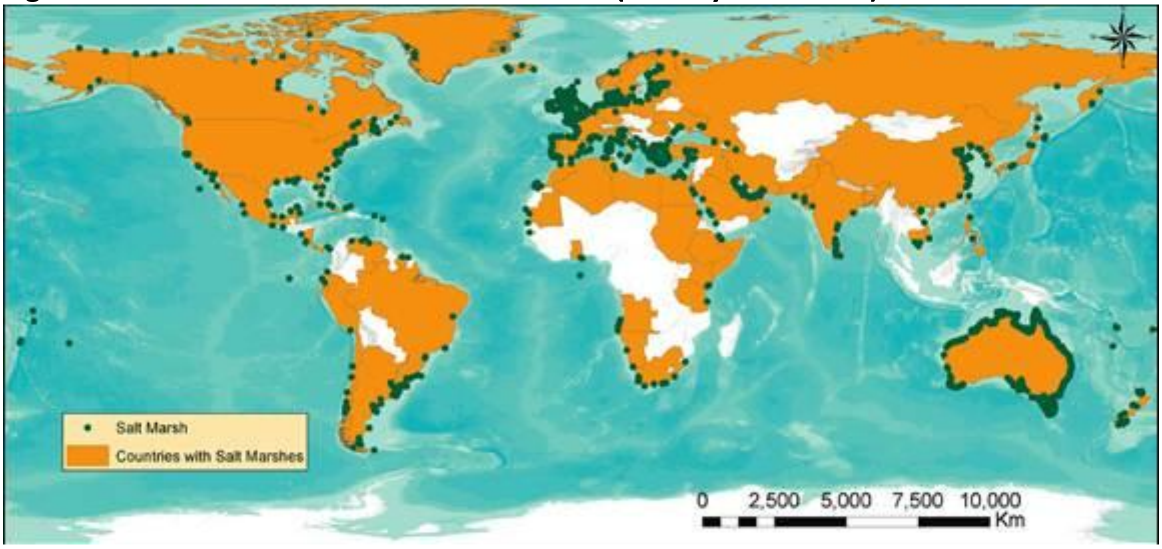
Figure 5.3: Global distribution of seagrasses



Source: Murray et al. 2011

21 Although mangroves is among the coastal ecosystems with great potential as carbon sink, we do not this ecosystem in the present analysis as they are most abundant in the tropical and sub-tropical zone.

Figure 5.4: Global distribution of salt marshes (Murray et al. 2011)



Source: Murray et al. 2011

5.2.3 How to estimate the benefits: methodological approach

Land use policy and land management practices to protect existing carbon stocks in the soils of terrestrial ecosystems, including increasing the resistance of carbon sequestration in forest and agriculture soils, will be crucial to an effective implementation of a climate change mitigation strategy. Furthermore a good understanding of the potential economic consequences of land use and management practices will contribute to defining the cost-effective policies in Europe to conserve and protect the existing ecosystems and natural resources and to cope with increasing threats due to climate change. A comprehensive economic valuation of carbon benefits provided by Natura 2000 sites needs a solid scientific base. For this reason, the estimation of the carbon benefits in the present report will be conducted following the following 3 steps, strictly respecting the 2003 IPCC Good Practice Guidance (GPG) *for Land Use, Land Use Change, and Forestry*:

Step 1. Characterization of the Status Quo and Baseline Scenario. This involves profiling the current carbon store and associated economic value provided by all Natura 2000 sites in Europe in a reference year (status quo)[22]. To do this, we need to estimate the biophysical-carbon stocks in the European Natura 2000 sites and combine these with a monetary metric unit, typically the social cost of carbon or the market price of carbon, which reflects the marginal abatement cost of carbon. These two measurements will allow us to calculate the economic, or welfare, value of carbon stocks.

Step 2. Characterization of a future scenario. This involves the study of policy driven land use changes and the assessment of their respective impacts in terms of changes in carbon stocks in the above ground biomass and below- ground soil organic matters. The baseline adopts a type of policy 'status quo' [23]and the future policy scenarios will focus

22 This was assumed to stay constant under the baseline scenario. This is a simplification; in reality this may prove conservative for some countries and not for others.

23 As per footnote 24.

on incremental changes in ambition in policy implementation. From an operative view point, we can proceed according to three main directions:

a. Trend analysis: by means of exploring the intertemporal analysis of land use changes and extrapolating these into future trends, typically within a 10 to 15 year time scale. Here we may also have specific information regarding the costs of land use degradation in the absence of policy or benefits from improved management on natural habitats;

b. Specific land-use policies: by means of working with well-defined land use changes as identified by policy makers or any other key stakeholder(s). Here we may have specific European policies on the use of land for bio-fuel, reforestation/afforestation as well as habitat de-fragmentation;

c. Spatial land use editor toolkit: this involves constructing an instrument in which the policy maker selects changes in land use to be sanctioned and the toolkit calculates the changes in carbon stocks and fluxes. The toolkit may be part of a decision support system characterized an explicit spatial dimension with information regarding land covers of specific habitats under consideration. (see for example, ARIES application in Mexico and US: http://www.ariesonline.org/case_studies.html).

Step 3. Interpretation of policy impacts and associated losses/gains on carbon value by comparing the selected policy scenarios and the baseline / 'status quo' scenario. Policy scenarios present a narrative description of the possible future paths regarding the Natura 2000 sites management in Europe. They are subjective and depend on the political preferences. In this regard, we consider mainly two realistic scenarios, i.e. (1) the policy ON scenario, where full Protected Area coverage (terrestrial PAs + fuller MPAs) with a move to full favourable conservation status will be evaluated; and (2) the policy OFF scenario, describing a narrative picture of the future in which some elements of degradation will occur across the Natura 2000 sites, with respect to the reference year 2010. In this report, year 2020 is defined as policy target for estimating the total changes.

5.2.4 Benefit assessment: preliminary estimate of the benefits

The calculation of current stocked carbon in Natura habitats

The 2003 IPCC - GPG *for Land Use, Land Use Change, and Forestry* has developed a systematic approach to calculate the total carbon stocks in above-and below- ground biomass, dead wood, litter and soil organic carbon by six land-use categories, i.e. forest land, cropland, grassland, wetlands, settlements, and other land. Each land-use category is further subdivided into land remaining in that category (e.g., Forest Land Remaining Forest Land) and land converted from one category to another (e.g., Forest Land converted to Cropland) (Penman et al. 2003). Among all the land uses, forests are the most important terrestrial ecosystems in terms of proving carbon-regulating services. To estimate the stocked carbon in plant and woody biomass, national Forest Inventory Data (FID) with annual greenhouse gas (GHGs) inventories in the Agriculture, Forestry and Other Land Use (AFOLU) are commonly used. From these we can calculate not only the total carbon stocks under each land-use category but also the net carbon changes as a result of growing biomass and land conversion. Typically, carbon stocks are estimated by first estimating the total biomass stocks on land and then convert then to carbon stocks using a conversion factor. By dividing total stocked carbon by the area of the ecosystem or habitat which provides the service, we can approximate the carbon density (tC/ha) of this particular type of ecosystem or habitat. As for estimating the changes of carbon stocks, there are two methods can be used depending on data availability:

1. Gain-loss method (also known as 'default method'): the carbon stock changes are estimated by considering all relevant processes, and calculated as the difference between annual carbon gains (due to growth of tress) and carbon losses (due to harvest, fires and other natural loss and disturbance);

2. Stock change method: the carbon stocks changes are the difference of carbon stocks for a given forest area at two points in time. This method is relatively less data demanding compared to gain-loss method and therefore is preferred in the present study due to limited time and data availability.

The current calculation of carbon density (tC/ha) for the terrestrial ecosystems relies on field measurements, taking into account total carbon stored by each land-use category in aboveground biomass and soil organic carbon stored up to 1m depth belowground (World Bank, 2009). This type of research is often costly and time-consuming. As regards Natura 2000 sites, the simplest and most practical way of estimating carbon densities for all the habitats concerned would be a survey of the literature. In the present study, carbon density by habitat is selected from the studies that included habitat types most relevant to the Natura 2000 habitat classification. Table 5.1 summarises the reviewed global average carbon density for a number of habitats, including temperate forest, boreal forest, temperate grass, desert/semi-deserts, tundra, wetlands, cropland, seagrass and salt marshes[24].

Table 5.1: Selected average carbon density estimates in the literature

Habitat type	Average carbon density estimated (tC/ha)	Reference
Temperate forest	150	World Bank (2009)
Boreal forest	410	
Temperate grass	240	
Deserts/Semi-deserts	40	
Tundra	130	
Wetlands	690	
Cropland	80	
Seagrass	212	Murray et al. (2011)
Salt marsh	285	

Furthermore, the selected carbon density estimates are applied to corresponding Natura 2000 habitat types, as shown in Table 5.2. Thus, total carbon stocks by habitat can be

24 It shall be noted that for marine and coastal habitats, both carbon in the living biomass and soil organic carbon are counted for in the present calculation.

calculated by multiplying carbon density of each habitat type by its total. Note that forest habitats in the Natura 2000 network are classified in terms of broad-leafed deciduous, coniferous, evergreen woodland and mixed forest, which is inconsistent with most of studies that we have found in the literature. These studies distinguish forests by biome classification, i.e. temperate, boreal and tropical forests. We are aware that carbon densities differ across forest biomes, however, we are not able to disentangle different forest biomes from the Natura 2000 habitats. The problem of data inconsistency among studies forces us to apply an average estimate of the carbon densities derived from temperate and boreal forest biomes in the literature to all forest and other woodlands that are counted in the Natura 2000 sites.

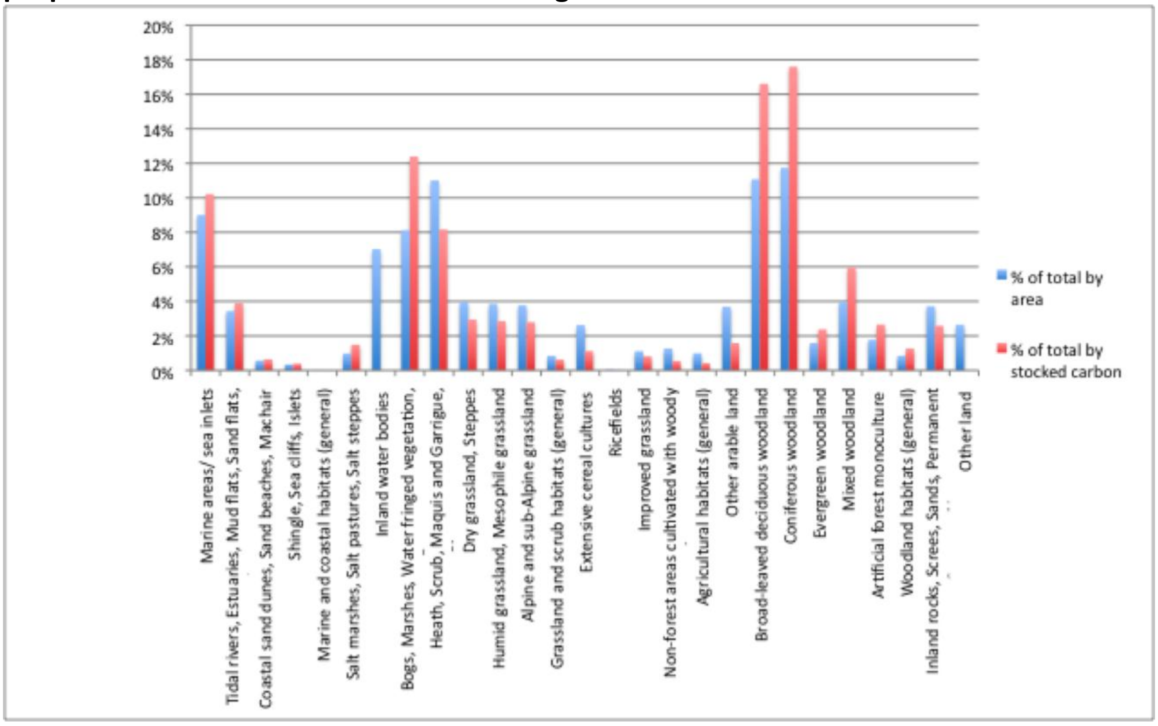
Table 5.2: **Selected estimates of carbon densities for Natura 2000 habitats**

MA ecosystem classification	Natura 2000 habitat types	Applied value of carbon density (tC/ha)
Marine and costal ecosystem[1]	Marine areas/ sea inlets	212
	Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons (including saltwork basins)	212
	Coastal sand dunes, Sand beaches, Machair	212
	Shingle, Sea cliffs, Islets	212
	Marine and coastal habitats (general)	212
Inland water ecosystem[2]	Salt marshes, Salt pastures, Salt steppes	285
	Inland water bodies (Standing water, Running water)	
	Bogs, Marshes, Water fringed vegetation, Fens	285
Dryland ecosystem[2]	Heath, Scrub, Maquis and Garrigue, Phygrana	139
	Dry grassland, Steppes	139
	Humid grassland, Mesophile grassland	139
	Alpine and sub-Alpine grassland	139
	Grassland and scrub habitats (general)	139
Cultivated ecosystem[2]	Extensive cereal cultures (including Rotation cultures with regular fallowing)	80
	Ricefields	80
	Improved grassland	139
	Non-forest areas cultivated with woody plants (including Orchards, groves, Vineyards, Dehesas)	80
	Agricultural habitats (general)	80
	Other arable land	80
Forest and other woodland[2]	Broad-leaved deciduous woodland (NB = temperate deciduous forest)	280
	Coniferous woodland (NB: temperate forest)	280
	Evergreen woodland (NB: temperate forest)	280
	Mixed woodland (NB = temperate)	280
	Artificial forest monoculture (e.g. Plantations of poplar or Exotic trees)	280
	Woodland habitats (general)	280
Mountain[2]	Inland rocks, Screes, Sands, Permanent Snow and ice	130
urban settlement[2]	Other land (including Towns, Villages, Roads, Waste places, Mines, Industrial sites)	

Sources: 1. Murray et al. (2011); 2. World Bank (2009);

The areas of total 27 different types of habitat included in Natura 2000 network are reported by European Environmental Agency for total 20 Member States – see Table A1.a and A1.b in Annex 1. By multiplying the carbon density selected for each habitat type (as identified in Table 5.3) by the size of the habitat, we can obtain the total carbon stocks currently stored by a specific type of habitat at country level – Figure 5.5 or see A3.a and A3.b in Annex 2 for details. The overall area of the habitat types covered in the analysis is 51.5 million ha, given the focus primarily on terrestrial sites[25]. The use of a lower area of Natura 2000 network, necessary for the carbon analysis given data availability and needs, underlines that the results further below should be seen as a very conservative estimate.

Figure 5.5: Percentage of habitats within the Natura 2000 network and the respective proportional contribution to carbon storage.



Source: own calculation

Our results show that total stocked carbon in the Natura 2000 network covered in the analysis is about 9.6 giga tons[26]. Of this total, forest and other woodlands present the most important carbon sinks, accounting for 52% of total carbon sequestrated (approximately 5.2 GtC). Second most important carbon sink is dryland ecosystems (including grasslands), amounting to 1.7 GtC of carbon stocks (or around 17% of the total carbon stocks), followed by marine/costal ecosystem (1.5 GtC or about 15% of total carbon stocks) and inland water systems (1.3 GtC or 14% of total carbon stocks). Although the current estimation is subject to high uncertainty and our current limited knowledge of carbon sequestrated by different nature habitats (in particular by marine/coastal ecosystems), our results may suggest that further investment in forested land conservation or sustainable forest management may enhance the overall carbon capacity of Natura 2000sites and increase the future carbon

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[25] This builds on 2009 data. This was the last data available at the time of study that allowed analysis according to the requirements of the methodology. Data source was: *EEA data 2009 (http://www.eea.europa.eu/data-and-maps/data/natura-2000-eunis-database)*

[26] Given that annual anthropogenic emissions of CO_2 are about 10 gigatons (Parry et al. 2007), all Natura 2000 sites store the equivalent of just under 4 years of global anthropogenic emissions.

credits. Finally, within the Natura 2000network, cultivated lands that comprise croplands for cereal production, rice fields and grassland for cattle feeding account for a very small portion of the total Natura 2000area. Therefore they make a limited contribution of 0.4 GtC carbon stocks (equivalent to 5% of total carbon stock). However, they are complex systems with great potential of increasing total carbon sequestration by improving cultivation activities, management practices and the use of machinery and fertilizers.

In order to value the carbon sequestration services of Natura 2000 habitats in monetary terms, a range of carbon prices are applied to reflect the damages caused by different degrees of climate change impacts[27]. In the present report, a number of well recognized EU studies (EC, 2008; DECC, 2009 and Centre d'analyse stratégique, 2009) have been looked at to choose the most suitable value for carbon prices in 2020, taking into account the 2020 emission reduction target for Europe as well as the estimated social costs of carbon[28]. Finally, the team has chosen to use the European Commission values (EC, 2008 and DECC, 2009) as the lower values and the value of the French study (Centre d'analyse stratégique, 2009) as the higher values – See Table 5.3.

Table 5.3: Carbon value used in this study (€/t, 2010)

CO_2-eq or C-eq	*Range*	*2010*	*2020*
Carbon dioxide (CO_2) or	*Low*	*17.2*[1]	*39*[2]
CO_2 - equivalent	*High*	*32*[3]	*56*[3]
Carbon (C) or C-equivalent	*Low*	*63.12*	*143.13*
	High	*117.44*	*205.52*

Note: the conversion between Euro/tCO2eq and Euro/tC is: 1€/tCO_2=3.67€/tC, based on the conversion to CO_2 from C using the ratio of molecular weights (44/12).

Source: 1. DECC (2009), 2. EC (2008), and 3. Centre d'analyse stratégique (2009)

The upper- and lower- bounds of carbon value in 2010 are applied to estimate the total carbon value provided by Natura 2000 sites and to reflect other co-benefits that conservation and forestry provide. Results are shown in Figure 5.6 or see Table A6.a, A6.b, A7.a and A7.b in Annex 2 for more details. It is important to note that, the use of a range estimate of carbon prices also aims to account for uncertainties of climate change damages, respectively.

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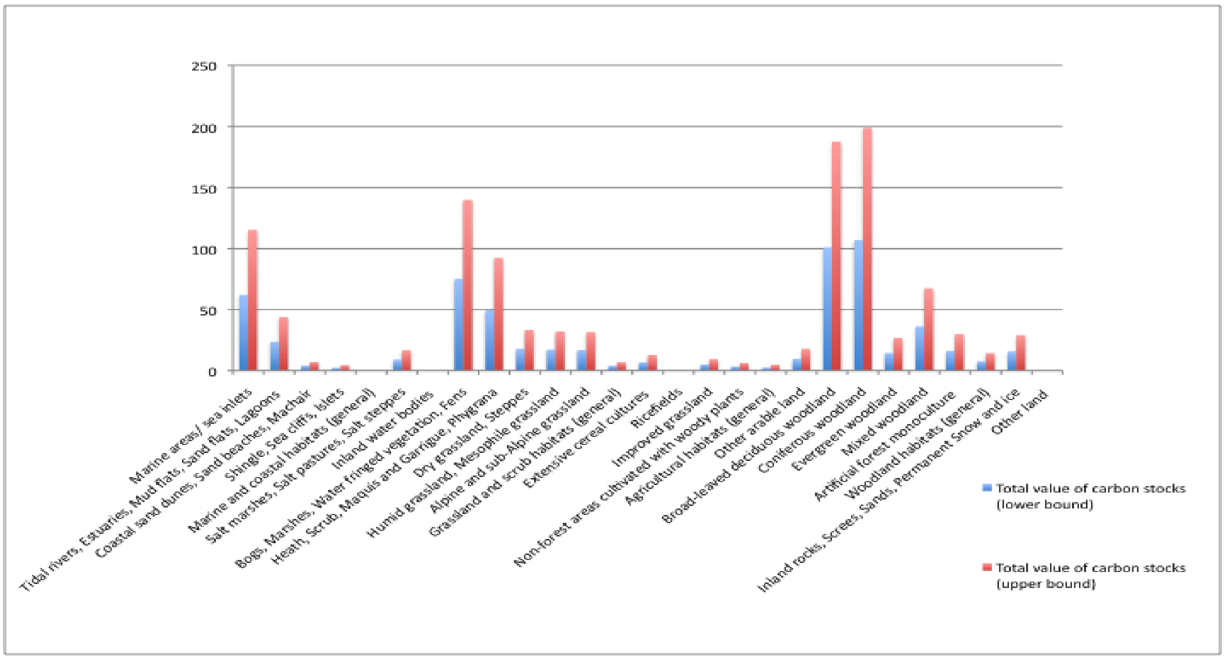
27 To assess the value of carbon storage different base values can be used, each with a different implication in meaning. In terms of value of Natura 2000, arguably, the marginal value of avoided damage from a tonne of carbon should be used as it reflects the benefits of action. Alternatives to this approach is the use of marginal costs of action to reduce carbon emissions. Furthermore, if trading markets exist, then a trading price could be used (e.g. ETS price), to the extent that there is market access. This selection of values can quickly get complicated by the range of estimates available and variability over time; some countries have offered guidance values (eg UK and France). Broadly speaking, guidance values used in this study present marginal damage cost estimates (higher values), and others the costs of national action (lower end of the range). ETS prices tend to be lower still as the strictness of the emission targets/objectives and the current economic situation is currently such that market prices are significantly lower than the above guidance ranges. In all cases the values will change over time.

28 Social Cost of Carbon is the net present value of the impact over the next 100 years (or longer) of one additional tonne of carbon emitted to the atmosphere today. It is outcome of Integrated Assessment Models (IAM), which translate climate damages into monetary costs (or externality) to a society.

Figure 5.6: Total economic value of carbon stocks by Natura 2000 habitats (Billion €, 2010)



Source: own estimation

All in all, our valuation estimates indicate that the total carbon value of the stock of carbon in the set of Natura 2000 habitats covered in the analysis lay between €607 and 1,130 billion in 2010, depending on the choice of carbon prices. Among all others, the forest habitats contain the highest carbon value in the network, ranging between €318 and 610 billion in 2010. The second highest carbon value is contained in the dryland (grassland) system, ranging between €106 and 197 billion in 2010, followed by Marine and inland water ecosystems, which account for €92 to 171 billion and €84 to157 billion, respectively. Note that these are stock values rather than annual values[29].

The calculation of changes in net carbon stocks in Natura 2000 habitats under future policy scenarios

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29 Hence care must be taken in comparing to results in chapter 4 and 6 which talk of annual values – from the flow of ecosystem services in one year.

Assessing, measuring and accounting for net changes in carbon stocks in natural ecosystems are particularly challenging tasks for two reasons. First, ecosystems display a natural variability in terms of carbon flows and fluctuations that are difficult to estimate (Eisbrenner and Gilbert, 2009). For example, the carbon uptake of the Earth's land and oceans has varied naturally over time (IPCC, 2000). Second, difficulties arise when we attempt to quantify the anthropogenic influences on carbon stocks in ecosystems, through large-scale changes of land use, particularly deforestation urbanisation and land-use conversions, as well the use and regulation of fertilisers, air pollution or waste deposits (Eisbrenner and Gilbert, 2009). Evidence has shown that past land-use conversions from forest land to crop production, wetland, grassland, and other land uses have resulted in substantial loss of carbon from the biomass and *vice versa.* Given that CO_2, the most common GHG, is sequestered in biomass and soils in forests, wetlands and grasslands at higher rates than in cropping systems, we can therefore expect a number of management practices that can result in an increase in soil organic carbon and carbon sequestrated by biomass, including the restoration of wetlands, the improvement of grassland and the establishment of agroforestry ecosystems and so on. On the other hand, policies that passively manage the existing protected areas or encourage land conversions from grassland to croplands will cause the release of stocked CO_2 to the atmosphere and reduce carbon stored in the ecosystems.

In this section, we focus on analysing and evaluating different impacts of potential EU policy options regarding the ambitions and targets of Natura 2000 management by 2020. In particular, we consider two different dimensions of policy impacts on the Natura 2000 habitats, namely policy ON and OFF scenarios. With respect to the policy ON scenario, we consider the positive impacts of land-use practices and management that: (1) improve the current status or quality of forest, grassland and cropland habitats without extending the conservation area (i.e. **qualitative aspects** of the policy), and (2) encourage the enlargement of conservation areas for certain habitats (i.e. the **quantitative aspects** of the policy). On the contrary, the policy OFF scenario refers to a Business-As-Usual scenario (or policy inaction scenario), in which we assume that the EU will not provide any future investments in the Natura 2000 habitats protection and management. As a consequence, certain degrees of natural degradation may occur on many Natura 2000 sites and thus result in the release of CO_2 to the atmosphere or loss of carbon value. However, it is scientifically uncertain, to what extent, the Natura 2000 habitats may degrade in the context of policy inaction. To simply the problem, we assume a zero rate of degradation to ease the current calculation, meaning that by 2020 the total quantity of carbon stocked in Natura 2000 habitats will remain the same as in 2010 (Status Quo). Nevertheless, it is necessary that future research shall shed light on this direction so as to improve the economic estimation.

(1) Assessing the carbon value under the Policy ON scenario:

To assess the impacts of 'policy ON' scenario on carbon stocks, we separately evaluate (a) the **quality improvement** of the existing Natura 2000 sites, based on the net annual change of C-stock (tC/ha/yr) due to improved land-use management (IPCC, 2000) – see Table 5.4 for details; and (b) the **quantitative changes** of Natura 2000 site in terms of changing in land-use composition and conversions between different land uses.

Table 5.4: A review of the relative potential in 2010 for net change in carbon stocks in the Natura 2000 network through some improved management

Activity	Global net annual change of C-stock (tC/ha/yr)	Global total net change of C-stock (MtC/yr)
Forest Management	+0.5	+100
Cropland Management	+0.3	+75
Grazing Land Management	+0.5	+70
Source: data are derived directly from the ECCP-Working Group on Forest Sinks final report, originally estimated by IPCC (2000)		

First of all, to estimate the economic gains of carbon stocks from the qualitative improvement of Natura 2000 sites, the annual change of C-stocks for three main habitat categories: forest, grazing lands and croplands, are estimated over a 10-year period of time to estimate the total stocked carbon in those habitats by 2020. This is done using the estimated net annual changes of carbon stocks under improved management practices given in Table 5.5. Furthermore, total carbon value provided by Natura 2000 sites in 2020 can be estimated by multiplying the estimated total carbon stocks in 2020 by the carbon price of that year. The gains of carbon value due to improved habitat management between the period of 2010 and 2020 are the difference of carbon values between the two points of time.

This calculation is expressed in Equation 5.1 below:

$$\Delta V_H = V_H^{2020} - V_H^{2010}$$

$$= p_{2020} \times \left[C_{2010} + A_H^{2010} \times \sum_{n=1}^{10} \Delta netC_H \right] - p_{2010} \times C_{2010} \qquad \text{Eq (5.1)}$$

: the estimated changes in carbon value by habitat types (*H*) (economic gains) between 2010 ( ) and 2020 ( ) (in 2010 Euro)

p: applied carbon prices for 2020 and 2010, respectively (in 2010 Euro)

A_H: The total area of the habitat in year 2010 (in *ha*)

: net annual change of carbon stocks (in tC/ha/yr)

C: total carbon stocked in Natura 2000 sites in year 2020 and 2010, respectively

n: a period of 10 years between 2010 and 2020

Second, the quantitative changes of Natura 2000 habitats in terms of changes in the total area and land-use composition by 2020 are projected based on the identified possible conversions between different land-uses in Natura 2000 networks – see Table 5.6. Note that In the case of Natura 2000 sites, since most of the sites are protected areas (PAs), it is unlikely that natural forest will be converted to cropland, grassland and other land uses. However, we shall note that the opposite conversion may happen if for example policy objective is to enlarge the coverage of forest areas and to restore wetlands. In Table 5.6, we summarize the potential conversion between Natura 2000 terrestrial habitats as well as the associated impacts on carbon storage.

Table 5.5: Possible conversion between different land-uses in Natura 2000 networks

From	To	Impacts on carbon storage
Cropland	Forest	+
Cropland	Grassland	+
Grassland	Forest	+
Grassland	Cropland	-
Grassland	Settlements	-
Wetland (e.g. peatland)	Cropland	-
Cropland	Settlements	-
Source: The table is summarized based on the global evidence reported by IPCC-GPG (2006)		

In practice, annual net changes of carbon stocks due to the land uses change are estimated using the **stock change method**, measuring the carbon stocks changes as the difference of carbon stocks for a given forest or other habitats at two points in time i.e. 2010 and 2020. **More specifically, to provide an illustrative example, we assume an increase of 10 per cent of forest-protected area in all the Member States by 2020, with respect to their national forest coverage in 2010.** This objective can be achieved in two ways. First, national environmental policy can set aside marginal farmland (or grassland which is already high in tree coverage and rich in biodiversity) to protect forest habitats close-by. Second, local policymakers can also decide to abandon some croplands and convert them to grassland to generate additional carbon credits.

In Table 5.6, we illustrate how to calculate the total area of habitats after land conversions have occurred. Bearing in mind the policy target of a 10 per cent increase in total forest area, 80 hectare of forest habitat in 2010 will extend to 88 hectare by 2020, accounting for 8-hectare of total increase, of which 50% is assumed due to conversion of cropland to forest and the other 50% is converted from grassland. This land-conversion matrix will be constructed at country level and then aggregated for the EU. It is important to note that the total area of Natura 2000 sites remains constant overtime.

Table 5.6: Example of land conversion matrix used for analysing the Natura 2000 sites (for illustration only)

Time 1 (2010)	Time 2 (2020)	Net land-use conversion between Time 1 and Time 2
F = 80	F = 88 (10% increase)	F = +8
G = 60	G = 56	G = -4
C = 70	C = 66	C = -4
Sum = 210	Sum = 210	Sum = 0
Note: F = Forest land, G = Grassland, C = Cropland		

As a consequence, we will be able to calculate the total carbon stocks in 2020 after the expected land-use changes. To keep it simple, we assume that the carbon densities for all habitat types remain unchanged by 2020, although it is crucially important to apply the estimated carbon densities to the new areas of the changed habitat. Finally, the annual change in carbon stocks in biomass for the same land-use category can be estimated using Equation 5.2 below (see Table A13 in Annex 2 for the estimated net changes of carbon after land conversions).

$$\Delta netC_H = \frac{(C_H^{2020} - C_H^{2010})}{(t_{2020} - t_{2010})}$$

$$= \frac{(A_H^{2020} - A_H^{2010}) \times D_H}{10} \qquad \text{Eq (5.2)}$$

$\Delta netC_H$: net annual change of carbon stocks by habitats (in tC/ha/yr)

D_H: estimated carbon densities by habitat type

A_H : The total area of the habitat in year 2010 (in *ha*)

C: total carbon stocked in Natura 2000 sites in year 2020 and 2010, respectively

t: year 2010 and 2020, respectively

Finally, the economic gains of carbon value as a result of the land use changes, they can be estimated following Equation 5.3.

$$\Delta V_H = p_{2020} \times (A_H^{2020} \times D_H) - p_{2010} \times (A_H^{2010} \times D_H) \qquad \text{Eq (5.3)}$$

(2) Results: estimated carbon value under the two Policy ON scenarios

The results derived from both qualitative and quantitative evaluation of potential policy ON impacts can be integrated in cost-benefits analysis of the policy alternatives and provide important insights on cost-effectiveness of these polices. In Table 5.7 and Table 5.8, we summarize the estimated total carbon stocks and the respective economic values by Natura 2000 habitats.

Table 5.7: Estimated total carbon stocks by Natura 2000 habitats (GtC)

Scenarios	Total	Marine Total	Inland Water Total	Dryland Ecosystem Total	Cultivated Ecosystem Total	Forest and Other Wood Land Total	Inland rocks, Screes, Sands, Permanent Snow and ice	Other land
Policy OFF Scenario in 2020	9.61	1.46	1.33	1.67	0.43	4.47	0.25	0.00
Scenario Policy ON-1 in 2020	9.78	1.46	1.33	1.74	0.45	4.55	0.25	0.00
Scenario Policy ON-2 in 2020	9.89	1.46	1.33	1.55	0.39	4.92	0.25	0.00

Note: see Table A3.a&b, A4.a&b and A5 in Annex 2 for detailed results

Table 5.8: Total Economic value of carbon services provided by Natura 2000 habitats (Billion €, 2010)

General habitats	Policy OFF – 2020		Policy ON_1: qualitative improvement - 2020		Policy ON_2: quantitative land-use changes – 2020	
	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound
Marine Total	208.6	299.6	208.6	299.6	208.6	299.6
Inland Water Total	191.0	274.3	191.0	274.3	191.0	274.3
Dryland Ecosystem Total	239.5	343.9	248.7	357.1	221.5	318.1
Cultivated Ecosystem Total	62.2	89.3	64.5	92.6	55.6	79.8
Forest and Other Wood Land Total	639.7	918.6	651.8	936.0	703.7	1010.4
Inland rocks, Screes, Sands, Permanent Snow and ice	35.6	51.1	35.6	51.1	35.6	51.1
Other land	0.0	0.0	0.0	0.0	0.0	0.0
Total	1376.7	1976.8	1400.3	2010.6	1416.0	2033.3
Δ wrt Policy OFF	-	-	+23.6	+33.8	+39.3	+56.5
Note: see Table A8.a&b, A9.a&b, A10.a&b, A11.a&b and A12.a&b in Annex 2 for detailed results						

As one can see, both future policy ON alternatives in terms of improving land-use management on terrestrial ecosystems, i.e. dryland, cultivated ecosystem and forests, and of enlarging protected area will have positive impacts on the total carbon storage and thus total economic gains to the society by 2020, with respect to the policy OFF scenario, namely policy inaction scenario. Excluding the costs of policy implementation, our results also suggest that in the short run, efforts in terms of enlarging the total area of protected forest habitats (i.e. Policy ON 2 involving a 10% increase in forestland) may generate at least €16 to 23 billion more immediate benefits than the policy that focus only on the improvement of on-site quality (i.e. Policy ON 1). This is because setting aside croplands and grassland as 'buffer zone' for forest conservation or regeneration can lead to higher growth rate of aboveground biomass and therefore increasing carbon density on those lands.

However, it is uncertain which of two policy options may generate higher benefits in the long run, if the entire carbon cycle and decay under different scenarios will also be counted for, as sustainable forest management practices may help ecosystems to reduce or slow down the process of releasing CO_2 to the atmosphere. On the contrary, if neither of the policy options were undertaken, we then place ourselves in a Policy OFF - 'policy inaction' scenario, where all the economic gains from improved policies on Natura 2000 sites are lost. Thus, a total of 1.71-2.86% of economic gains from scenarios ON1 and ON2 by 2020 can be intercepted as lower-bound estimates of the costs of policy inaction. If we take into account also the released carbon from degraded habitats (if a non-zero rate of degradation were applied instead), the total costs will be much higher.

5.2.5 Conclusions and recommendations for future analysis

In the present study, we adopted the state-of-the-art methodologies to quantify the total carbon stocked by Natura 2000 habitats as well as to project the future changes of carbon stocks influenced by alternative policy options for the management of Natura 2000 habitats by 2020. Furthermore, in order to estimate the economic value of Natura 2000 habitats, we used a range of carbon prices derived from the most recently EU studies, rather than a central estimate to count for uncertainty issues. In order words, nevertheless the reported economic valuation exercise is conducted based on the best information and knowledge available regarding the Natura 2000 sites, the authors are aware of a number of limitations in the estimation and suggest that the users should be cautious when interpreting and implementing the presented results for any policymaking. In addition to the issue of area coverage mention above (which leads to conservative results) we highlight a number of issues that shall be particularly considered:

1. Time issue. In this study, we consider a short-term policy scenario to evaluate the impacts of Natura 2000 management on carbon stocks by 2020. Despite the fact that the focus of our study is not on climate policy only, It however shall be noted that a 10-year period is rather short to evaluate precisely the policy impacts on changes in carbon stocks, knowing that the time it takes for a carbon atom to complete its cycle between atmosphere-biosphere systems is about 100 years[30] (CDIAC - Carbon Dioxide Information Analysis Centre: http://cdiac.ornl.gov/faq.html#Q16). Therefore, one should be cautious when using the present value estimates for any long-term policymaking debate.
2. The applied carbon density rates are estimated based on global evidence, rather than EU evidence, which means that our estimation of carbon stocks by the Natura 2000 sites may refer to a lower-bound estimate, as the carbon density in protected natural reserves are usually higher than average. In the future a more thorough assessment could usefully build on spatially explicit EU carbon values, which may benefit from GIS data and modelling.
3. The present assessment focuses only on terrestrial ecosystems, subject to our limited knowledge about carbon sequestration capacity by many essential ecosystems, such marine and costal ecosystems. Therefore, future efforts should be placed on improving our understanding, particularly on 'blue carbon' issues – i.e. those relating to marine ecosystems.
4. The policy assumptions on future land-use changes and their respective consequences are far too simple from the reality. A better understanding of the interface between CO_2 and other GHGs, especially in the case of agricultural land management, is essential for improving the overall estimation of land-use change impacts on net carbon changes.
5. The analysis of Policy OFF scenario is very conservative in the present study. In particular, the assumption of a zero degradation rate for all Natura 2000 habitats in the context of policy inaction is illustrative rather than realistic. However, it is

30 Ken Caldiera of the Carnegie Institution for Science has shown that bout 50% of the added CO2 due to an instantaneous doubling of pre-industrial carbon dioxide would be removed after about 200 years and about 80% of it would be removed after about 1000 years, but complete removal of the remaining 20% to the deep ocean and carbonate rocks would have to rely on geological processes operating over much longer time periods.

scientifically uncertain, to what extent, the Natura 2000 habitats may degrade in the context of policy inaction and how this degradation may affect the stocked carbon (which refers most likely to a non-linear relationship). This is a direction on which future research shall focus.

6. The costs of policy action are not tackled here, but shall be addressed in future research. In particular, hypotheses that the spatial variability of costs can be substantial shall be tested, as the results may shed light on the distributional dimension of the policy action and therefore shall be brought into the policy discussions.

As regards the area coverage, the area of the network has been changing significantly over the past few years, most recently due to the extension of the marine protected areas. There are also issues as regards overlap between SACs and SPAs (recall chapter 2), which require quite sophisticated spatial treatment to address accurately. It is expected that data in due form will become available in due course that can help overcome this issue. A road map for valuation for carbon storage/sequestration is presented together with other services and methods in chapter 7.

5.3 Moderation of extreme events (Avalanche regulation, Storm damage control, Wild fire mitigation, Flood control)

Key messages

- Natural hazards have caused significant damage across the EU over time. For the period 1990 – 2010 the value of economic losses from natural disasters in the EU-25 amounted to around €163 billion. Moreover, due to demographic trends and impacts of climate change, it is likely that the vulnerability of human settlements to natural hazards will increase in the future; risks and costs can be expected to rise as well.

- Given the important functions that natural barriers and green infrastructure can provide, Natura 2000 sites can and have played a role in the mitigation of natural hazards, such as floods, avalanches or landslides.

- Using natural measures to mitigate impacts of natural disasters can lead to cost effective solutions which are often less expensive than man made ones, and lead to a series of co-benefits (biodiversity, wider ecosystem services)

- In practice, Natura 2000 sites' contribution to flood control can complement wider green infrastructure (e.g. forest and farmland) as well as brown infrastructure (e.g. dykes). The three elements are interconnected spatially and functionally and this needs to be factored into land use and spatial planning.

- It is difficult to distinguish the specific role of Natura 2000 in natural hazard mitigation from that of other natural/protected sites, given that both can play a role, and that their beneficial effects can spread to wider areas beyond the location of the green infrastructure/natural assets.

- The site-specific nature of natural hazards mitigation and the limited data availability on the role of Natura 2000 in reducing risks across Europe means that, at this stage, it is not yet possible to estimate Natura 2000 wide benefits.

- It is needed to proactively explore the role of natural capital in helping to reduce natural hazards risks and impacts, focusing on the role of green infrastructure, protected areas and Natura 2000 in particular. This would allow identifying opportunities for cost savings and co-benefits in land planning policies and disaster prevention strategies.

- For future assessments, more primary valuations and research into the role of ecosystems in natural hazards prevention is needed. There is also growing potential in the use of GIS approach, which could be used to better identify the spatial distribution of natural hazards risks in the context of Natura 2000 protected areas designations.

5.3.1 *What is the service: Description of the moderation of extreme events service*

Extreme events in Europe have led to over eighty thousand cases of premature mortality over the period 1980 to 2010. Around 15 million people in Europe have been affected over the period with an associated cost estimated at around €163 billion. This equates to an annual average damages of €7 billion/year (see Table 5.9).

Table 5.9: Summary of Natural Hazards impacts on EU (EU-25; excluding Malta and Cyprus): number of people affected, mortality cases and costs (1980 to 2010)

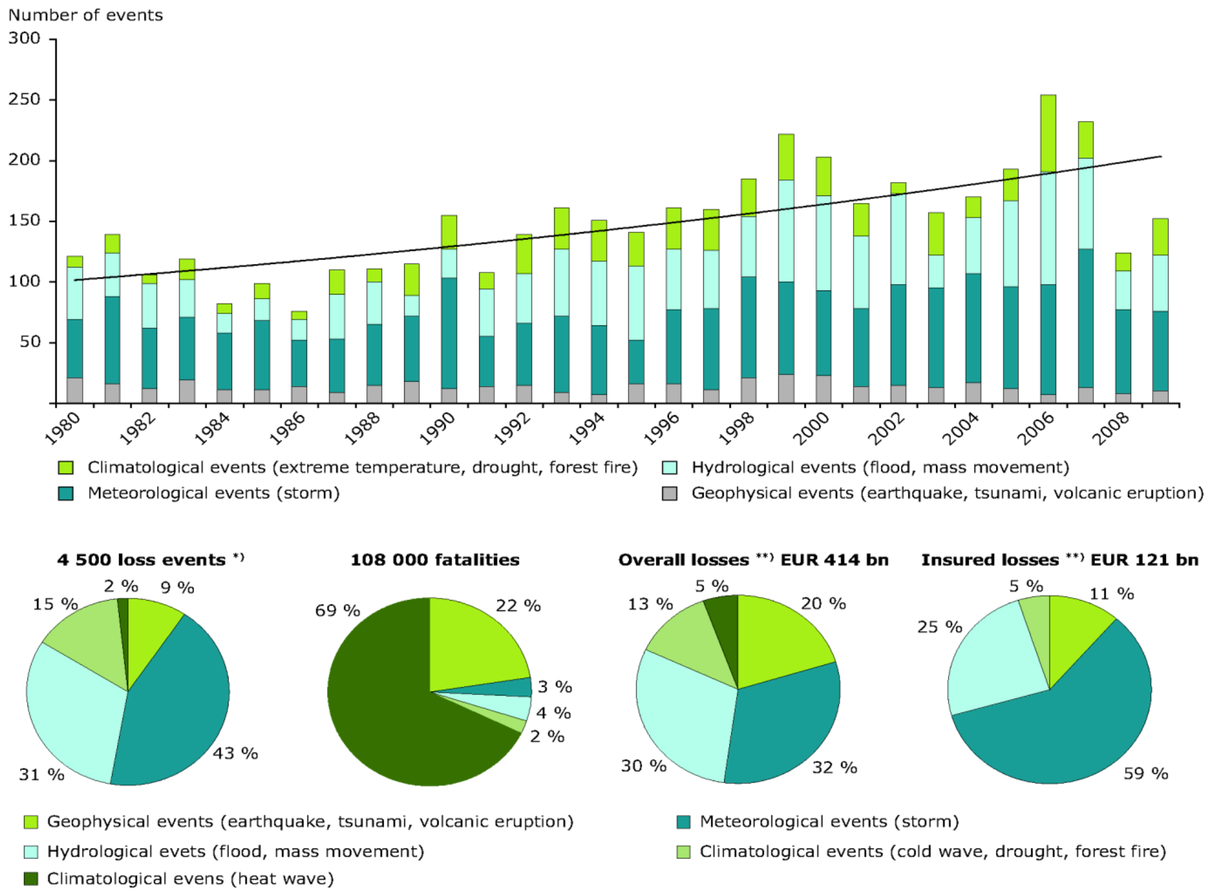
Natural hazard	Period 1980 to 2010			Annual average over the period 1980 to 2010		
	Death	Total affected	Damage (mil €)	Death	Total affected	Damage (mil €)
Drought	0	6,000,000	13,611	0	200,000	601
Extreme temperature	78,161	14,360	10,449	2,605	479	461
Flood	1,955	3,245,689	66,149	65	108,190	2,920
Mass movement dry	22	15	0	1	1	0
Mass movement wet	468	24,875	1,086	16	829	48
Storm	1,545	5,457,334	64,250	52	181,911	2,837
Wildfire	338	184,879	7,840	11	6,163	346
Total	82,489	14,927,152	163,384	2,750	497,572	7,213

Source: http://www.emdat.be/

Notes: Exchange rate of 0.755 $/EUR used (source: http://www.oanda.com/currency/average).

The figure below presents the occurrence of natural hazards throughout the last thirty years, grouped into four broad categories: climatological (heat waves), hydrological (floods, mass movements), meteorological (storms) and geophysical events (earthquake, tsunami, volcanoes). The distribution of impacts in terms of total causalities or total losses is also showed. The graph shows a significant increase in the occurrence of natural hazards, especially the meteorological and climate events. Storms appear to have the biggest incidence, and also lead to the highest economic losses. Heat waves, however, cause the major number of fatalities.

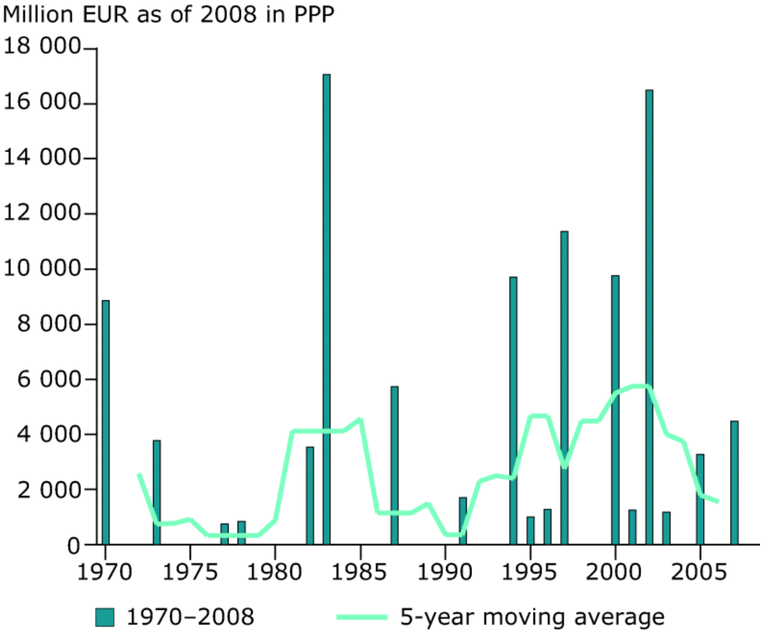
Figure 5.7: Natural disasters in EEA member countries from 1980 to 2009



Source: http://www.eea.europa.eu/data-and-maps/figures/natural-disasters-in-eea-member

Europe has suffered over 100 major damaging floods in recent years. It has been estimated that since 1998 floods have resulted in about 700 fatalities, the displacement of about half a million people and at least €25 billion in insured economic losses (EEA, 2004; see figure below). In addition, floods can also have negative impacts on human health. For example, substantial health implications can occur when floodwaters carry pollutants, or are mixed with contaminated water from drains and agricultural land (European Commission, 2007).

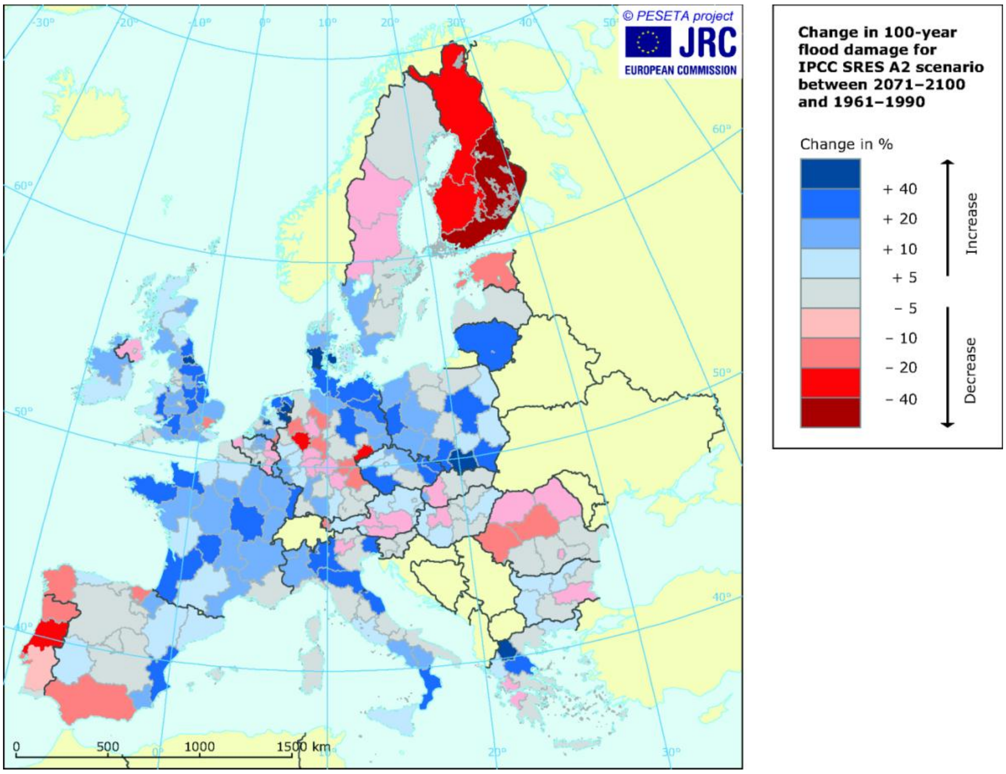
Figure 5.8: Losses from major flood disasters in Europe between 1970 and 2008



Source: *http://www.eea.europa.eu/data-and-maps/figures/normalised-flood-losses-in-europe*

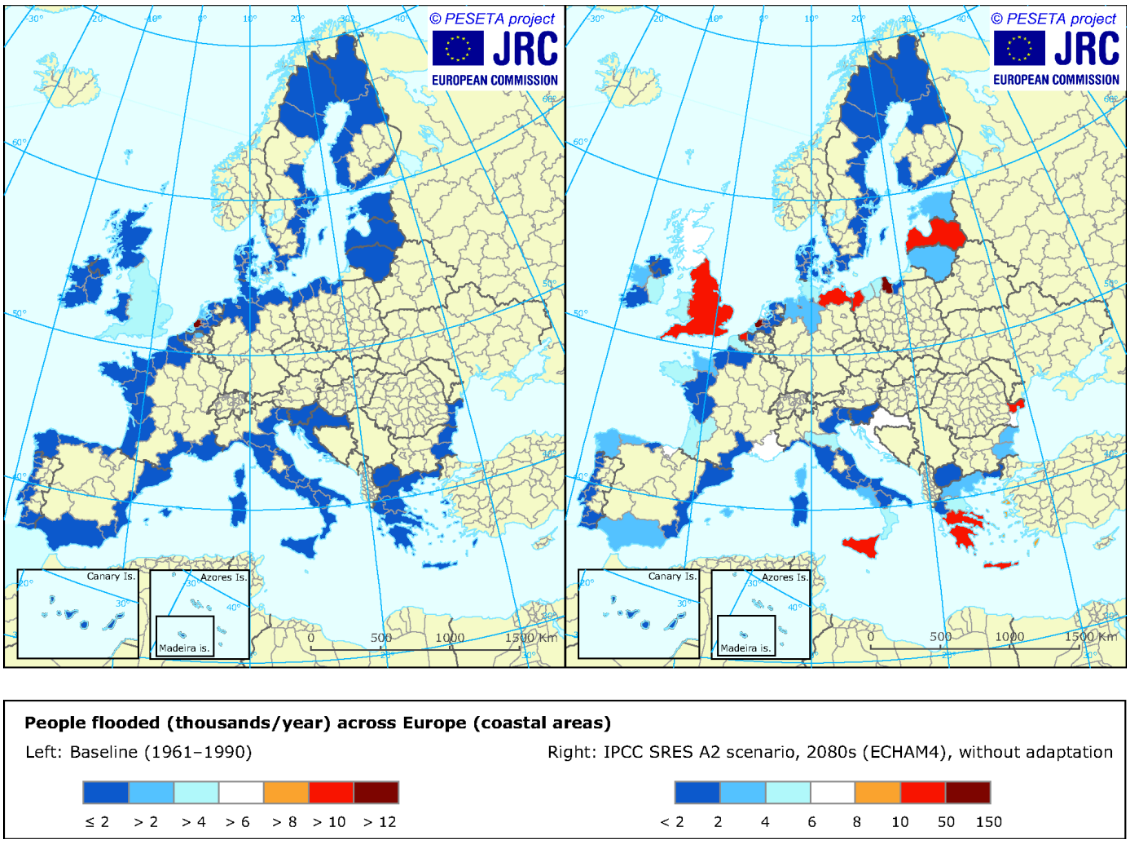
It is also widely acknowledged that the flooding risk in Europe is increasing as a result of climate change - i.e. due to higher intensity of rainfall as well as rising sea levels (IPCC, 2001) – as illustrated in the IPCC scenarios in the figures below. Additionally, there has been a marked increase in the number of people and economic assets located in flood risk zones (European Commission, 2007). The value of the regulation that is provided by different ecosystems is therefore likely to be escalating, given an increase in human vulnerability to natural hazards (TEEB, 2010).

Figure 5.9: Change in flood damage (2017-2100 scenario)



Source: http://www.eea.europa.eu/data-and-maps/figures/projected-change-in-damage-of-river-floods-with-a-100-year-return-period-between-2071-2100-and-1961-1990

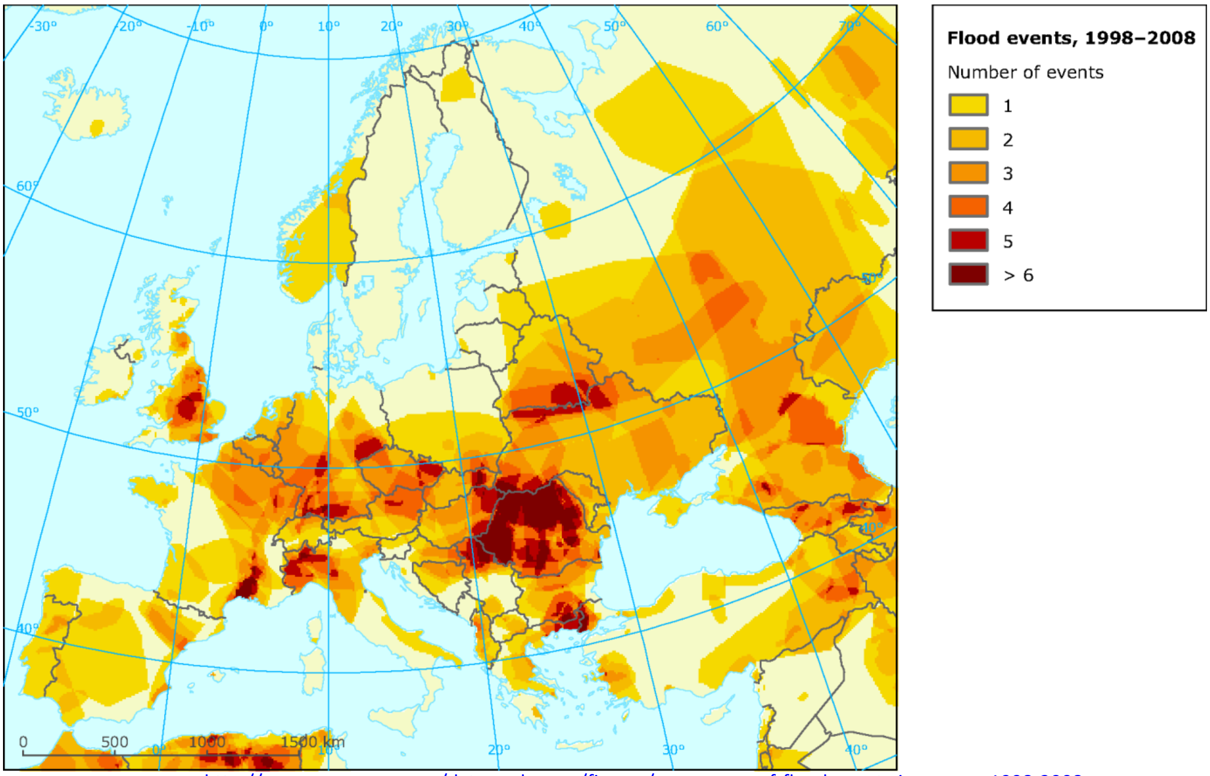
Figure 5.10: People flooded across European coastal areas (baseline and 2080 scenario)



Source: [*http://www.eea.europa.eu/data-and-maps/figures/modelled-number-of-people-flooded-across-europes-coastal-areas-in-1961-1990-and-in-the-2080s*](http://www.eea.europa.eu/data-and-maps/figures/modelled-number-of-people-flooded-across-europes-coastal-areas-in-1961-1990-and-in-the-2080s)

Changing climate also affects the amount of rainfall and available water resources, including the availability of groundwater. This can lead to water scarcity and over-exploitation of water which in turn can have several adverse effects, including economic costs. For example, the over-exploitation of ground water can cause saltwater intrusion. Therefore, the ability of ecosystems, including Natura 2000 sites, to regulate water flows is of increasing significance (water provisioning services are discussed in more detail in section 5.4).

Figure 5.11: Recurrence of flood events in Europe between 1998-2008



Source: EEA 2004 http://www.eea.europa.eu/data-and-maps/figures/occurrence-of-flood-events-in-europe-1998-2008

Ecosystems (especially forests and wetlands) can help reduce the likelihood or scale of extreme events – e.g. avalanches, storms, fire and floods – **sometimes at a lower cost than that of man-made risk reduction measures**. These benefits are naturally very site specific and depend on the interrelationships between extreme events, ecosystems, social systems (e.g. populations density) and economic systems affected (economic assets such as buildings and infrastructures).

With regard to water flows, natural ecosystem, including Natura 2000 sites, can play an important regulating role. Services include, for example, regulation of timing and magnitude of water runoff, regulation and **mitigation of floods** and support to recharging of ground water resources. From the ecosystem functioning point of view, water regulation services are based on the combined effects of vegetation and soil characteristics. Vegetation cover maintains certain soil characteristics, e.g. permeability, that enable infiltration of rain water into the ground. Reduced vegetation cover can therefore increase surface runoff and decrease infiltration, resulting in lower recharging of the groundwater reserves. Surface runoff, e.g. due to the clearing of forests in the upper catchment area, can also cause higher peak flows during the wet season, which in turn increase the risk of flooding. Similarly, straightening of rivers and suppression of natural flood plains can increase in the likelihood and adverse impacts of extreme flood events.

Ecosystems play also important roles in moderating the effects of **storms** on human systems. They affect both the probability and severity of events, and they can moderate the effects of extreme events, for example by protecting coastal communities from storms and hurricanes. Storm protection refers to the role of ecosystems in protecting society from storm damage. Storm impacts can be lessened through maintenance and management of environment vegetation and through natural or human-made geomorphological features (e.g. natural rivers, channels, dune systems, terrace farming etc.). Ecosystems such as coastal wetlands and dunes for instance can act as natural buffers to mitigate the effects of storms on coastlines, where storm risk to local population is likely to become higher with the rising of sea level due to climate change. Coastal wetlands for instance are said to reduce the damaging effects of hurricanes on coastal communities by absorbing storm energy in ways that neither solid land nor open water can (Simpson and Riehl, 1981).

An ecosystem's ability to mitigate **avalanches** is directly related to its forest cover and the density of trees that can reduce the strength of avalanches. Tree cover holds snow in place and, in an event of an avalanche, the impact of the snow against the trees slows it down.

Ecosystems ability to mitigate **wild fires** can be defined as the capacity of ecosystems to maintain natural fire frequency and intensity (MA, 2005). There are several important direct anthropogenic drivers that can effects ecosystem ability to mitigate wild fires, e.g. land management practices, land clearance and agriculture, housing development, logging, harvesting and reforestation and fire suppression schemes (MA, 2005). Also, trees with deep root systems may resist reduced precipitation longer before becoming flammable compared with trees with shallower roots (MA, 2005).

It is therefore clear that protected areas and wider natural capital / green infrastructure can contribute to mitigating risks of natural hazards, including flooding, fire, avalanches, and storms. In this study we focused primarily on flood control for the assessment of benefits of Natura at an EU scale, as data and evidence in this area were more readily available. Case examples as regards benefits of Natura 2000 for avalanches and storms, however, have also been noted to help clarify and communicate the benefits.

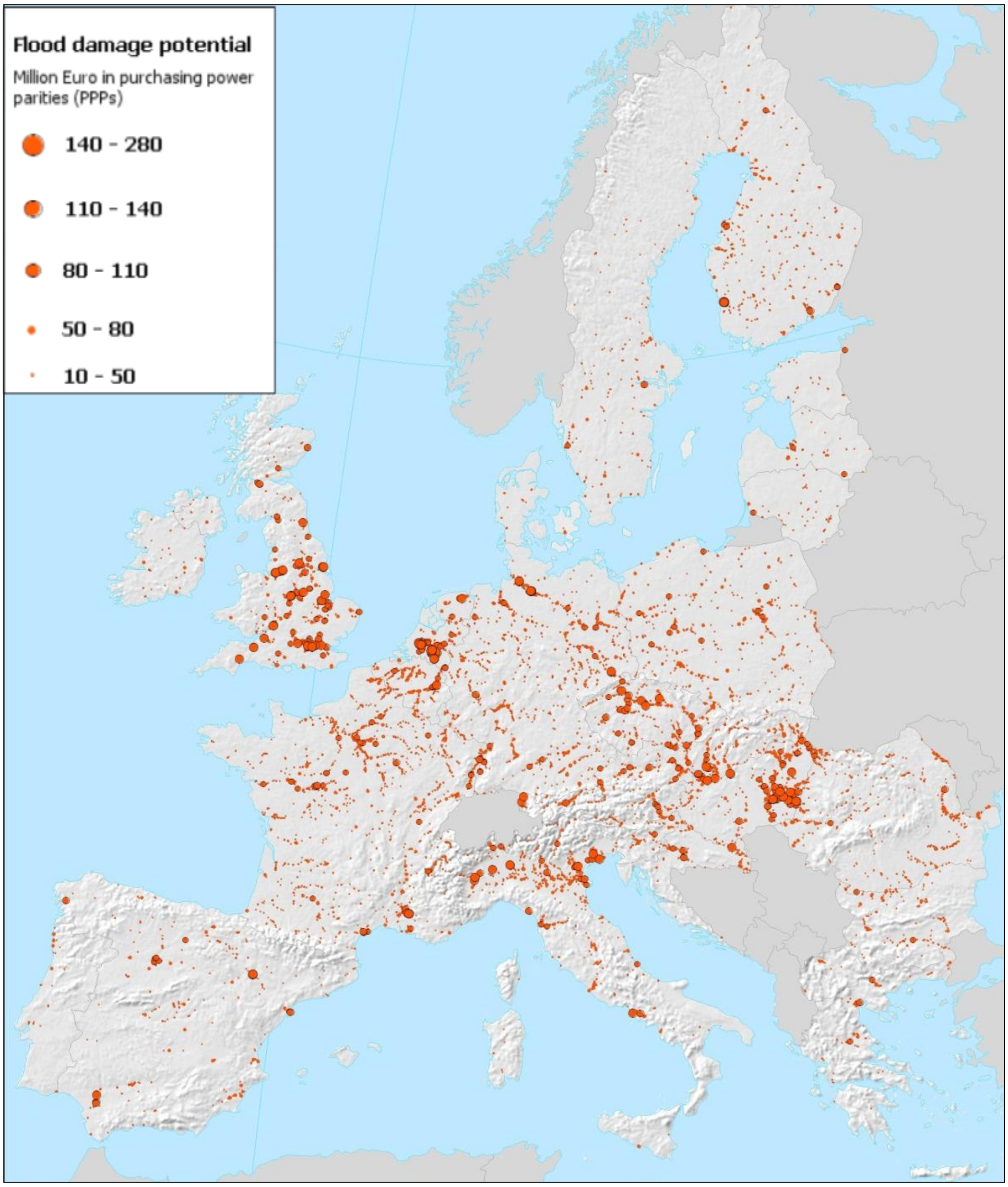
5.3.2 Where are the benefits: spatial distribution of extreme events

Among the wide range of benefits they provide, protected areas are known for their important role in mitigating the damaging impacts of natural disasters (e.g. TEEB, 2011; MA, 2005). In particular, protected areas are recognized to maintain healthy, intact and robust ecosystems, which help mitigate the impacts of disasters and restore destroyed or degraded areas (Mulongoy and Gidda, 2008). Protected areas play as well an important role in decreasing the vulnerability of communities to disasters and reducing their physical exposure to natural hazards, often providing them with livelihood resources to withstand and recover from crises (ibid).

There are numerous examples of protected areas and national parks serving as a defence against various natural disasters. For instance, national parks such as Triglav in Slovenia and Hohe Tauern in Austria explicitly recognise the value of such services in their management plans. In Spain, the reforestation of part of the catchment above the city of Malaga and its incorporation into Montes de Malaga Natural Park allowed to decrease the regular flooding that had affected the city for 500 years. The floodplain value of the Dyfi valley, draining the mountains of the Snowdonia National Park in Wales, was one reason for its recognition in 2009 as a biosphere reserve by UNESCO (EEA, 2010).

Site's ability to control extreme events depends on the ecosystem types they host and their characteristics. For instance, sites located along catchments areas (e.g. river slopes and floodplains) and coastal zones are likely to play a role in regulating water flows. In addition, sites located near areas suffering from water scarcity or floods could help maintain the water balance – see for instance a map of flood damage potential in the figure 5.12 below. For example, inland waters, such as lakes and wetlands, are traditionally considered to be very important for the temporal regulation of water flow, mainly by accumulating water during wet periods (reducing peak flow). In addition, there is evidence that floodplain wetlands have the effect of reducing or delaying floods. However, the role of headwater wetlands (e.g. bogs and river margins) in reducing floods has not been demonstrated. Given these variations, it is important to note that the actual potential to deliver flood protection differs from site to site.

Figure 5.12: Map of flood damage potential in Europe



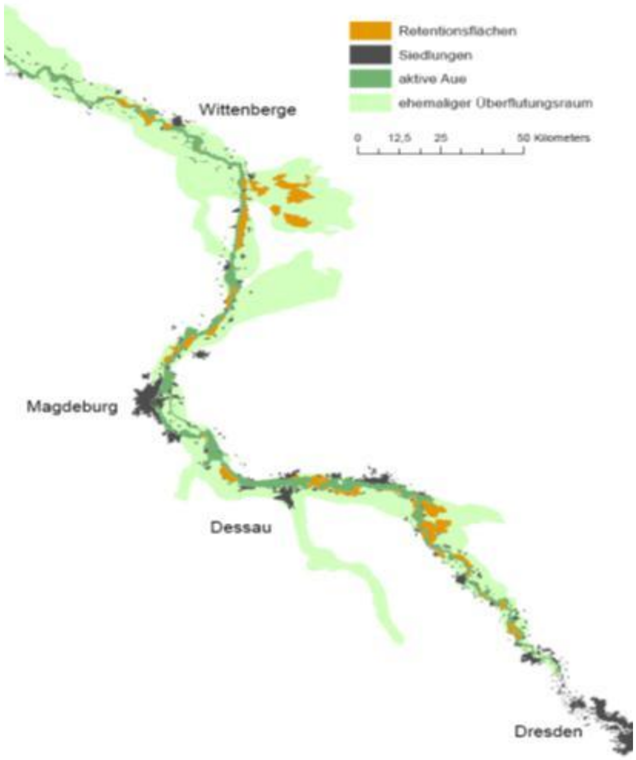
Source: JRC, 2011

Overall, growing attention is being paid to ecosystem-based solutions for natural hazards mitigation. Increasing evidence suggests that, in many cases, a degradation of natural ecosystems is likely to lead to exacerbated consequences of natural hazards (Dudley et al., 2010). Using ecosystem-based, rather than man-made, solutions has often proved to be significantly cost-efficient, and natural flood protection measures, for instance, are increasingly being incorporated into land-planning strategies (e.g. Government of the Slovak Republic, 2010). Some examples are illustrated in the boxes below. However, it has to be noted that the exact functioning of the effect of ecosystems on natural hazards mitigation is still insufficiently understood and needs to be improved (e.g. TEEB, 2011; MA, 2005).

Box 5.1 Elbe river, Germany

The flooding of the river Elbe, Germany, in 2002 led to damage of over €9 billion. It was estimated that flood damage, together with the cost of dams, by far exceeded the costs of upstream agreements with land holders as regards use of their land for flooding. In short payments to farmers and forest land holders was less than alternative costs of dams and expected flood damages.

After the flooding, the value of upstream ecosystems in regulating floods was re-discovered. As a result, local authorities started changing their spatial planning and seeking arrangements with landowners upstream.



Source: TEEBcase by Teichmann and Berghöfer (2010), Grossmann et al. (2010)

Box 5.2 Scheldt estuary, Belgium-Netherlands

Major infrastructural works were planned in the Scheldt estuary, flowing from Belgium into the Netherlands. These included the deepening of the fairway to the harbour of Antwerp and complementary measures to protect the land from storm floods coming from the North Sea.

A cost benefit analysis (CBA) was carried out, taking into account ecosystem services and using a Contingent Valuation study to value the recreational value of the new floodplains. It showed that an intelligent combination of dikes and floodplains can offer more benefits at lower cost than more drastic measures such as a storm surge barrier near Antwerp. The hydrodynamic modelling also showed that floodplains are the best way to reduce future flooding risks.

The CBA results revealed that the net benefits of floodplains were higher than those of man-made infrastructures, and indicated a preference for floodplains with reduced tidal areas (RTA) over floodplains with a controlled inundation area. Based on these results, the Dutch and Flemish governments approved an integrated management plan consisting of the restoration of approximately 2,500 ha of intertidal and 3,000 ha of non-tidal areas, the reinforcements of dikes and dredging to improve the fairway to Antwerp.

Table 5.10 Alternatives for flood protection in the CBA (Phase 1: different measures; Phase 2 optimisation)

PHASE	1					2
measurements	storm surge barrier	over-Schelde	dykes (*340km*)	floodplains (*cia, 1800 ha*)	floodplains (*rta, 1800 ha)*	floodplains (*1325 ha)* + dykes (*24 km*)
investment and maintenance costs	387	1.597	241	140	151	132
loss of agriculture				16	19	12
flood protection benefits	727	759	691	648	648	737
ecological benefits				8	56	9
other impacts: - shipping - visual intrusion	 -1 			 -3	 -3	 -5
total net benefits	339	-837	451	498	530	596
payback period (years)	41	/	27	17	14	14

Note: Figures are net present values in million Euro 2004, based on central estimates for economic growth and discounting (4 per cent). Non-use values for nature development are not included in the figures.

Source: Taken from TEEB (2011); based on: De Nocker et al (2004), Meire et al (2005), Broekx et al (2010)

From existing evidence and available economic valuation studies it is difficult to estimate the benefits of the Natura 2000 network related to natural hazards protection. The literature reviewed was often connected to the benefits of wider green infrastructure, with no explicit focus on protected areas. As such, it has been difficult to identify examples in the EU where there is a direct linkage between protected areas on their own and natural hazards control, although some of the examples in the table below are obtained from partially protected areas.

With regard to flooding, Natura 2000 network has an important role to play in mountain areas. In fact, as floods often originates in mountain areas and these are generally more flood-prone due their topography, they are most likely to directly benefit from natural protection. Considering that 43 per cent of Natura 2000 sites are located in mountain areas, their regulation of water discharges and their natural storage mechanism can benefit many river systems throughout Europe (EEA, 2010).

There is a number of studies from Natura 2000 sites which recognise the importance of natural hazards prevention. For instance, in the analysis of the Azoras Islands Natura 2000 site by Cruz and Benedicto (2009), the regulation of extreme events is ascribed the highest level of importance, but no explicit valuation exercise is executed to value of this service in monetary or quantitative terms. It is noted, though, that floods and landslides are very habitual events in the area, and in 1997 caused 29 deaths and around €20 million in damages. Similarly, in Oaş-Gutâi Plateau and Igniş site in Romania and in Białowieża Forest in Poland flood protection has been assigned a high level of importance although due to the lack of data a valuation was not possible (Kazakova and Pop, 2009; Pabian and Jaroszewicz, 2009).

Overall, according to a survey among key stakeholders the role of Natura 2000 network in mitigating natural disasters is well recognised, although the importance ascribed to this service varies across the EU (Gantioler et al., 2010). In particular, high relevance of natural hazards control is ascribed to Natura 2000 network in eastern Member States. This fact seems to suggest that the values presented below (in Table 5.11) may underestimate the importance and the value of these services, as the figures build mostly on examples from Western Europe.

5.3.3 How to estimate the benefits: methodological approach

Given the scarcity of data available, estimating the value of the ecosystem services related to extreme events regulation is currently a challenging task. A theoretical approach, e.g. for flood control, can be as follow (a similar approach could be adapted also to other natural hazards):

a) Show the spatial relevance of PAs to flood control, by **presenting flood maps in combination with PAs** (e.g. building on work of the JRC on flood risk, and of the EEA on PA mapping)

b) Identify the **total value historically lost / at risk from flooding** – e.g. building on past losses and studies for future risks if and where they exist. This would be a 'context number' to see the issue of flood risk management /mitigation by PAs in context.

c) **Present cases** where PAs have been useful for flood risk management and identify the level of contributions to reduced risk/avoided damage – both with the aim of presenting best practices and also to extrapolate numbers useful for the next steps.

d) **Assess where PAs have offered what benefits of mitigating flood risk** – e.g. where they happened (cases examples), what share of the risks have been mitigated etc. Ideally from this a range of possible contributions of PAs can be developed. Clearly in some cases they will be near nil, in others higher – this will depend on data availability.

e) **If possible, calculate the potential share that would be amenable to reduced flood risk by PAs** already now – i.e. existing benefits, and potential future, e.g. if full conservation status obtained, conservation measures applied, and indeed links to wider green infrastructure realised. In other words, determining whether flood damage would be greater in the absence of Natura 2000, and whether and by how much flood risks could be lower with a fully completed FCS Natura 2000 network. Again, this will largely depend on data availability.

In the context of this study, insufficient information and methodological complexities did not allow for an overall estimate of the benefits of Natura 2000 with regard to this ecosystem services. However, a set of information was collected on maps and case examples (step a and c), as well as insights on total value lost and PAs insights (step b and d). On the basis of the information available, a 'back of the envelope calculation' was attempted in order to provide a first order of magnitude of the benefits (see box 5.4). Some insights on future approaches have been provided when relevant.

Should further data become available in the future, a more thorough assessment may become possible. However, it should be noted that natural hazards mitigation is a very spatially- and context-dependent ecosystem service, therefore it is particularly difficult to extrapolate results from individual sites. In other words, the actual delivery of the service depends on various characteristics of a site in question – in particular the position and proximity of a site to human settlement(s), habitat type, the level of natural hazard risk etc. Given the variations between individual sites, the use of benefit transfer from site evidence to the whole network would be questionable[31], even if there would be a greater amount of information than currently available.

Nonetheless, in general monetary valuation can be complemented by other ways of assessing ecosystems' ability to mitigate floods or other disasters. Alongside quantitative assessments (e.g. water retention capacity), qualitative recognition of site's ability to reduce the risk of flooding and other natural disasters can often serve to inform decision-making, complementing or, where absent, motivating subsequent monetary valuation. It is therefore desirable that more detailed assessments of the ecosystems capacities and data gathering is conducted for further work on benefit estimation of Natura 2000.

A promising approach for the estimation of the benefits of natural protection against disasters is the use of Geographical Informational Systems (GIS). By combining various data sources and making them spatially explicit, such as through ecosystem provision maps, it is possible to use GIS to address various problems facing ecosystem benefit estimation. In particular, parameters such as proximity to settlements or certain functional capacity of an ecosystem might be incorporated into geographic data, and hence incorporated into a spatial perspective. In the case of flood mitigation, for instance, comparing ecosystem GIS data for Natura 2000 sites and flood risk data might provide useful inputs for estimating the potential for avoided damage/risk (see figure 5.12 above for an example of flood risk map).

5.3.4 Benefit assessment: preliminary estimate of the benefits related to the regulation of extreme events

There is a small but growing literature on the value of ecosystems in mitigating flood events and handful of examples for other natural disasters. The Table 5.11 below presents a range of per-hectare examples from around the EU, and Table 5.12 presents a wider set of studies from both the EU and the world. There is naturally a very large variability in per hectare values depending on the nature and scale of the risk and the population and assets at risk. However, the valuation of the natural hazards protection in monetary terms may not always be possible – for some examples see Box 5.3.

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31 As discussed above, this is indeed less of a case for more homogeneous goods and services, as carbon storage and sequestration

Table 5.11: Flood mitigation values from Ecosystems – per hectare values

Location name	Ecosystem	Protected status	Value[32]	Unit	Service area (ha)	Authors
Humber estuary, UK	Coasts and Estuaries	Natura 2000	10170	€/ha/yr	265	Arcadis Belgium et al. (2011)
Skjern river basin, Denmark	Floodplain	Not	13.9	€/ha/yr	290	Dubgaard et al. (2002)
Catalonia, Spain	Coastal shores	Partially	49257	€/ha/yr	440	Brenner-Guillermo, J. (2007)
Dutch Wadden Sea, The Netherlands	Estuaries	Partially	542.5[33]	€/ha/yr	270,000	De Groot, R. (1992)
Tamar Catchment, UK	Salt water wetlands	Partially	14037	€		Everard, M. (2009)
Alkborough Flats, North Lincolnshire, UK	Salt water wetlands	Partially	31290	€/ha	440	Everard, M. (2009)
Essex, East Anglia, UK	Tidal marsh	Unknown	6075[34]	€/ha/yr		King and Lester (1995)

Source: Van der Ploeg, S. and R.S. de Groot (2010)

32 Values presented are as in the year of study, converted to Euro using year's average

33 For the conversion to EUR an average exchange for the year 2000 is used (USD*1.085 = EUR*1.00)

34 The standardized 2007 value has been taken from Van der Ploeg, S. and R.S. de Groot (2010) The TEEB Valuation Database; an average exchange for the year 2007 has been used (USD*0.73082=EUR*1.00).

Table 5.12: European and international examples

Location name	Ecosystem service	VALUE & SCOPE	Method	Comments	Source
Kalkense Meersen Natura 2000 site, Belgium	Flood mitigation	€640,000 – 1,654,286 per annum	Restoration costs	Values estimated for conservation measures aiming at restoring the original river landscape by means of wetlands restoration and restoration of estuarine habitats.	Arcadis Belgium et al. (2011)
Slovak Republic	Flood mitigation	minimum €3.75 billion	Avoided costs	The value represents a mix of funds saved by the Slovak Republic which would have to be otherwise spent to achieve similar results as from an implementation of the land management programme and avoided costs.	Government of the Slovak Republic (2010)
Alps, Switzerland	Avalanche, rock fall and landslide protection	€1.6 – 2.8 billion per annum		In the Alpine region in Switzerland the use of forests is recognised as a major component of disaster prevention. Today forests, making up 17 per cent of the total area of Swiss forests, are managed mainly for their protective function.	ISDR (2004), Dudley et al. (2010)
Meuse River, the Netherlands	Flood mitigation	decrease of 9% in the value of houses	Hedonic pricing[35]	Flood occurrence decreased the value of houses in the flood-prone area.	Daniel et al. (2009)
Rhine and Meuse delta, the Netherlands	Flood mitigation	€3.3 billion	Avoided costs: avoided damages	Value based on nature protection related policies, such as land use change and floodplain restoration; value of the damage avoided over the next 100 years.	Brouwer and van Ek (2004)
Landschaft Davos, Switzerland	Avalanche protection	€2 million per annum	Risk analysis / cost avoidance	Study used spatially explicit models to quantify avalanche protection and considered various scenarios for the assessment	Grêt-Regamey and Kytzia (2007)
Andermatt, Switzerland	Avalanche protection	€116,000 per hectare per annum	Risk analysis / cost avoidance	Estimated for a hectare of 'protective forest'; Study used spatially explicit models to quantify avalanche protection and considered various scenarios.	Teich and Bebi (2009)
State of Tirol, Austria	Avalanche and rock slides protection	€100,000 per annum	Avoided costs: replacement costs	This value represents avoided funds which would need to be invested in technical measures to protect people and property against avalanches and rock slides.	http://www.tt.com/csp/cms/sites/tt/Tirol/2366946-2/schutzw%C3%A4lder-ersparen-%C3%B6sterreich-j%C3%A4hrlich-600-mio.-an-verbauungen.csp
River Bassee Floodplain, Fr	Flood mitigation	€91.47 – 304.9 million per annum		Value of flood control services	Agence de L'eau Seine Normandie, Ministry of Ecology and Sustainable

35 Hedonic pricing assumes that environmental characteristics (e.g. a pleasant view or the disamenity of a nearby landfill site), as well as other property features, are reflected in property prices. The value of the environmental component can therefore be captured by modelling the impact of all possible influencing factors on the price of the property

Location name	Ecosystem service	VALUE & SCOPE	Method	Comments	Source
					Development
Napa River Basin, California, USA	Flood mitigation	€1.15 billion	Avoided damage costs	Value based on the restoration of a River basin. High benefit: cost ratio.	TEEB (2010), TEEBcase by J. Lucido (2010)
Cape Town, South Africa	wildfires, floods and storm protection	€0.47 – 6.2 million per annum	Avoided costs: avoided damage	The value based on the cost of damages avoided from buffering of fires, flooding and storm surge by natural assets.	TEEB (2011b)
Lao PDR	Flood mitigation	€4 million per annum	Avoided costs	The value of the ecosystem services of That Luang Marsh, the largest urban wetlands situated on the outskirts of Vientiane City in the Lao PDR.	TEEBcase by P. Gerrad (2010)
Sri lanka	Flood mitigation	€4,450,000 per annum		Represents the flood attenuation value of two reserves in the Muthurajawella Marsh near Colombo.	TEEB (2010)

Box 5.3 Other examples of disaster prevention values from around the world

In New Zealand, it has been estimated that the presence of the Whangamarino wetland results in avoided costs of many millions of dollars, which would be spent on constructing stopbanks along the river to decrease the risks from flooding (TEEB, 2010; Dudley et al., 2010).

During unprecedented monsoon rainstorm in Mumbai in 2005, it has been estimated that many lives and properties have been saved thanks to the Sanjay Gandhi National park, which has absorbed much of the rainfall (Trzyna, 2007).

Loss of protection from coastal marshes was estimated to have been a major contributory factor in the €51 billion damage caused by Hurricane Katrina in the southern US (Stolton et al., 2008).

In Haiti, Hurricane Jeanne and related floods killed approximately 5400 people as a consequence of the destruction of mangroves and the loss of soil-stabilising vegetation, causing landslides that led to most casualties (TEEB, 2011).

A study aiming to analyse the role of wetlands in reducing the flooding related to hurricanes in the United States have estimated an average value of US$8,240 per hectare per year, with coastal wetlands in the US estimated to provide US$23.2 billion a year in storm protection services (Dudley et al. 2010).

As noted above, due to the deficient amount of valuation studies and data availability, as well as the limited scope of this study, it has not been possible to provide a robust estimate of the value of Natura 2000's potential to mitigate natural disasters. However, an illustrative 'back of the envelope' estimation was attempted, on the basis of the available per hectare values for salt marshes - see Box 5.4 below.

Box 5.4 Scale of the benefits – an experimental assessment

A preliminary rough estimate for the value of flood mitigation potential of Natura 2000 network has been attempted, on the basis of an available estimate for the value of salt marshes. Salt marshes were chosen as these provided the only values which could be applied to one of the Natura 2000 habitat categories, and the values estimated (by King and Lester, 1995) were considered relatively reliable, at least on the local level.

Per hectare value of salt marshes for flood protection were estimated to be €6,075.06 per hectare per year (King and Lester, 1995)[36]. This could be tentatively applied to the total area of salt marshes included under Natura 2000 sites, to identify a possible, first cut overall value.

From the available data on Natura 2000, it can be inferred that the area of Salt marshes, Salt pastures and Salt steppes is around 700,000 hectares. As we cannot separate the area of salt marshes from the other two habitats, we assumed that these three function similarly when comes to flood protection. This is clearly a strong assumption and may lead to over or underestimates, depending on the site.

By multiplying this area size (700,000 ha) with the estimated per hectare values, we obtained **an first rough estimate of the value of salt marshes' potential to mitigate floods in Natura 2000** of €4,250 million per annum.

This approach is only an illustrative estimation. It has to be stressed that this figure is nothing more than a rough estimation of the potential of Natura 2000 salt marshes, salt pastures and salt steppes to provide flood protection and this figure crucially relies on the estimated per hectare value from the study by King and Lester (1995). What this approach does not take into account, alongside other issues, is the proximity of a site to human settlements. As a certain part of the salt marshes in Natura 2000 sites is located in unpopulated areas, no human settlement would be damaged by potential floods, therefore the value of the service would be close to zero. As such, this number should be taken as a gross overestimate. Moreover, the value used was estimated for the UK only, hence it is questionable to which extent it can be applicable to all Europe's salt marshes.

Overall this result should be taken as an experimental value, illustrating a potential approach for estimating the benefits of Natura 2000, if relevant data and valuation studies, covering wide set of habitats and countries, become available.

5.3.5 Conclusions and recommendations for future analysis

Natura 2000 network and protected areas in general can often serve as an efficient defence against natural disasters. The benefits ecosystems can bring in this regard are frequently substantial, and **often** at a lower costs than man-made technical solutions. Given an expected increase in human vulnerability to natural hazards in

[36] The standardized 2007 value has been taken from Van der Ploeg, S. and R.S. de Groot (2010) The TEEB Valuation Database; an average exchange for the year 2007 has been used (USD*0.73082=EUR*1.00).

the future, due to climate change and demographic pressures, the value of extreme events regulation that is provided by different ecosystems will likely increase.

Valuation of ecosystems' ability to mitigate natural disasters, such as floods, storms or avalanches is a very complex issue. Due to the functional variability between the sites and other influencing factors, such as proximity and position of a site to human settlements, the actual delivery of natural hazards mitigation varies from site to site. Moreover, the amount of valuation studies and the degree of representative values for wide approximation – especially for Natura 2000 sites - is very limited.

As such, given the state of current knowledge, data availability and methodological constraints, it is very difficult to provide any robust estimate of the benefits provided by the Natura 2000 network with regard to the mitigation of extreme events.

A back of the envelope assessment of the possible value of the service for salt marshes highlighted the limitations of the assessment process, since transferring values from a site to another risks to overlook important local characteristics, and therefore lead to significant over or underestimations.

This analysis allowed to identify a number of recommendation for future work on this topic:

- Overall, a **better understanding of the role of ecosystems and their interactions with respect to natural hazards mitigation** is needed.
- A significantly **higher number of natural hazards valuation studies** is needed, especially conducted in the context of protected areas or, ideally, Natura 2000. In particular, an increased number of studies from Eastern Member states should be conducted in order to increase the geographical representativeness of the available research on this topic.
- **Monetary valuation** does not need to be the only valuation technique, and should be complemented by **quantitative and qualitative assessments**.
- It is desirable to **gather and process more data** on the ecosystems' ability to provide natural hazards control, by habitat and, possibly, by Natura site.
- **The spatial distribution of disaster** (e.g. flood, avalanche) **risk, compared with actual designations of Natura 2000 sites and human settlements** should be better mapped to evaluate the potential of Natura 2000 to provide natural hazards protection. The use of GIS technique can offer a promising approach which can substantially contribute to benefit estimation.

5.4 Water regulation, purification and provision

Key Messages

- Water purification and provision are important ecosystem services that are provided by natural ecosystems, including those protected by the Natura 2000 network.
- The availability of freshwater varies across Europe, as does the price that European consumers pay for their water bills. In Germany, the average household spends about €200 per year on water bills.
- The Natura 2000 network can help address challenges related to the overexploitation and the pollution of surface and groundwater, and thus contribute to securing drinking water supply in Europe.
- Several European cities depend on protected areas for their drinking water supply. Municipalities and private water companies save money on water treatment due to natural treatment from protected ecosystems and can pass on the savings to consumers, resulting in lower utility costs for EU residents.
- To cite examples from central and northern Europe: for the 4 European cities of Berlin, Vienna, Oslo, and Munich, protected areas led to average per capita benefits ranging between €15 and €45 per year for both water purification and provision combined. This compares to average household water bills of €200 per year in Germany[37]. This underlines the magnitude of the benefits from ecosystem-based water purification and provision, which has the potential to not only save water companies money, but also eventually pass on a share of the benefit to citizens or local governments. It will be important for cities to explore the role of natural capital (e.g., protected areas, wider green infrastructure) in the purification and provision of water, and ensure that it is integrated in the water management plans required under the EU Water Framework Directive.
- As hydrological systems and socio-economic contexts vary across the EU, it is difficult to extrapolate individual water values to the entire Natura 2000 network. Based on a simplified extrapolation (exploratory assessment), the estimated annual value of natural water purification provided by forest and freshwater habitats in the Natura 2000 network could be estimated at €2.2 – €25 billion and the estimated annual value of freshwater provided by the entire Natura 2000 network could be in the order of €2.8 – €3.2 billion. These ranges should be seen as an experimental assessment and not formally used.
- More research is needed to increase the evidence base on the role of protected areas in securing Europe’s drinking water supply. This includes primary valuation studies and an assessment of how municipalities and the private sector benefit from water-related ecosystem services. Geographic information system (GIS) technology can provide a means to map the availability of water purification and provisioning services in Europe and to improve water quality.

[37] Figures from Germany (Statistisches Bundesamt, 2011)

5.4.1 What are the services: description of the water regulation, purification and provision services

Water filtration and provision are important ecosystem services that are provided by natural ecosystems, including protected areas such as Natura 2000. The economic value of water filtration and provision will vary in each case depending on the type of ecosystem. In general, ecosystems that have intact groundcover and root systems are highly effective in improving water quality (Brauman et al. 2007). The monetary estimates for the value of these ecosystem services vary significantly; for example, for water provision, figures found in the literature review for this study range from $3.6 per hectare per year (Costanza et al. 2006) to $245 per hectare per year (Turner et al. 1988). The range of figures that will be presented in this section as the value of water filtration and provision provided by the Natura 2000 network are based on extrapolations from existing values of these ecosystem services.

The process of natural water filtration occurs in several steps. Although all components of an ecosystem have an effect on its hydrologic services, vegetation often plays the most significant role (Brauman et al. 2007). A combination of vegetation, soils, and microbes removes pollutants from surface water and groundwater in a variety of ways: by diluting contaminated water, absorbing water from the root zone, biochemically transforming nutrients and contaminants, and reducing water speed to increase infiltration (*ibid*). These processes have a profound effect on water quality. Natural ecosystems also increase infiltration of storm water into aquifers, where it is stored as groundwater. See Figure 5.13 for further explanation of how natural hydrologic processes become beneficial ecosystem services.

Figure 5.13: The relationship of hydrologic processes to ecosystem services ('hydrologic service')

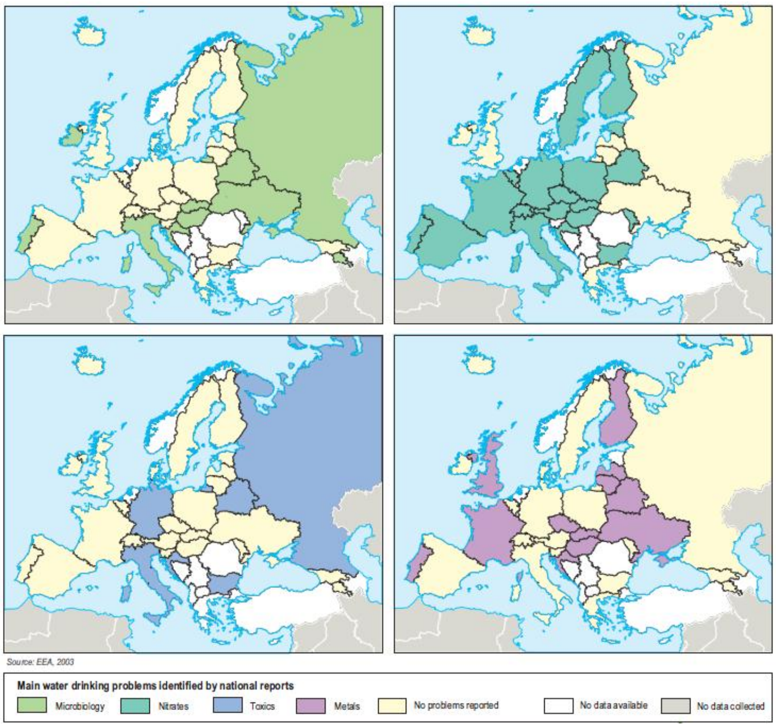
Ecohydrologic process (what the ecosystem does)		Hydrologic attribute (direct effect of the ecosystem)	Hydrologic service (what the beneficiary receives)
Local climate interactions Water use by plants	→	Quantity (surface and ground water storage and flow)	**Diverted water supply:** Water for municipal, agricultural, commercial, industrial, thermoelectric power generation uses **In situ water supply:** Water for hydropower, recreation, transportation, supply of fish and other freshwater products **Water damage mitigation:** Reduction of flood damage, dryland salinization, saltwater intrusion, sedimentation **Spiritual and aesthetic:** Provision of religious, educational, tourism values **Supporting:** Water and nutrients to support vital estuaries and other habitats, preservation of options
Environmental filtration Soil stabilization Chemical and biological additions/subtractions	→	Quality (pathogens, nutrients, salinity, sediment)	
Soil development Ground surface modification Surface flow path alteration River bank development	→	Location (ground/surface, up/downstream, in/out of channel)	
Control of flow speed Short- and long-term water storage Seasonality of water use	→	Timing (peak flows, base flows, velocity)	

Source: Brauman et al. 2007.

Human activities that modify land cover and habitats present in ecosystems subsequently impair the ability of ecosystems to continue providing these services at optimal performance. The effects of changes in land cover on hydrologic processes usually do not become apparent until about 20 per cent of a catchment has been altered (from healthy ecosystem), with a range of 15 per cent to 50 per cent of (Brauman et al. 2007). According to the World Resources Institute, in 1998 less than 20 per cent of the world's major watersheds had 10 per cent or more of their land protected (Revenga et al. 1998); many of the world watersheds are already altered to such an extent that hydrological functions reduced. Once an ecosystem has been disturbed to the point where water filtration and provision services are reduced, it takes time to restore them. Soil formation and tree growth, for example, are slow processes and thus ecosystem restoration projects for the purpose of enhancing water filtration are generally ineffective in the short-term (Brauman et al. 2007).

The EU Water Framework Directive (WFD) states that water is not 'a commercial product like any other but rather, a heritage, which must be protected, defended and treated as such'. Having abundant, clean water supply is important for every sector in Europe including industry, agriculture, energy production, and household usage. Drinking water in most European countries is of high quality, whether it is filtered naturally or in treatment plants. However, the four main threats to water quality in Europe have been identified as metals, toxics, nitrates, and microbiological problems (UNEP 2004). The figure below shows the geographical distribution of the reporting of these problems throughout the EU.

Figure 5.14: Main problems posed by contamination to drinking water across Europe.



Source: UNEP 2004.

Water provision is equally an issue of major concern. In 2003, 18 per cent of the EU's population was living in countries classified as 'water stressed', where freshwater provision is far below optimal levels (UNEP 2004). About 60 per cent of cities in Europe with more than 100,000 inhabitants receive water from overexploited groundwater aquifers (*ibid*). Although overexploitation is a separate issue, taking water provision into account when designating protected areas may help address water stress.

5.4.2 How to estimate the benefits: methodological approach

The availability of primary valuation studies is critical for the implementation of a benefit-transfer exercise. The TEEB database (van der Ploeg and de Groot 2010) served as the main instrument to gather applicable benefit estimates for an estimation of water filtration and provision values in the Natura 2000 network. The latest version of the database contains 65 values for water-related ecosystem services. However, due to missing information on the nature of some values, only a selected sample could be used in this study.

Water purification

Table 5.14 lists the available valuation studies from the TEEB database. The available estimates lead to an average value of €1,576 per hectare per year for the economic benefits generated by water purification services, with a range of €527 – €4,174 per hectare per year. Applied to the 80 million hectares of the entire Natura 2000 network, this would result in EU-wide benefits of about €126 billion per year (2009 values), covering a broad range of biomes and habitats.

Table 5.13: Overview of valuation studies – water purification

Source	Original Value	2009 Value (EUR)[1]	Valuation Method	Location	Biome
Brenner Guillermo, J. 2007	403 USD/ha/yr	527	Benefit Transfer	Spain	Forests
Brenner Guillermo, J. 2007	3,191 USD/ha/yr	4174	Benefit Transfer	Spain	Freshwater
Cruz, A. de la and J. Benedicto 2009	18.1 EUR/ha/yr	27.4	Replacement Cost	Portugal	Temperate forest and grassland

[1]Adjusted by purchasing power parities and inflation

To refine this calculation, land cover data from the study areas were taken into account. The low end of the estimated value for water filtration was determined by extrapolating the benefit calculated for annual water filtration from the Pico da Vara/Ribeira do Guilherme Natura 2000 park in Portugal. The entire protected area of the park is 6067 hectares and 1982 hectares of this area make up the Pico da Vara/Ribeira do Guilherme Natura 2000 site. The land cover of the site is as follows: approximately 75 per cent woodlands and forested areas, 10 per cent grasslands, and 5 per cent inland water bodies, with 'other arable land', rocks, etc. making up the remainder of the land area.

The region where Pico da Vara/Ribeira do Guilherme is located is classified as a 'low water quality area', which leads most local people to buy bottled water (Cruz and Benedicto 2009). Pico da Vara/Ribeira do Guilherme did not become a protected area until 1999, with expansion in 2005; as noted above, hydrologic ecosystem services take time to come into effect and therefore this area may not see improvements in natural water filtration for some time. The main contributor to water pollution in the area is cattle. Cruz and Benedicto (2009) calculated that should management policies succeed in reducing the amount of cattle in the protected area and thus the associated pollution, the benefit of natural water filtration at the Pico da Vara/Ribeira do Guilherme Natura 2000 park would be approximately €110,000 per year. They arrived at this figure by estimating that each family of five people spends €46.5 per year on bottled water due to poor water quality. Naturally filtered high quality water would result in a savings of €9.3 per person per year, or €0.0015 per person per year per hectare of protected park land.

In order to account for differences among protected areas that may result in different valuations, figures from a separate study were used to calculate a second estimate of the EU-wide benefit. Brenner (2007) provides more figures for the value of ecosystem processes in protected areas, including filtering, retention, and storage of freshwater (e.g., aquifers), depending on the type of land cover. Table 5.14 shows these values and the corresponding calculations for the EU-wide benefit. Although Natura 2000 has 27 different habitat categories, Brenner was able to find just four figures that are relevant to this study.

To obtain one estimate for the economic value of natural water filtration from Natura 2000 sites throughout the EU, the estimates for water filtration benefits for Pico da Vara/Ribeira do Guilherme park described above were used in an extrapolation. The figure for the benefit of natural water purification per hectare per year, €18.13, was multiplied by 80 million, which is the total amount of terrestrial Natura 2000 hectares. The resulting figure for the total EU-wide benefit is approximately €1.45 billion per year. When adjusted for Portugal's purchasing power parity in 2009, the benefit is about €2.2 billion per year.

The figures from Brenner (2007) were extrapolated to obtain a second estimate. As noted, Brenner's figures are specific to the type of land cover that provides the ecosystem service. Land cover data for the entire Natura 2000 network indicates that 32.3 per cent of Natura 2000 land is forested, while 6.8 per cent consists of freshwater habitats (Mücher et al. 2009; see Annex 1 for the complete land cover data). Therefore, Brenner's figures for the benefits from freshwater wetland, open freshwater, and riparian buffers were averaged to obtain one figure for the benefit from freshwater habitats. Then the monetary figures for the benefit from forests and freshwater habitats were multiplied by the number of hectares of each habitat in the entire Natura 2000 network. As forests and freshwater habitats comprise approximately 39 per cent of the total Natura 2000 land cover, the resulting figure of approximately €25 billion is the high range estimate for water provision from 39 per cent of the Natura 2000 network. In order to have a more complete picture of the full benefits, more empirical research is needed to come up with estimates of the economic value of water filtration from other types of ecosystems besides forests and freshwater habitats. Note that the value of water purification is very site specific and reflects not only the ecological functions of the forest ecosystem, but also the pollution loading, the beneficiaries (their number, proximity, and income levels) and existence of substitute sources.

Table 5.14: EU-wide benefit of water filtration from Natura 2000 areas by land cover

Land cover type	**Value from Brenner (2007) in 2004 USD/ha/year**	**Value adjusted to 2009 EUR-PPP/ha/year**	**Natura 2000 land cover (m ha)**	**Value of water filtration** € bn
Temperate forest	$403	€363	25.84	€9.4
Freshwater wetland	$3,815	Average adjusted value of benefits from freshwater habitats: €2,872	5.44	€15.6
Open freshwater	$1,011			
Riparian buffer	$4,747			
All other land cover types	N/A	N/A	48.72	N/A
Total				€25.0

In summary, the estimated annual value of natural water filtration provided by forests and freshwater habitats in the entire Natura 2000 network is €2.2 – €25 billion.

The TEEB database contains a range of additional monetary estimates for water regulation services that could potentially be used to expand the evidence base. However, the database does not specify any respective sub-services, thus an immediate use of these values was not possible.

The Joint Research Center (JRC) of the European Commission prepared a study (La Notte et al. 2010) that provides further insights on the 'value' of the 'water purification' ecosystem service – in quantitative terms. The authors assessed the provision of the service in biophysical terms, using maps of ecosystem services at a European continental scale. The methodology is applied to the water purification service (filtration and decomposition of wastes and pollutants) of aquatic ecosystems (rivers, streams, and lakes) in the Mediterranean biogeographical region. The particular focus of the study is on the retention of excess nitrogen in surface waters.

Based on monetary estimates retrieved from the COPI and TEEB databases, they apply different valuation methods (see Table 5.15) and estimate a monetary value of natural water purification services within a range of €4.8 to €40.1 billion. This range only applies to the Mediterranean region, i.e. for parts of Portugal, Spain, France, Italy, and Greece. As no explicit spatial reference is provided, these values cannot be extrapolated to the Natura 2000 Network.

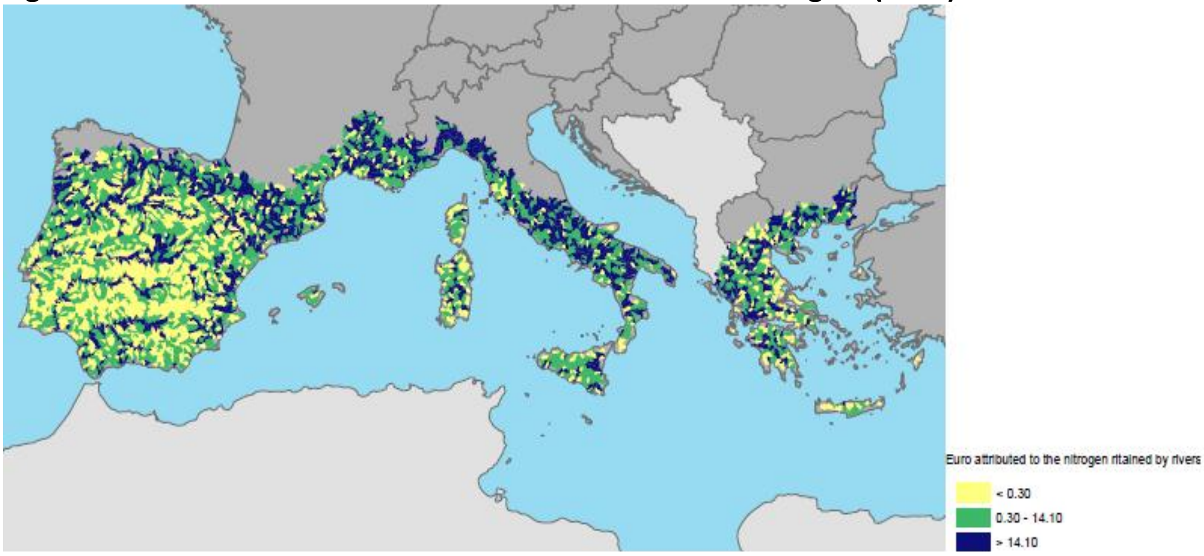
Table 5.15: Monetary value of nitrogen retained in the Mediterranean bio-region (€ billion)

Valuation method	1990	2005
RC: CW	3.4	4.8
RC/CV	29.3	40.1
RC: denitrif. and load reduction	5.1	7.0
EA/RC	24.6	33.7

Legend - RC: replacement cost; CW: constructed wetland; CV: contingent valuation; EA: energy analysis

Figure 5.15 shows the monetary values attributed to the nitrogen retained by rivers.

Figure 5.15: Economic valuation of the Mediterranean bio-region (2005)



Source: La Notte et al. (2010)

Water provision

Table 5.16 lists the available valuation studies from the TEEB database. The available estimates lead to an average value of €275 per hectare per year for the economic benefits generated by water provision services, with a very wide range of per hectare values. The values of water provision are extremely site specific, and dependent on the ecosystem extent, state and functions, as well as the number, proximity and income of beneficiaries, and also the existence of alternative sources of water. Applied to the 80 million hectares of the entire Natura 2000 network, this results in EU-wide benefits of about €22 billion per year (2009 values), covering a broad range of biomes and habitats. This is a highly experimental assessment, to illustrate value and encourage further research.

Table 5.16: Overview of valuation studies – water provision

Source	Original Value	2009 Value (EUR)[1]	Valuation Method	Location	Biome
European evidence base					
Cruz, A. de la and J. Benedicto 2009	99.7 EUR/ha/yr	122.32	Replacement Cost	Portugal	Temperate forest and grassland
Evidence base outside of Europe					
Acharaya, G. and E.B. Barbier 2000	413 USD/ha/yr	15.48	Factor Income / Production Function	Nigeria	Inland wetlands
Anielski, M. and S.J. Wilson 2005	0.076 CAD/ha/yr	0.06	Direct market pricing	Canada	Temperate and boreal forests
Butcher Partners Limited 2006	39.8 NZD/ha/yr	22.9	Avoided Cost	New Zealand	Grasslands
Emerton, L. and L.D.C.B. Kekulandala 2003	1232 LKR/ha/yr	42.4	Avoided Cost	Sri Lanka	Coastal wetlands

Karanja, F., L. Emerton, J. Mafumbo and W. Kakuru 2001	724638.0 UGX/ha/yr	1346	Replacement Cost	Uganda	Inland wetlands
Karanja, F., L. Emerton, J. Mafumbo and W. Kakuru 2001	46317 UGX/ha/yr	86	Replacement Cost	Uganda	Inland wetlands
Nunez, D., L. Nahuelhual and C. Oyarzun 2006	223,6 USD/ha/yr	0.6	Production function	Chile	Temperate forest
Verma, M. 2001	29817 INR/ha/yr	2569	Avoided Cost	India	Freshwater

[1]Adjusted by purchasing power parities and inflation

Applicability of results

The TEEB database provides a limited sample of values for the economic benefits of water provision and purification services. It needs to be noted that a benefit transfer from case studies outside of the EU to the European context is subject to high uncertainties. Although purchasing power parities and inflation were taken into account when transferring the values to the area of the Natura 2000 network, differences in the ecological and socio-economic conditions remain largely unaccounted for. This applies particularly to valuation studies that have been carried out in developing countries, e.g. Acharaya and Barbier (2000), Karanja et al. (2001), Verma (2001) and Emerton and Kekulandala (2003).

Thus it seems appropriate to apply a number of selection criteria to assure the suitability of the values for EU-wide extrapolation: Only valuation studies from protected or partially protected areas in relevant (temperate) biomes in high or upper middle income countries should be taken into account in such an extrapolation. Furthermore, valuation studies older than 15 years should be excluded from the analysis.

If these selection criteria are applied to the studies listed in Table 5.18, only Cruz and Benedicto (2009) and Nunez et al. (2005) provide suitable values for extrapolation to the Natura 2000 Network. Cruz and Benedicto (2009) estimated that the value of water provision from the Pico da Vara/Ribeira do Guilherme Park is €604,997 per year, which comes out to €99.7 per hectare year. When multiplied by the total number of Natura 2000 hectares and adjusted for land cover, inflation and purchasing power parity (PPP), the value of water provision from the Natura 2000 network is approximately €3.2 billion. Nunez et al. (2005) calculated the value of water provision from protected native temperate forests in Chile. They calculated an average value of $223.6 per hectare per year. Using the same adjustments for inflation and PPP in 2009 values and taking land cover into account, the value extrapolated from Núñez et al. (2005) for water provision from the Natura 2000 network is €2.8 billion. The table below displays these figures.

Table 5.18: Water provision values for the entire Natura 2000 network.

Study	Land cover[38]	Value of water provision per hectare per year	Adjusted value EUR-PPP 2009	Extrapolated value for the Natura 2000 network € bn
Cruz and Benedicto 2009	32% forest	€99.7	€122.32	€3.16
Núñez et al. 2005	100% temperate forest	$223.6	€283	€2.848

In summary, when applying strict selection criteria, the estimated range for the annual value of water provision provided by the entire Natura 2000 network is €2.8 - €3.2 billion.

The above estimates should be seen as experimental to explore the method and its limitations - the paucity of base data and combined with the generally very site specific nature of water provision and value (recall discussion in chapter 3) mean that there results should not be used formally outside the context of experimental assessment. More useful for water purification and provision are the site based assessments.

5.4.3 Benefit assessment: preliminary estimate of the benefits in selected case studies - Major European cities benefiting from protected watersheds

There are both economic and environmental benefits to be gained from using protected areas as natural water filtration and provision systems for municipal water supplies. The environmental benefits are two-fold. First, an ecosystem that is protected solely for the purpose of water filtration or provision will provide other beneficial ecosystem services such as climate and air quality regulation. Second, tap water has a much lower environmental footprint compared to bottled water. Botto (2009) performed ecological footprint and life cycle assessment analyses for six Italian bottled water companies and compared them to the analyses for tap water supplied to Siena, Italy. He found that the ecological footprints and carbon footprints of the tap water were about 300 times lower than those of the bottled water. In addition he found that every 1.5 litres of bottled water produced required an additional 2.11 litres of water used in the bottling and packaging processes (*ibid* 2009). A conservative estimate of annual spending on bottled water by EU consumers is €25 billion (Rettman 2007). Although many consumers of bottled water in the EU may be motivated by factors other than lack of clean tap water, ensuring that there are no low water quality areas in the EU, such as the area surrounding Pico da Vara/Ribeira do Guilherme park, will give all EU residents at least the option to choose tap over bottled water.

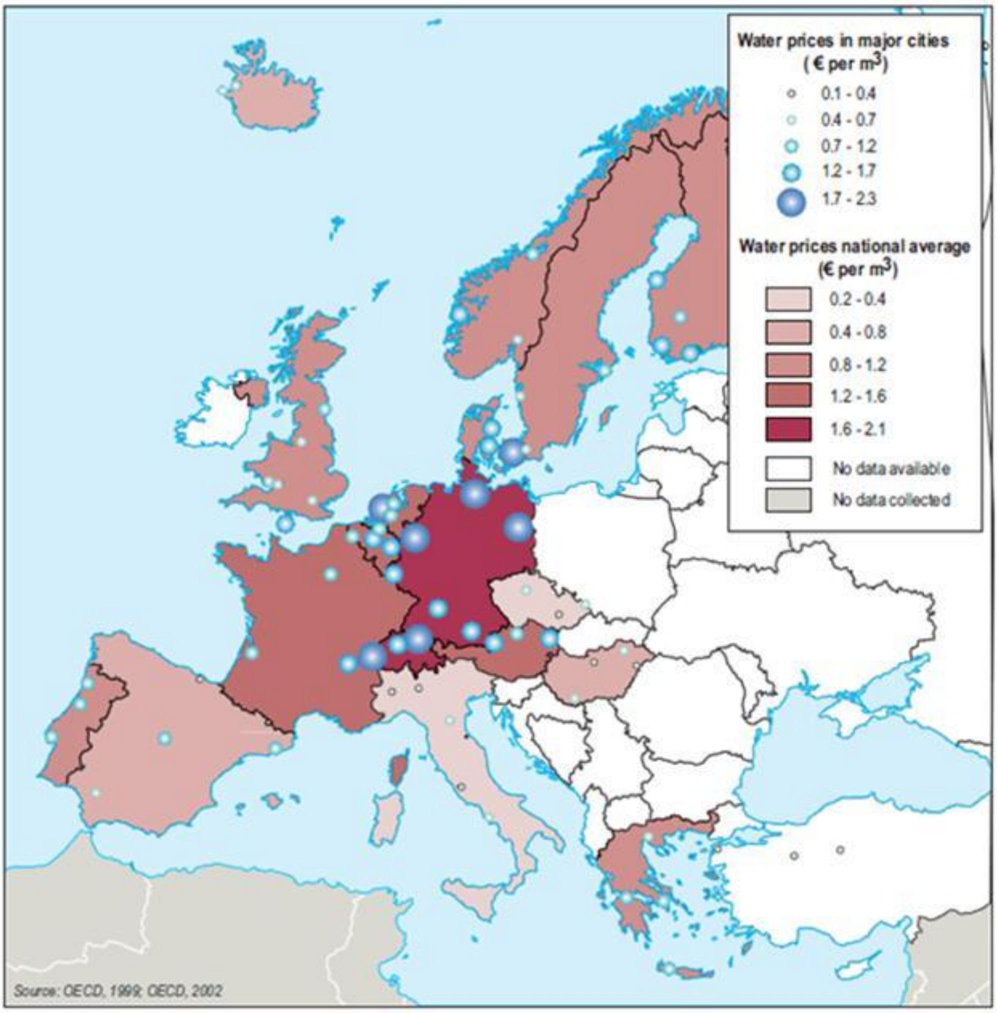
In terms of the economic benefits, municipalities that save money on water treatment due to natural treatment from ecosystems should be able to pass on the

[38] As with the calculations for water filtration, we were limited to adjusting the estimates for water provision based on the figures available for certain land covers. Therefore the land cover figures in this table include only those where data was available to form estimates.

savings to consumers, resulting in lower utility costs for EU residents. In cases where the treatment of drinking water is subsidized by the municipality, the municipality could stand to bear substantial savings depending on the costs of maintaining the protected area.

Since 2010 the EU Water Framework Directive (WFD) has required Member States to implement water pricing policies that provide adequate incentives for the sustainable use of water resources while recovering the costs of water services. As taxes, subsidies, and other factors influence the widely varying water prices across the EU, it is unclear how much money consumers save when their water utility benefits from natural filtration. Figure 5.16 shows the price of water per cubic meter across the EU between 1996 and 1998; however an updated version of this figure following the implementation of the Water Framework Directive may look quite different. The latest data from the Household Budget Survey on Eurostat indicates that in 1999 the average EU household spent €379 per year on water supply which amounts to €508 in 2009 (Eurostat 2007). Although water supply expenditure makes up just 1.5 per cent of overall household expenditures, based on the average annual calculation for the value of water provision based on cubic meters supplied to the city of Berlin for example, each resident receives a benefit of about €17 per year from the freshwater provided by protected areas. When multiplied by the number of residents in the household, the potential for substantial savings from hydrologic ecosystem services can be seen.

Figure 5.16: The price of water in major cities across Europe



Data from 1996-1998. Source: UNEP 2004.

The following case studies highlight places in Europe that are already reaping the benefits of water filtration and provision from ecosystem services. The case studies and the associated calculations are based on Natura 2000 sites, protected areas that do not have Natura 2000 designation, and natural areas that are not protected but are managed in order to maintain optimal water quality. Included are four case studies of four major European cities as well as an example from the private sector involving Nestlé Waters. The cities of Munich, Berlin, Vienna, and Oslo all benefit from natural filtration in different ways, as outlined below. Other major European cities where protected areas are important for drinking water filtration include Madrid, Sofia, Rome, and Barcelona; see Dudley and Stolton (2003) for the most comprehensive information on the role of protected areas in providing clean drinking water to those cities as well as to the rest of the 25 largest cities in Europe.

Although this report focuses on case studies within the EU, it is worth mentioning perhaps the most well-known large-scale case study regarding using protected areas to improve water quality. Faced with the need to construct a new $6 billion water treatment plant that would have had minimum annual operating costs of $300 million, New York City decided to consider other options. It became obvious that protecting the watershed located in the nearby Catskills mountains was the more cost effective option. Therefore after several years of negotiations, the City signed a memorandum of understanding with dozens of stakeholders including federal and state authorities, environmental organizations, and about 70 local towns that have an interest in the watershed. In this agreement, the City committed to investing $1.5 billion over the course of 10 years which includes funds to restore and protect the watershed as well as providing a $60 million trust fund for grants and loans for sustainable development activities within the watershed (Postel and Thompson 2005). About 75 per cent of the watershed land was privately owned, so land acquisition by the City was an important component of the protection plan. New York City residents now enjoy naturally filtered water as well as the savings reaped from avoiding the construction and operating costs associated with a water treatment plant.

Munich, Germany

Around 80 per cent of the city of Munich's water supply comes from the Mangfall Valley and the Loisach Valley in the Bavarian Alps, located approximately 40 kilometres outside the city. Although the area is not protected, the city's utility company, Stadtwerke München, has been purchasing land in order to rent it with strict guidelines to ensure that the water collected is sustainable and pure: no fertilizers or agricultural chemicals of any kind may be used on the land, and meadows may only be cut once the wildflowers have gone to seed. The locations where the water is actually collected are protected. The city designated a zone of 6,000 hectares of watershed to manage and protect, 2,250 of which have remained agricultural land while the rest have forest cover.

Despite having protected the areas directly surrounding the water sources, residues from chemicals used in farming were still finding their way into the water, and the chemical levels in the drinking water were rising (Meiffren and Pointereau 2009). Although the concentrations remained far below the federal safety standards, Stadtwerke München decided to do something about the increasing chemical concentrations before they became a bigger problem. In 1992 Stadtwerke München started the 'Öko-Bauern' (Eco-Farmers) initiative. Farmers were offered monetary incentives in order to convert to organic farming, thus removing the need for expensive filtration procedures to remove nitrates and pesticide residue from drinking water. Each farm received a subsidy of €281 (550 DM) per hectare per year for six years to help with the cost of conversion, with reduced grants of €230 per hectare per year for the following 12 years (Höllein 1996).

Twenty-three farmers signed a contract to convert to organic farming in the first year, 1993, totalling 800 hectares. By 1996, 92 farms covering 2250 hectares, or 70 per cent of agricultural land in the area, had converted to organic farming making this the largest organic farming region in Germany. By 1996, nitrate levels had already dropped from 14 µg/litre down to 8-10 µg/litre, while levels of the herbicide atrazine fell from 50 µg/litre to below 10 nag/litre (Meiffren and Pointereau 2009). The result is tap water with a chemical quality similar to mineral water. The cost of supporting organic agriculture amounts to €830,000 per year, or €0.01 per cubic meter of tap water consumed. These are reasonable figures, as combating nitrification in France has cost €0.03 per cubic meter of water (*ibid* 2009). Paris and Beijing have undertaken similar measures but not on this scale.

Berlin, Germany

Berlin's water supply is provided entirely by groundwater from nine waterworks, all of which are surrounded by protected zones. The total area protected for the purpose of maintaining water quality is 230 km2. Depending on the distance from the well, water use or activities in or around the water are either severely restricted or prohibited.

There are three categories of protection zones. Zone I is the well head protection area, which prohibits any use of the area at all within 10 meters of the well head. Zone II covers a diameter of 100 meters around the well, and forbids any activity that can remove or destroy the upper soil stratum, such as construction or excavation work, camp sites, commercial animal husbandry, and the use of fertilizers. Finally, Zone III protects an area of 2.5 kilometres around the well, prohibiting any activity that could lead to the contamination of the groundwater (Berliner Wasserbetriebe 2011). Figure 5.17 depicts the city of Berlin with the locations of waterworks, treatment plants, and pumping stations.

Figure 5.17: Berlin water protection zones. Source: Berliner Wasserbetriebe 2011.

Vienna, Austria

In December 2001 Vienna was the first city in the world to protect its drinking water for future generations under Constitutional Law through the Vienna Water Charter, or 'Wiener Wassercharta' (Vienna Waterworks 2011). Vienna obtains almost all of its drinking water from mountain springs originating in the Lower Austrian-Styrian high alpine zones. In 1965 the entire Rax-Schneeberg-Schneealpen massif was designated as a protected area comprising the First Vienna Mountain Spring Pipeline, and in 1988 the Pfannbauern spring was added to the network as the Second Spring. Since this addition, under normal conditions, these protected areas are able to supply all of Vienna with fresh alpine spring water. The location of the springs and pipes in relation to Vienna can be seen in Figure 5.18.

These two spring zones cover over 600 square kilometres. Two pipelines of 150 and 180 kilometres in length carry about 400,000 m3 of water daily from the mountains directly to the city. No pumping is needed due to gravity, and in fact the pipelines generate 65 million kilowatt-hours of energy per year. Because the springs are in protected areas the water does not require treatment, however the law requires a 'safety disinfection cycle' which includes chlorine and chlorine dioxide (Vienna Waterworks 2011). Tourism, agriculture, and any sort of general development in the spring zones are very restricted.

During periods of high water demand, additional water is provided by the Lobau well-field. The wells are located in the Danube Floodplains National Park, and thus the water is bank-filtered from the groundwater flow that runs parallel to the Danube. The added purification from the soil results in especially high quality water. The Vienna Waterworks has implemented the ISO 9001:2000 Standard, which specifies requirements for quality management systems to provide products that consistently meet regulatory requirements.

Figure 5.18: Map of Vienna's water supply

Source: *http://www.aquamedia.at/templates/index.cfm/id/1533*

Oslo, Norway

The city of Oslo obtains its drinking water from the large forested Maridalen watershed immediately surrounding the city (see the map in Figure 5.19). Maridalen includes Oslo's most important source of drinking water, Lake Maridalsvannet, which has been protected since 1866 (City of Oslo 2008). Bathing or other aquatic activities are strictly prohibited in Lake Maridalsvannet, although it is a popular recreational area for hiking, cycling, etc. Maridalsvannet is the intake reservoir for the Oset Water Treatment Plant, which is operated by the Oslo Water and Sewerage Works.

The Maridalen watershed has a catchment area of 252 square kilometres and each year about 95 million cubic meters of water are extracted for drinking water (City of Oslo 2008). The untreated water is clear, odourless and tasteless, and therefore requires only very simple treatment. Due to Norwegian regulations requiring a minimum of two hygienic barriers for drinking water, coagulation and filtration are used as the first barrier in combination with UV disinfection as the second barrier (*ibid*). Still, the high quality of the raw water saves Oslo from having to apply more intensive water treatment methods.

Figure 5.19: Oslo and the protected Maridalen watershed with Lake Maridalsvannet

Source: Google Maps

The table below displays the compiled data from the city case studies. The estimated values for water filtration and provision are based on the figures provided by Cruz and Benedicto (2009), Brenner (2007), and Núñez et al. (2005). Their benefits estimates were broken down into cubic meters (m^3) of water provided and/or filtered, were transferred to the four case study sites by adjusting for inflation and PPP, and lastly multiplied by the amount of cubic meters of water supplied annually to the case study sites. It was not possible to calculate a range for the value of water filtration based on cubic meters produced due to a lack of data in the Brenner study.

Table 5.17: Economic value of water filtration benefits from protected areas in Munich, Vienna, Berlin and Oslo.

City	Method of protection	Total area protected (hectares)	Land use	Amount of water supplied	Approximate number of people served	Benefits	Estimated annual value of water filtration based on m^3 produced	Estimated annual value of water provision based on m^3 produced
Munich	Protected areas and conversion to organic agriculture	6,000	1/3 agriculture, 2/3 forest	301,000 m^3 per day	1 million (80% of the city)	Decreased pesticide and chemical residues No treatment required	€8,624,915	€12,635,211 - €47,168,232
Vienna	Strict protection, Vienna Water Charter	Over 60,000	All protected forest	400,000 m^3 per day	1.7 million (entire city)	No water treatment required	€11,461,681	€16,790,978 - €62,721,903
Berlin	Groundwater protection zones	23,000 (1/3 of the city of Berlin)	Urban landscape, 40% 'green areas'	585,000 m^3 per day	3.5 million (entire city)	Less contamination	€16,762,709	€24,556,805 - €91,730,783
Oslo	Landscape protection area	25,200	All protected forest and lakes	250,000 m^3 per day	455,000 (85% of the city)	Minimal treatment required	€7,163,551	€10,494,361 - €39,201,189

5.4.4 *Conclusions and recommendations for future analysis*

We have estimated (as an experimental assessment) that the annual value of natural water filtration provided by the entire Natura 2000 network is €2.2 – €25 billion (whereas this figure is solely based on the benefits from forests and freshwater habitats) and that the range for the annual value of water provision provided by the entire Natura 2000 network is €2.8 – €3.2 billion, when applying strict selection criteria. Not applying these selection criteria, the benefits related to water purification could be as high has €22 billion for the entire network. In this context, it should be noted that La Notte et al (2010) estimate the value of natural water purification services within a range of €4.8 – €40.1 billion in the Mediterranean region alone. To put this into perspective: only in Germany, households spend almost €8 billion per year on their water bills (excluding sewage), or on average €200 per household per year, with an average price of €1.65 per m^3 (Statistisches Bundesamt, 2011).

It needs to be emphasized that the underlying calculations are subject to severe limitations given limited data availability and the site specificity of vale. The results should be seen as experimental and not used outside of this context.

The limited amount of available valuation studies carried out in a protected-area context required us to base the assessment on only a handful of economic estimates. Furthermore, although differences in income have been taken into account in extrapolating the available estimates to the entire Natura 2000 network and in transferring them to individual protected areas around five major European cities, we were – due to the lack of available data – not able to include more advanced demand functions in the calculation. However, both hydrological conditions and the demand for water-related ecosystem services vary across the EU and should thus be taken account for in a proper extrapolation exercise.

Implications for the extrapolation exercise

To conclude, and taking into account the remarks on aggregation and scaling-up in Chapter 3, the aggregation of values which were estimated by applying different valuation techniques has to be done with care and transparently.

Careful consideration also needs to be given to the scope and geographical coverage of the original studies. Thus, even though we can list studies under the same ecosystem service flag, the conditions under which these values were elicited and the types of services provided differ between locations and are context-specific. It is a challenge to extrapolate values on water provisioning from scarce resource contexts to other areas where water provisioning it is not a big issue. In this context, we would probably overestimate values if they were transferred.

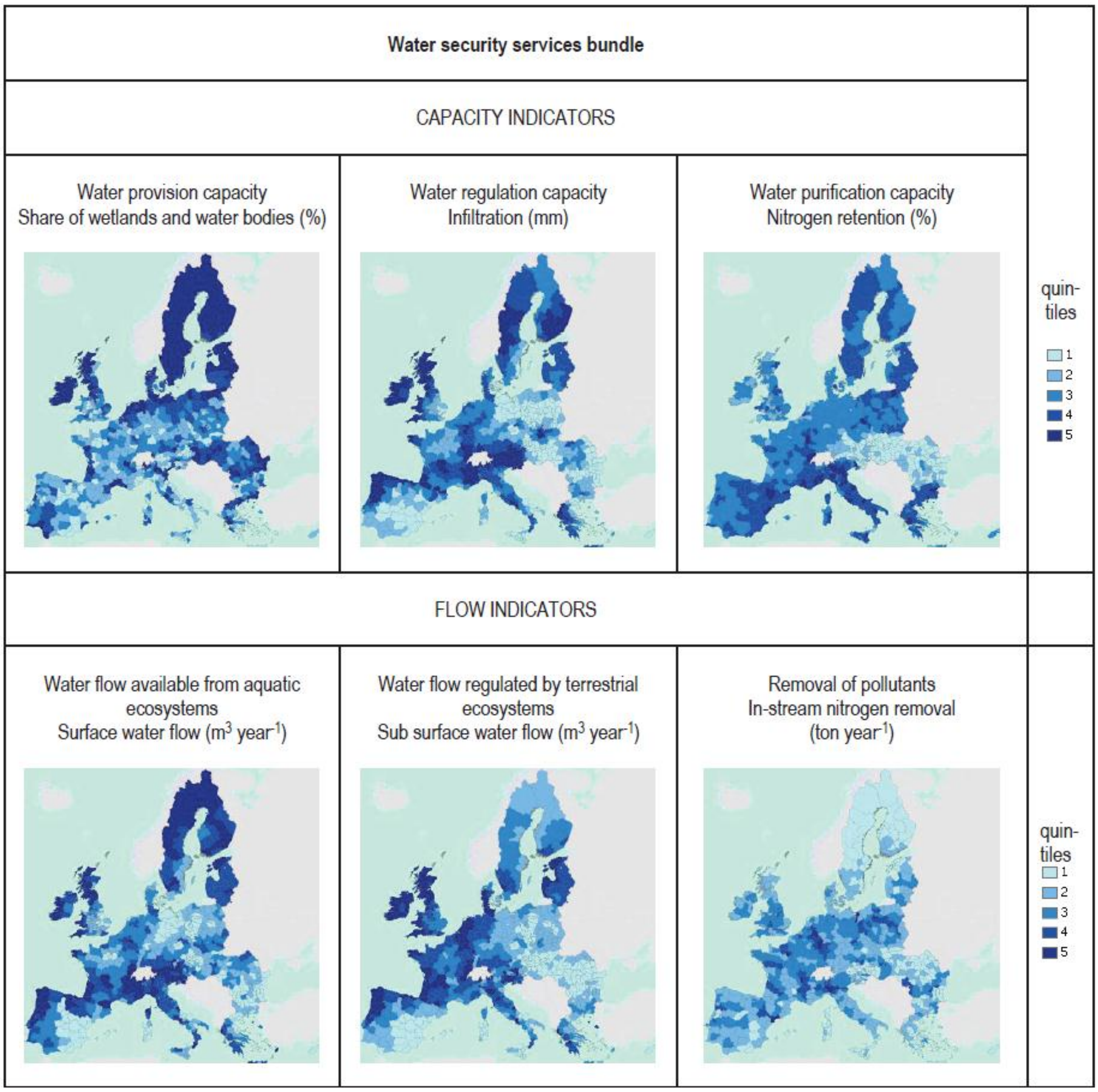
Scoping the possibility of applying current research

In Europe, there is an ample list of valuation studies that have assessed the economic value of water use and the associated benefits of improving overall water quality in a given area/country according to the WFD quality status levels. The scope of these studies is difficult to match with those of the ecosystem services approach because the values presented in these studies often cover several ecosystem services at once, as values do not differentiate between specific services. Values in WFD related studies are usually gathered to evaluate the benefits of reaching a policy target and not to account for the different services provided by changes in the number of aquatic ecosystems.

The European Environment Agency (EEA) is currently investigating the possibility of developing freshwater ecosystem accounts. At this stage, the accounts are trying to identify relevant services and indicators for their measurement. From the valuation side, the EEA is looking at the use of available information on restoration costs from the WFD Programmes of Measures to elicit values. The work done on ecosystem accounting in the UK might provide further methodological insights.

The JRC work (La Notte et al. 2010) provides an interesting approach for the assessment of water purification services in the Mediterranean region. However, in the current format the data cannot be extrapolated to the Nature 2000 Network. The study uses a modeling tool to assess the percentage of nitrogen that is cleaned up by the river itself. This is location-specific, thus it would require a lot of effort to come up with relevant values for specific Natura 2000 sites without accounting for location-specific conditions through the application of JRC's GREEN model. Furthermore, the authors don't take into account demand side characteristics in their extrapolation, which is a major drawback of the work. However, once these issues have been solved, the JRC work could potentially serve as basis for an EU-wide extrapolation of water-related ecosystem services. The maps in Figure 5.20 show indicators for capacity and flow of water quantity and water quality regulation by aquatic and terrestrial systems in the EU.

Figure 5.20: Water quantity and quality regulation in the EU



Source: Maes et al. (2011)

Research needs

More empirical research that quantifies the benefits of water filtration and provision from protected areas in Europe is needed in order to gain a better understanding of the benefits. The literature review conducted for this section suggests that a great deal more of this research has been carried out in developing countries, especially in Latin America and Africa, as compared to Europe. One way to move forward with this is to conduct an analysis to see which Natura 2000 sites have ecosystems that provide water filtration and/or provision services that are not currently being used for those purposes.

Although the literature review conducted for this study identified monetary values for water filtration and provision from two types of land cover (forest and freshwater), further research to identify the values for other types of Natura 2000 land cover would be instrumental in recognizing the areas with the potential to provide the greatest economic benefits. Spatial data could then be used to identify which populations in the EU could benefit from those services. A helpful starting point for this may be the 'Major European Watersheds' chapter of the UNEP (2004) publication 'Freshwater in Europe'. The chapter profiles 18 major watersheds in Europe, providing a range of information on the demographics in the area, the environmental state of the watershed, the policies governing them, as well as statistical and geographical information.

The dependence of major parts of the European population on functioning ecosystems could be a major research theme. A survey among water companies could help to elicit avoided costs from water purification ecosystem services. In addition, a survey among European cities might allow one to learn more about demand-side characteristics.

To summarise, research is needed in two major fields:

- Primary valuation of (water-related) ecosystem services in protected area contexts. To date, the dependence of people (or water utilities) on protected areas can only be estimated by analysing the design of relevant PES schemes. More primary research is needed on the dependence of communities on hydrological systems in protected areas. The use of Geographical Information Systems (GIS) can be helpful in this context.

- The EEA Land Ecosystem Accounts (LEAC) can provide a means to locate hydrological systems which are of high value to people. The work done by JRC is a first step in the identification of aquatic ecosystem services on a large geographical scale. Future work will need to include demand-side characteristics in order to take account of value differences in water scarce or water abundant regions, respectively.

5.5 Pollination

5.5.1 What is the service: description of the pollination service

Pollination represents an essential ecosystem service for human wellbeing, being a key ecological process on which natural and agricultural systems depend (e.g. TEEB, 2011; MA, 2005; Balmford et al, 2008). It is estimated that insect pollinators are directly responsible for 9.5 per cent (around €153 billion) of the total value of the world's agricultural food production in 2005 (Gallai et al., 2009). Insect pollination is also estimated to increase the yields of 75 per cent globally important crops and is responsible for an estimated 35 per cent of world crop production (Klein et al., 2007).

Biotic pollination plays a crucial role in the reproduction mechanism of many plant species (Nabhan & Buchman, 1997). For instance, a study by Ollerton et al. (2011) estimated that about 87.5 per cent of flowering plants are being pollinated by animals. These are typically insects, including bees, flies, beetles, moths, butterflies and wasps, although also vertebrates (particularly birds and bats) can function as pollinators for some species.

In many agricultural systems domesticated pollinators are actively being used for crop pollination. Domestic (i.e. managed) pollination, mostly by honey bee *Apis mellifera*, is chiefly used for pollination in agricultural systems and is usually seen as the main contributor to biotic pollination.

The importance of wild pollinators in agricultural production is also increasingly being recognised (e.g. Westerkamp & Gottsberger, 2000; Kremen et al., 2007; Kremen & Chaplin-Kramer, 2007). A recent study by Breeze et al. (2011) shows that it is likely that wild pollinators have already been playing a way more substantial role in pollination services than previously thought. Wild pollination, for instance, can act in synergy with domestic pollination to increase crop yields (Greenleaf & Kremen 2006). In addition a diverse composition of native pollinators provides insurance against year-to-year population variability and loss of specific pollinator species (Kremen et al. 2002; Rickets 2004; Tscharntke et al. 2005). Additionally, species diversity resulting from the presence of both domestic and wild pollination can also ensure that a larger number of plants are pollinated, because of pollinator-specific spatial preferences for different flowering plant or crop field (Klein et al., 2008).

Growing evidence shows a substantial decrease in the number of pollinators in many regions, with the strongest declines documented in Europe and North America (Potts et al., 2010b; Johnson, 2007). In particular, during recent decades there has been a drop in the number of beekeepers in 18 European countries and a substantial decrease in the numbers of colonies in central Europe (Potts et al., 2010a). Interestingly, data by the Food and Agriculture Organization (FAO) showed that the global population of the managed honey-bees hives increased by approximately 45 per cent. However, the same study also revealed that the global agricultural demand for pollination has actually risen substantially more than the managed honey-bee populations (more than 300 per cent), suggesting future pollination problems (Aizen and Harder, 2009).

There are various reasons to expect that wild pollination services supported by Natura 2000 and other protected and semi-protected areas will be increasingly more needed in the future. As global population and hence the demand for food increases, it can be expected that the demand for pollination services will move in the same direction. However, the trend in the number of managed pollinators is not keeping up with the agricultural demand for their services and will be increasingly under pressure. Therefore, considering general regional declines in managed pollinators and recently documented cases of colony collapses (e.g. Johnson, 2007), it can be expected that the importance and hence the value of wild pollination is likely to increase.

5.5.2 Where are the benefits: the role of Natura 2000

Protected areas provide habitats and breeding grounds for pollinating insects and other species with economic and/or subsistence value (TEEB, 2011). As noted by Kremen et al. (2004), wild pollinators often depend on natural or semi-natural habitats for the provisioning of nesting (e.g. tree cavities, suitable soil substrates) and floral resources that cannot be found within crop fields. Consequently, the available area of natural habitat has a significant influence on pollinator species richness (Steffan-Dewenter 2003), abundance (Heard et al., 2007; Morandin et al., 2007), and pollinator community composition (Steffan-Dewenter et al., 2002; Brosi et al., 2007). Accordingly, habitat area in the neighbourhood of crop fields has been found to be strongly related to a direct measure of the pollination service measured here in terms of pollen deposition provided by bees (Kremen et al. 2004;) – see also the box below for other factors influencing the pollination service's provision. Hence, as a network of natural and semi-natural habitats, Natura 2000 has a significant role to play in securing continuous provision of pollinating service in the EU.

The importance of Natura 2000 in providing pollination services has also been recognised by key stakeholders. In a survey assessment carried out to estimate the level of appreciation and awareness of Natura 2000 related ecosystem services, pollination was identified as one of the most relevant ecosystem services (see Figure 5.21) (Gantioler et al., 2010).

Box 5.5 Factors influencing the pollination service delivery

There are numerous factors influencing the benefits of pollination to agriculture. Evidence shows that pollination services decline with increasing distance of natural/semi-natural habitat to the agricultural site (Carvalheiro et al., 2010; Ricketts et al., 2008). This relationship, however, might be different for both different crops and different pollinators (Balmford et al., 2008).

The quality of the natural and agricultural habitat, in particular its ability to provide nesting and floral resources, is being reported as another important influence (Klein et al., 2003;

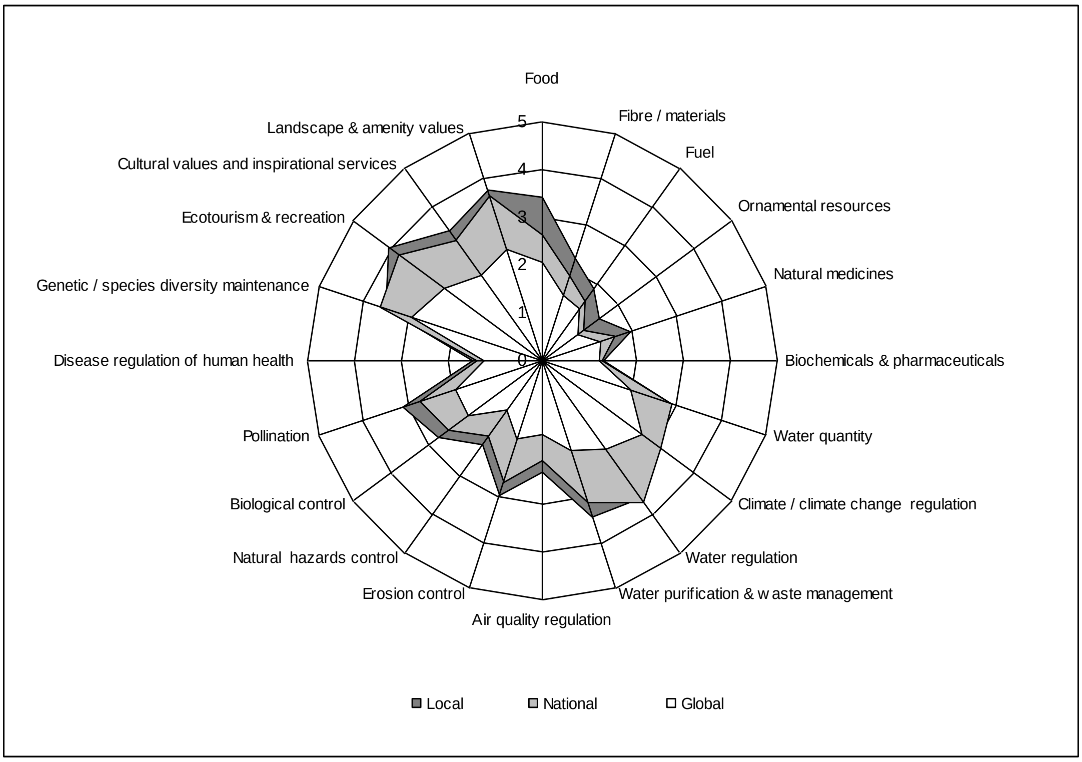
Goulson et al., 2005; Potts et al., 2005), although not all the species are dependent on it.

Wild pollinators' density at the crop site and their diversity has also a significant impact on crop yields (Balmford et al., 2008). Interestingly, functional diversity of the pollination species might be of more importance to crop yields than either species abundance or its richness (Klein et al., 2008).

Furthermore, the identity of the pollinator species is also important, due to the fact that different crops benefit from pollination by different species (Klein et al., 2007)

Source: based on Balmford et al., 2008

Figure 5.21: Estimated / perceived relevance of Natura 2000 in providing different ecosystem services at local, national and global level (on a scale of 1-5)



Source: Gantioler et al., (2010)

5.5.3 Benefit assessment: limitations of a preliminary estimate

From the existing evidence on pollination it is very difficult to provide any quantitative or monetary value of the benefits stemming from the Natura 2000 network. This is due to the fact that there is generally very sparse evidence on the values of pollination, especially in the context of Europe or protected areas. Moreover, most of the valuation studies concentrating on pollination services are conducted in the context of tropical agriculture (see Box 5.6 below). The transferability of these values to the European context is therefore questionable. Secondly, as the benefits from pollination are mostly connected to agricultural production, the valuation exercise is very site-specific. The majority of the Natura 2000 terrestrial-sites have the potential to provide pollination services to some extent, but the actual delivery of these services to agriculture is dependent on numerous factors (see box 5.5). The existing studies do not provide Natura 2000 site-specific values, therefore these should be inferred by more general information on habitats and broader regions, for instance by transferring per hectare values (e.g. as in Priess et al., 2007; Ricketts et al. 2004). Furthermore, it is important to note that the current scientific understanding of different factors influencing pollination and the trends in pollinators' populations is far from complete. This makes the valuation exercise problematic and it creates difficulties to separate the importance for pollination of Natura 2000 out of the wider context.

Nonetheless, there are numerous valuation studies from around the world and other pieces of information which allows for a rough illustration of Natura 2000 related pollination service (see Box 5.6). The values provided should serve as illustrative examples.

It is important to note that, beyond its impact on agriculture, pollination's contribution to human wellbeing has a broader scope. Even though currently unknown, pollination value and services to wildflowers and for recreational and other cultural services is expected to be significant (UK NAE, 2011, chapter 14).

Box 5.6 Pollination values

<u>EU context</u>

- The annual economic value of insect-pollinated crops in the EU-25 is about €14,2 billion (approximately 10 per cent of the annual economic value for all food production). The number for global agricultural production amounts to €153 billion. (Gallai et al., 2009; for a more detailed analysis of this study see Annex 5)

- Using the methods of Gallai et al. (2009), the United Kingdom's National Ecosystem Assessment estimated the economic value of biotic pollination as a contribution to crop market value in 2007 at €629 million (England: €532 million, Northern Ireland: €28 million, Scotland: €69 million, Wales: unknown) (UK NEA, 2011)

- A recent EEA's report (EEA, 2010) identifies the importance of natural pollination, particularly for alpine herbs, forests and semi-natural grasslands. Although the actual importance of pollination in the mountain ecosystems remains poorly known, it is important to acknowledge this in the context of our study - considering that 43 per cent of Natura 2000 sites are located in the mountain areas.

- Klein et al. (2007) found that the production of 87 out of 115 leading global crops (representing up to 35 per cent of the global food supply) were increased by animal pollination.

<u>Non-EU/global values</u>

- Estimated benefit that accrued to the Kakamega farmers in Kenya as a result of feral bee pollination of the eight selected crops was about €2.57 million - almost 40 per cent of the annual local market value of these crops in 2005 (Kasina et al., 2009).

- Ricketts et al. (2004) found that forest-based pollination in Costa Rica increased the yields of coffee by 20 per cent within 1 km from the forest. It was estimated that the value of pollination service from nearby patches of forests to local coffee production farm was around €50,000 per year.
- Losey & Vaughan (2006) estimated that wild pollinators alone are responsible for about €2.4 billion of fruits and vegetables produced in the United States.
- The average value of pollination services provided by forests in Sulawesi, Indonesia, was estimated at €46 per hectare. Due to on-going forest conversion, continued decline of pollination services is expected to directly reduce coffee yields by up to 18 per cent and net revenue/ha by up to 14 per cent within 20 years (Priess et al, 2007).
- Between US$ 1.1 million and US$9.6 million (on average between 1986 –1992) was estimated to be the yearly agriculture revenues dependent on any type of pollinator in Yucatan, Mexico (Drucker and Magana, as in Freitas, and Pereira, 2004).
- Pollination services of protected areas in South Africa's Cape Region are worth approximately US$ 400 million annually (Mulongoy and Gidda, 2008).

5.5.4 Conclusions and recommendations for future analysis

Wild pollination is a key ecosystem service supporting both natural and agricultural systems. Even though pollination is known to provide significant benefits, particularly by increasing agricultural production, the exact understanding of the process itself is still lacking. That poses numerous problems for the valuation of this service. Nonetheless, a significant number of studies aiming to estimate the value of pollination at different scales have been carried out. A synthesis of key findings was presented in this section to elicit the current research in this area.

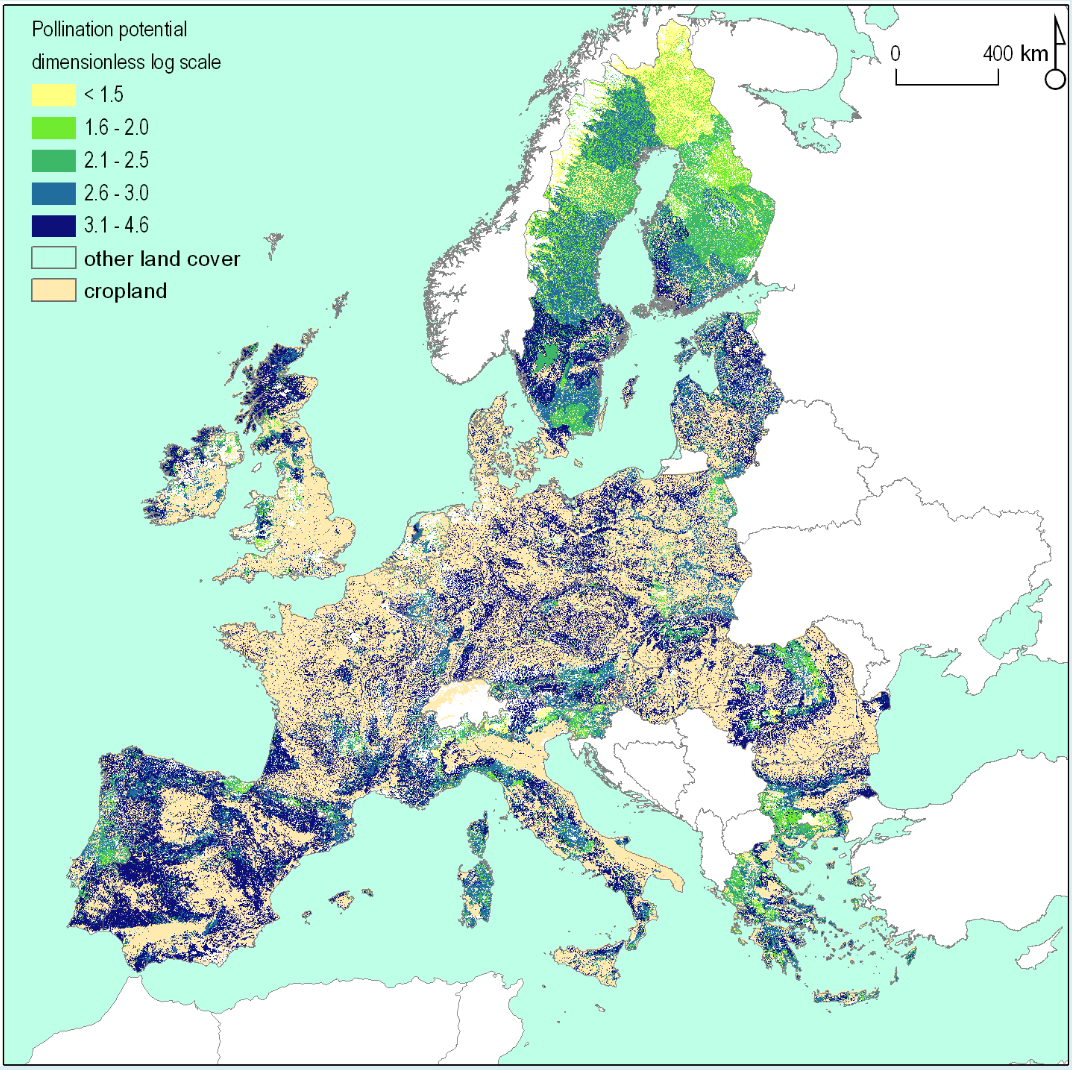
However, the current evidence base does provides no or little contribution to the value of pollination services stemming from Natura 2000 network or from protected areas in general. As such it is not possible to provide any robust number on the value of pollination services resulting from the network. For any future work on the benefits of Natura 2000 it is therefore desirable that valuation studies concentrating on the role of protected areas, and particularly Natura 2000, are conducted, and an increased amount of scientific evidence contributing to our understanding of the pollination process is brought forward.

An increased use of Geographic Information Systems (GIS) might offer a promising contribution to future estimations of the value of wild and managed pollination. As most ecosystem services are spatially dependent, an increased effort is being made to geographically map the level of provision and the potential for delivery of various services, including pollination (see Box 5.6 and Figures 5.24 below). A combination of ecosystems and agriculture GIS data might help determine the interaction between pollination potential and agricultural production. Moreover, if sufficient data become available in the future, this approach can significantly help to estimate the pollination potential of the Natura 2000 network.

Box 5.7 Pollination potential mapping

Significant work in the area of ecosystem services mapping has been done by the European Joint Research Centre. In its recent Scientific and Technical Report (JRC, 2011) alongside maps of other ecosystem services, a map based on an indicator for pollination potential has been developed. In this regard, dependency ratios from Klein et al. (2007), visitation rates of pollinators based on distance relationships from Ricketts et al. (2008) and a spatial distribution of crops from Grizzetti et al. (2007) were used. From this data maps of 'the pollination potential or the capacity of natural ecosystem to provide pollination services to croplands' were constructed at the aggregated level and at more detailed 1 km resolution (see Figure 5.22 below). Ideally, future mapping exercise could combine ecosystem services mapping with Natura 2000 maps to better identify the services provided by the Natura 2000 sites.

Figure 5.22: Pollination potential, 1km resolution



Source: JRC (2011)

5.6 Agriculture, erosion control and forestry products

Human relies extensively on biodiversity for the provision of food, as the complex interlinkages between ecosystem services underpins world's food security (see Table 5.18). Around 35 per cent of world's surface is used for growing crops and rearing livestock (MA, 2005). Agro-ecosystems directly contribute to the provision of food for human consumption through supporting the world's agriculture. Biodiversity and ecosystems have also an indirect role in world's food supply by, inter alia, allowing nutrient and water cycling or soil formation.

Alongside ecosystems contributions to agricultural output[39], natural ecosystems provide various biodiversity resources, such as wild mushrooms, plant fuel, ornamental flowers and game. Although these resources comprise a small portion of food supply in comparison to agriculture, they can play a substantial role in supporting livelihoods, particularly in developing countries. For instance, it has been estimated that ecosystem services and other non-marketed goods account for between 47% and 89% of the so-called 'GDP of the poor' (TEEB, 2011). In the context of the EU, the role of these resources lies especially in supporting local economies and providing cultural and recreational activities, such as family mushroom-picking or recreational hunting.

This chapter discusses the role of Natura 2000 sites in supporting EU's agricultural production and in providing other resources, with a focus on non-wood forest products such as wild mushrooms and game.

Table 5.18: Biodiversity benefits to agriculture through ecosystem services

Provisioning	Regulating	Supporting	Cultural
• Food and nutrients • Fuel • Animal feed • Medicines • Fibres and cloth • Materials for industry • Genetic material for improved varieties and yields • Pest resistance	• Pest regulation • Erosion control • Climate regulation • Natural hazard regulation (droughts, floods and fire) • Pollination	• Soil formation • Soil protection • Nutrient cycling • Water cycling	• Sacred groves as food and water sources • Agricultural lifestyle varieties • Genetic material reservoirs • Pollinator sanctuaries

Adapted from UNEP, 2007. *Global Environment Outlook. GEO 4: environment for development.* United Nations Environment Programme. Malta. p. 172.

5.6.1 Agriculture

[39] The overall value of the output depends on the ecosystems and human inputs. Only a share of the agricultural product price can be taken as directly due to the ecosystem.

What is the service: description of the agricultural products provision service

Protected areas, such as the Natura 2000 sites, are often managed under agricultural schemes while still contributing to the principle of sustainable development and nature conservation. Contrary to the widely-held view, designation of Natura 2000 sites does not aim to put all human activity on hold. Besides a few exceptions (such as intact natural forests and underwater caves) Natura 2000 sites are often managed for productive activities[40]**.** In fact, many of the Natura 2000 sites are valuable also thanks to the way they have been managed before their designation, and it is often desirable to continue with these activities to maintain the area's species and habitats in favourable conservation status (see Box 5.8).

Box 5.8 Species and agricultural practices

For many species from around Europe agricultural practices are essential for their survival and future prospects. For instance, grain production is associated with the presence of the great bustard (Otis tarda) in Spain, while humid hay- and grazing- meadows are essential for the corncrake (Crex crex) to remain in the banks of the Loire. Similarly, the pastures of open wooded meadows allow the hermit beetle (Osmoderma eremita) to flourish in the area of southern Sweden.

Source: http://ec.europa.eu/agriculture/envir/report/en/index.htm

Where are the benefits: spatial distribution of the service

Protected areas where agricultural activities are carried out form a significant part of the Natura 2000 network. The share of these areas varies between 20 and 40 per cent of Member States' Natura 2000 area. In total, agro-ecosystems cover about 38% of the EU-27 Natura 2000 land area - 17.5 % regularly cultivated; 14 % which need extensive practice; and 6.5 % with complex agro ecosystems[41]. These sites include about 8.6 million hectares of pasture, representing over 18 per cent of total pasture land across the EU. They are therefore largely dependent on the continuation of appropriate agricultural practices (Cooper et al., 2009). However, according to the findings of a recent assessment of the conservation status of habitats and species of Community interest[42], habitat types associated with agriculture have in general a worse conservation status than non-agricultural habitats. As such, there is a great interest in finding solutions which would let Natura 2000 farmland remain productive, while at the same time maintaining and ideally improving its natural environment.

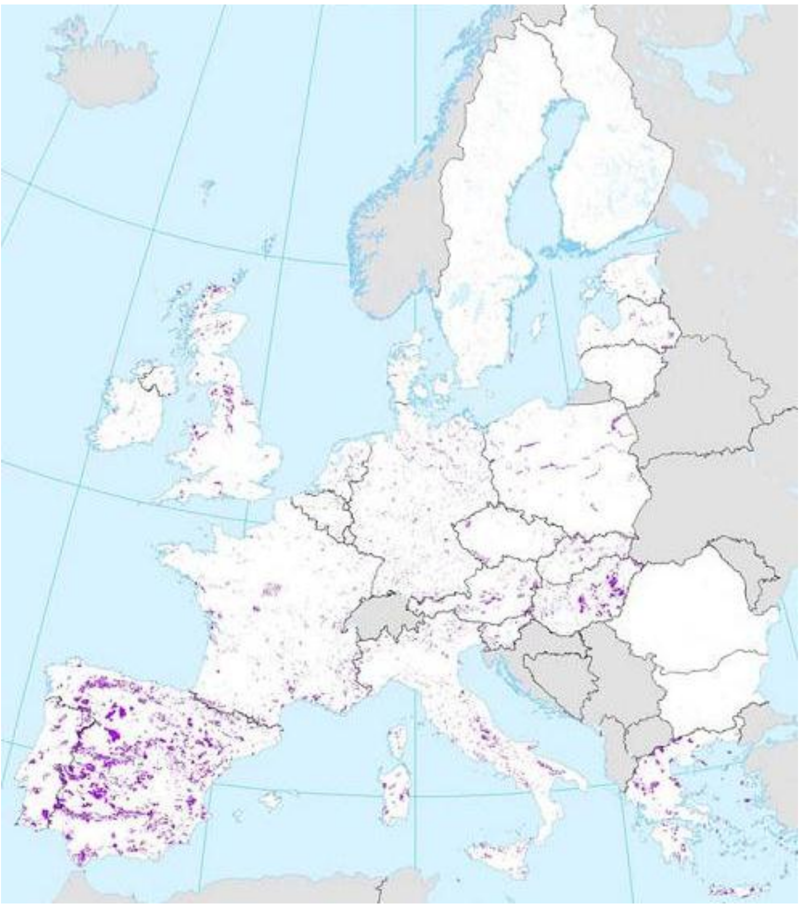
40 http://ec.europa.eu/agriculture/envir/report/en/index.htm

41 EU 2010 Biodiversity Baseline. EEA Technical report nº 12/2010

42 Monitoring reports under art. 17 of the Habitats Directive: http://ec.europa.eu/environment/nature/knowledge/rep_habitats/index_en.htm.

For an overview of the estimated location of Natura 2000 high nature value (HNV)[43] farmland, see figure below.

Figure 5.23: Estimated location of the Natura 2000 HNV farmland



NOTE: The figure shows locations of the Natura 2000 HNV farmland which has been identified by using standardized geographically located information on habitats and species from the Natura 2000 database. This exercise was a part of the broader project aiming to estimate the distribution of the HNV farmland at the European level
Source: Paracchini et al. (2008)

Considerations on benefit assessments: Agricultural co-benefits of Natura 2000 sites

Organic agriculture represents a promising agricultural management option for Natura 2000 sites and protected areas under agricultural land-use (e.g. Scialabba, 2003; see box below). Although organic farming does not necessarily imply high nature conservation value, it can offer clear benefits for biodiversity when compared

43 HNV farming commitments were established first in the 1998 EU Biodiversity Strategy which includes the explicit objective "to promote and support low-intensity farming systems ...". The term High Nature Value (HNV) farming is used to desribe broad types of farming that, because of their characteristics, are inherently high in biodiversity. Typically, these are low intensity farming systems.

to conventional forms of agriculture. Depending on latitude, it has been estimated that organic farming has between 46 and 72% more uncultivated natural habitats and host 30% more species than non-organic farming (Kukreja, 2010). Due to lower cultivation intensities and bigger share of natural areas, more indigenous species are present in the sites under organic farming, which in turn creates more intact and better-functioning ecosystems (ibid). Research also shows that organic farming can help to reduce non-renewable energy inputs and greenhouse gas emissions in an efficient way in areas related to Natura 2000 sites (Litskas et al., 2009). More research into the use of organic agriculture within the Network should be conducted, in order to better understand its implication. Existing evidence, however, already suggests that organic farming may indeed represent a viable option for some of the Natura 2000 sites.

It is likely that the support for Natura 2000 and High Nature Value (HNV) farming in the EU offers significant synergies, however it is currently difficult to determine their potential overlap. It is known that Natura 2000 network is protecting a significant portion of HNV farming area, especially parts that are of recognised biodiversity quality (for further information see Paracchini et al., 2008, also Figure 5.25 below). Conversely, HNV farming directly benefits conservation of Natura 2000 farmland habitats, being either within actual sites or in the wider countryside.

From the current available data it is difficult to estimate the portion of agricultural output directly attributable to the Natura 2000 network. As of now, it is possible estimate only the portion of Natura 2000 area under agricultural use. Integrating the Natura spatial data with the Farm Accountancy Data Network (FADN) would allow a better determination of the agricultural output derived from Natura 2000 sites. Such integration is a pre-condition for any future estimation of agricultural benefits related to the Network.

It has to be noted that Natura 2000 farming also plays a significant role in the maintenance of local breeds and local plant and tree varieties adapted to valuable semi-natural habitats (see figure below showing the location of estimated Natura 2000 HNV farming areas). The maintenance of the farmed Natura habitats often critically depends on carefully managed grazing, in which local breeds play vital role. Their replacement by more productive breeds of cattle and sheep has proved to be one of the main causes of biodiversity degradation. There has been in fact a continuous decline in global crop and livestock genetic diversity, which may pose a significant risk both for biodiversity and agricultural production. For instance, about one-fifth of livestock breeds are at risk of extinction (Secretary of the Convention on Biological Diversity, 2010). Intensification and standardisation of agriculture has lead towards current reliance on a fraction of species formerly used, which in turn has increased the vulnerability of the system to the external pressures, such as climate change. On the contrary, local varieties of crops, e.g. dry cereals in the Iberian steppe croplands or traditional fruit trees in the extensively grazed orchards in Central Europe, and local breeds, which are used in many Natura 2000 sites, are so well adapted to the soil/climatic conditions that they can be considered an integral part of the agricultural biotope. Conservation of these varieties is of a significant importance, as they are likely to play an essential role in future agricultural adaptation strategies. Natura farming, therefore, can contribute to the protection of the genetic resource base for agriculture.

However, results of a recent study suggest that strategies aiming at synergies between protection of biodiversity and agricultural production have limits. The study by Phalan et al. (2011) shows that land sharing (i.e. land is farmed with nature-friendly agricultural practices) is less favourable for biodiversity conservation than land sparing (i.e. part of the land is intensively farmed, while other part is left protected). Having analysed the population numbers of selected species of trees and birds in both agricultural and natural areas in Ghana and India, the paper discovered that leaving certain areas fully protected while intensively managing other areas (i.e. land sparing) offers better prospects for biodiversity. In all analysed scenarios, the same level of food was produced, but the areas with 'agriculturally-friendly' practices (i.e. land sharing) led to lower populations of species (Phalan et al., 2011). Although likely context specific, these results and the consequent debate on this topic[44] highlight the importance of understanding the interplay between agriculture and biodiversity which need to be taken into account in land and policy decisions.

It should also be noted that some agricultural practices may be nevertheless constrained by the designation of Natura 2000 and that economic (especially employment) considerations may become a source of conflict. It may be possible that 'incremental opportunity cost' approach could be used to compensate farmers in Natura 2000 sites based on the social returns that the Natura 2000 site can offer to the wider public. An adequate assessment of the benefits of Natura 2000 in agricultural areas can therefore play a key role in policy decisions.

Importantly, when looking at the benefits of Natura 2000 with regards to the EU's food security, it is important to take into account also its indirect role in supporting EU's agriculture. In particular, protected areas, such as Natura 2000, play a significant role in harbouring wild pollination, controlling the spread of pests and pathogens, regulating and filtrating water or supporting soil fertility through erosion control (see Sections 5.4, 5.5, 5.6.2, 5.10).

Some examples of the positive interrelation between agriculture and Natura 2000 are shown in Box 5.9 below.

Box 5.9 Some Examples of Farming in the Context of Natura 2000

Being the first major farming for conservation project in Ireland, the Burren LIFE Project seems to offer a good 'value-for-money' solution with minimum estimated economic return of 235%. (Rensburg et al, 2009)

Organic agriculture has been recognised as a particularly useful option within the Mount

44 http://nature.berkeley.edu/kremenlab/Articles/Conservation.%20Limits%20of%20Land%20Sparing%20Science%20Letter.pdf

Etna national park in Sicily and the Sneznik regional park in Slovenia (EEA, 2010)

Traditional agriculture, and primarily sheep farming, has significantly contributed to the well-preserved and stable conservation status of habitats, flora and vegetation in the Island of Pag, in Croatia. Agriculture and conservation here co-exist, facilitating the production of the traditional cheese of Pag, and hence contributing to the local economy. The continuity of this situation is in the interest of local population (Sundseth, undated).

In a Rhön grassland area in south east Germany, mostly included in Natura 2000, an infrastructure for locally produced sheep products has been developed. Mowing and grazing through the use of sheep helped with site management, while a market for locally produced Natura 2000 products has been established (Sundseth, undated).

5.6.2 Erosion control

What is the service: description of the erosion control service

Erosion is commonly defined as carrying away or displacement of solids (e.g. sediment and soil) and other particles by wind or water. Erosion is a natural process, but is heavily increased by human land use, in particular by intensive and inappropriate land management practices such as deforestation, overgrazing, unmanaged construction activity and road-building.

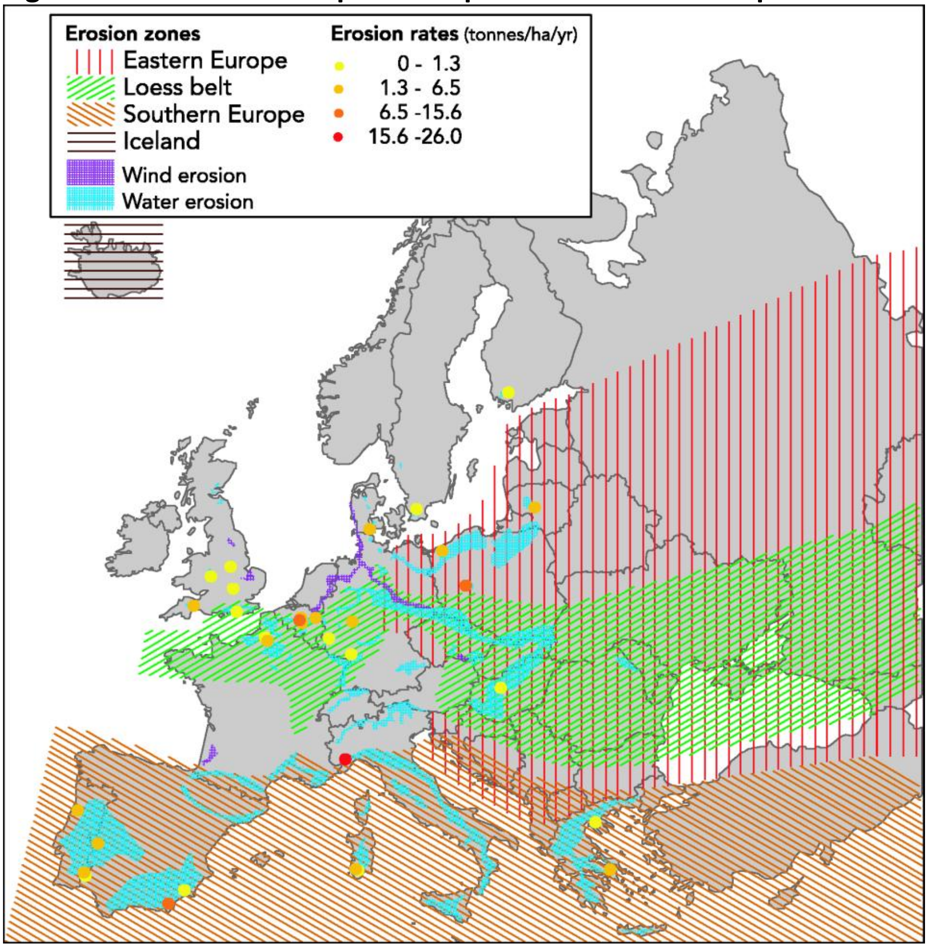
Managed areas, e.g. areas used for the production of agricultural crops, generally experience a significant greater rate of erosion than areas under natural vegetation. This capacity of natural ecosystems, like Natura 2000 areas, to control soil erosion, is based on the ability of vegetation (i.e. the root systems) to bind soil particles, thus preventing the fertile topsoil from being blown or washed away by water or wind. In addition, healthy vegetation cover can also mitigate the negative impacts of tramping by livestock.

Soil erosion can cause several negative impacts. For example, erosion diminishes soil fertility resulting in reducing crop yields and biomass for livestock. In addition, soil erosion increases the sediment load in water bodies which in turn can cause a decline in water quality and alter the flow of water.

Where are the benefits: spatial distribution of the service

Soil erosion, in particular water induced erosion, is a widespread problem throughout Europe. It has been estimated that about 12 million hectares of land in Europe (e.g. part of the former Soviet Union), or approximately 10 per cent of the area, is strongly or extremely degraded by water erosion (as in Jones et al. 2003). In general, the highest erosion rates are located in the central and southern Europe, including the Mediterranean region (see Figure 5.24 below). For example, in parts of the Mediterranean erosion has reached a stage of irreversibility, leaving behind areas with no soil cover (Jones et al. 2003). Therefore, it is evident that ecosystems' ability to control soil erosion is of high value in Europe.

Figure 5.24: Soil erosion: probable problem areas in Europe



Source: http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=489

Considerations on benefit assessments: benefits of Natura 2000

Preventing erosion can be of relevance to all terrestrial Natura 2000 sites located in erosion prone areas. These areas include, for example, steep slopes and areas with naturally thin soil cover. In addition, sites situated close to lakes, river banks and sea might be of high value, given the possible negative effects of soil erosion on the status and quality of water bodies.

For example, the Mediterranean region is particularly prone to erosion. This is because it is subject to long dry periods followed by heavy bursts of erosive rain, falling on steep slopes with fragile soils, resulting in considerable amounts of erosion (Jones et al. 2003).

Box 5.10 Quantitative examples of valuing erosion control

A study by Ruijgrok et al. (2006) estimated that the value of erosion control in pristine scrubland areas in Europe and in Belgian grasslands was €44.5/ha, at 2008 prices. These values were estimated on the basis of the avoided cost method.

Source: Braat et al, 2008

5.6.3 Non-wood forest products

What is the service: description of the non-wood forest product provision service

Forests in Europe contribute substantially to the supply of non-wood goods (NWGs), such as wild berries, mushrooms or wild animals. In the tables below, a summary overview of the harvested amounts of these good is provided for various European regions. However, for reasons of consistency, quantities harvested for self-consumption and other uses are omitted. As such, the reported quantities represent an underestimation, as self-consumption might often represent a significant part of the overall harvest and benefits derived.

Table 5.19: Quantity and values of forest related products harvested in Europe

Region	Christmas trees		Mushrooms and truffles		Fruits, berries and edible nuts		Cork		Resins, raw material – medicine, aromatic products, colorants, dyes		Decorative foliage, incl. ornamental plants (mosses,..)		Other plant pro-ducts
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Value
	1000 pcs	1000 €	tonnes	1000 €	tonnes	1000 €	tonnes	1000 €	tonnes	1000 €	tonnes	1000 €	1000 €
Russian Federation	6	4	9 332	21 006	49 053	105 501	-	-	5 059	7 861	-	2 240	3
North Europe	17 162	132 104	4 428	12 493	52 231	15 107	-	-	882	182	400	58 824	-
Central-West Europe	38 850	733 900	732	14 550	239	883	1 550	775	145	32	1 581	7 202	55231
Central-East Europe	1542	2 830	29 935	10 587	61 362	28 132	-	-	957	1 621	350	1 802	106
South-West Europe	-	110 828	366 873	124 161	208 236	299 574	167 665	323 850	7 351	2 364	-	-	7997
South-East Europe	631	377	17 398	11 283	5 056	10 296	-	-	17 368	12 476	37	921	408
Europe	58 193	980 043	428 699	194 081	376 178	459 494	169 215	324 625	31 762	24 536	2 368	70 989	63745
Europe without the Russian Federation	58 187	980 039	419 367	173 075	327 125	353 993	169 215	324 625	26 703	16 675	2 368	68 749	63742

Region	Game meat		Living animals		Pelts, hides, skins and trophies		Wild honey and bee-wax		Raw material for medicine, colorants		Other animal pro-ducts
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Value
	tonnes	1000 €	1000 pcs	1000 €	1000 pcs	1000	tonnes	1000 €	tonnes	1000 €	1000 €
Russian Federation	16 945	16 945	16 945	16 945	16 945	16 945	16 945	16 945	16 945	16 945	16 945
North Europe	33 535.2	5 791	-	-	47 316	345.5	-	-	-	-	-
Central-West Europe	42 264	217 505	-	-	28 700	6 738	10 150	25 616	-	-	1 340
Central-East Europe	23 903.4	15 117	3 117	1 221.2	50 358.6	2 136	-	-	160	1 115	2 461.1
South-West Europe	2 634	149 537	-	-	-	-	37 869	101 088	-	-	-
South-East Europe	2 368.31	4 266.5	-	-	6 526.3	8 439.16	4 275	3 660	-	-	-
Europe	121 650	409 162	20 062	18 166	149 846	34 604	69 239	147 309	17 105	18 060	20 746
Europe without the Russian Federation	104 705	392 217	3 117	1 221	132 901	17 659	52 294	130 364	160	1 115	3 801
EU-27	121 650	394 457	3 117	1 221	126 032	16 679	47 469	119 704	160	1 115	1 366.1

Source: Forest Europe et al., 2011

Even though the importance of non-timber forest goods varies between countries, the reported quantities show that they represent an important source of local income (Forest Europe et al., 2011). However, it has to be noted that there are problems associated with data collection on NWGs as, for instance, data gathering is a costly process, many countries collect data only for the NWGs of a local significance, and there are problems associated with data harmonisation across Europe.

In some parts of Europe the harvest of many of non-timber forests goods is a matter of recreational and/or cultural activities. For instance, in the Czech Republic and other Slavic countries, mushroom picking is a common recreational and family activity, which is enjoyed particularly by urban dwellers. Similarly, in many countries in Europe, such as Sweden or Norway, hunting is considered an important outdoor recreational activity (see box below).

Considerations on benefit assessments: benefits of Natura 2000

Although some estimates of the overall numbers of non-woods goods are available, it is difficult to disentangle from these the benefits related exclusively to the Natura 2000 network. Nonetheless, as the biggest abundance of these species can be observed in high biodiversity habitats it is likely that the contribution of Natura 2000 is significant. Clearly, more data is needed for further estimation of the benefits derived from Natura 2000 in this field. As noted above, however, data collection on NWGs is difficult and substantial part of the harvested goods can be expected to be used for self-consumption and other uses, for which reliable estimates is generally hard to obtain.

Additional information and case examples are also provided in the box below.

Box 5.11 Case examples and further information on wild mushrooms and game

Wild mushrooms: Wild edible fungi are considered to be one of the most valuable NWGs with a significant potential for trade expansion. Moreover, they have a nutritional value comparable to many vegetables and they play a significant role in subsistence uses, particularly in developing countries (Boa, 2004).

From the data obtained from annual surveys throughout the years 1994-2009 it has been estimated that, on average, each household in the Czech Republic collects around 5.8 kg of mushrooms each year. Throughout this period Czechs harvested about 20.6 million kg of mushrooms each year, worth around EUR 71.9 million. (Ministry of Agriculture of the Czech Republic, 2010)

In Italy, mushroom-picking is regulated by national legislation. As a consequence, anybody who wants to do so needs to obtain a licence. In some regions this can be obtained only after passing a basic course and associated test. Moreover, mushroom picking is allowed only on certain days and in certain quantities, both varying on a regional level.

Game: Over 65% of the EU's countryside is managed in a collaborative manner for hunting and conservation.[45]

Funded within the 7th Framework Programme, the project Hunting for sustainability aimed to assess the social, cultural, economic and ecological functions and impacts of hunting across a broad range of contexts in Europe and Africa. According to project, there is about

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45 http://www.facenatura2000.net/conference%202009/conclusions%20and%20recommendations.Natura2000%20&%20wildlife%20use%20conference.pdf

925.000 hunters in Spain (in 2006), 51.308 registered hunters in Croatia (2008), 264,000 in Sweden (2009/10) and 430 000 in Norway (2008/09).

Shooting influences the management of 4.4 million hectares of land in Scotland and it is an important economic activity worth around £80M to the Scottish economy (2004 estimate) (Hunting for sustainability, country profiles[46]).

46 http://fp7hunt.net/Presspublications/HUNTfacts.aspx

5.7 Natural medicines and genetic resources

5.7.1 What is the service: description of the Natural medicines and genetic resources provision services

Globally, biodiversity provides an important source for the development of new medicines, cosmetics and biochemicals. According to recent assessments, 50,000 to 70,000 plant species are used for traditional and modern medicine worldwide (Schippmann et al. 2006). For example, in some Asian and African countries, up to 80 per cent of the population depends on traditional medicine for primary health care (World Health Organization 2008). Access to natural compounds also plays a significant role in modern pharmaceutical research and development. It has been estimated that 25 per cent of the drugs sold in developed countries and 75 per cent of those sold in developing countries were developed using natural compounds (Pearce and Puroshothamon, 1992), demonstrating that biodiversity is of value to pharmaceutical firms in their efforts to develop new drugs.

Biodiversity is also crucial to protect the variety of crop and livestock biodiversity and genetic resources, which are essential for food production and security. Crops, livestock and their wild relatives have the genetic variability that provides the raw material for breeding new crop varieties, through classical breeding and biotechnological techniques (FAO 1997, 2007). The loss of local species and varieties has often resulted in irreversible loss of the genetic diversity they contain. This has dangerously shrunk the genetic pool that is available for natural selection, and for selection by farmers and plant and livestock breeders. Consequently, the vulnerability of agricultural crops and livestock production to sudden changes, such as global warming and the appearance of new pests and diseases, has increased (Esquinas-Alcázar 2005).

5.7.2 Considerations on benefit assessments: benefits of Natura 2000

The importance of genetic conservation is emphasised in global assessments of the relationship between biodiversity and ecosystem services (e.g. MA, 2005; Balmford et al, 2008; TEEB, 2011). Much of the evidence refers to developing countries and emphasises the importance of biodiversity in sustaining the livelihoods of the poor, and in contributing to food security and future development opportunities.

Less attention has been paid to the importance of conserving genetic resources in the EU context. This is perhaps because the EU only holds a small proportion of the world’s biodiversity, and because our biodiversity has been relatively well studied, and offers less potential for new discoveries.

Nevertheless, it is apparent that Natura 2000 sites provide a variety of benefits through the conservation of genetic resources (Kettunen et al, 2009). These include:

- The conservation of species with potential medicinal uses;
- The maintenance of extensive farming systems, employing traditional crop and livestock breeds;
- The conservation of crop wild relatives, which have an important role to play in maintaining food security and production (see box below).

Box 5.12 Importance of Protected Areas in Conserving Crop Wild Relatives

Crop Wild Relatives (CWR) are the wild ancestors of crop plants and other species closely related to crops. Hopkins and Maxted (2011) observed that they are likely to play a significant role in securing 21st century food security, because of their potential use in plant breeding to produce crops which withstand adverse impacts of climate change, increasing scarcity of nutrients, water and other inputs, and new pests and diseases. A high proportion of global food production is from a small number of scientifically-bred crop varieties, with narrow genetic variation. This has resulted in loss of approximately 75% of global crop genetic diversity as these new varieties replaced a much greater range of more genetically diverse traditional crop varieties. In the UK 303 taxa (i.e. species, subspecies and varieties) belonging to 15 families are wild relatives of significant agricultural and horticultural crops.

A paper by Maxted et al (2007) highlighted the role of protected areas in CWR conservation. All of the 17 CWR hotspots that would need to be protected to conserve two thirds of CWR species in the UK are designated as protected areas - 8 of these sites are SACs and a further 9 are nationally designated as Sites of Special Scientific Interest.

Kettunen et al, 2009

While Natura 2000 sites offer significant potential benefits in conserving genetic resources, existing assessments suggest that the current value of the services provided by the network at EU level is limited. For example, a review of existing evidence and interviews with national stakeholders (Gantioler et al, 2010), found that the role of Natura 2000 in preserving genetic and species diversity is recognised to be of high importance, but that the value of actual benefits gained from using sites for food, fibre, medicines and pharmaceuticals is currently low. Indeed, while Natura 2000 offers at least the potential for new commercial discoveries, there is no evidence of current interest in Natura 2000 sites as a resource for bio-prospecting.

Globally, studies have estimated the value of the benefits of bio-prospecting to be typically in the range of $0-20/ha, with the upper end typically referring to particularly biodiverse habitats such as tropical forests (Pearce, 1993; TEEB, 2011).

5.7.3 Conclusions and recommendations for future analysis

No estimates of the value of ecosystems in conserving genetic resources are available at the EU level, and therefore it is not possible to assess the value of the services provided by the Natura 2000 network. Available evidence suggests that the market value of these services is likely to be minimal, but that their social value is significant. Overall, Natura 2000 is seen as playing a valuable role in conserving species which may have potential uses to society in the future, and to future generations.

The benefits of Natura sites in conserving genetic resources may be seen as an example of 'option value'. It may be difficult to separate the value of these benefits from non-use values associated with biodiversity. Society's willingness to pay to conserve biodiversity is likely to reflect both the values we place on its existence and our desire to protect it for the potential future benefits that it may provide, so a distinction between the values placed on these two elements may be difficult to be made.

5.8 Air quality regulation

5.8.1 What is the service: description of the air quality regulation service

Ecosystems help regulate air quality by removing contaminants from air, through physical processes such as filtration and biological processes such as decomposition and assimilation (Balmford et al, 2008). Natural vegetation, and especially trees and woodlands, improves air quality through the uptake, transport and assimilation of a wide range of gaseous and particulate air pollutants (Forest Research, 2011). Air quality regulation is especially supported by the maintenance and management of healthy forests with diverse vegetation structures and features increasing the surface area for the removal of pollutants (Kettunen et al, 2009).

Kettunen et al (2009) identify the following benefits from air quality regulation:

- Reduced concentrations of pollutants in air have benefits for human health by reducing respiratory diseases;
- Adverse impacts on ecosystems (e.g. acid rain, eutrophication) may be reduced. As well as affecting natural habitats, these may affect agricultural, timber and fish production as well as water quality and a variety of ecosystem services;
- By limiting damage to ecosystems, the service preserves values related to aesthetic, cultural, religious, recreational or educational benefits; and
- Air quality regulation may reduce negative radiative forcing and so the impacts of climate change.

5.8.2 Considerations on benefit assessments: benefits of Natura 2000

Ecosystem services related to air purification are most valuable in or close to urban areas, where pollutant concentrations and human health effects are greatest. Although different types of ecosystems can have benefits in regulating air quality, the greatest benefits are provided by forest ecosystems.

Little evidence of the value of benefits of ecosystems in enhancing air quality is available in the EU. However, estimates were carried out in two studies – one in the Netherlands (Ruijgrok et al, 2006) and one in the UK (Powe and Willis, 2002). These give markedly different benefit estimates.

Ruijgrok et al (2006) estimated the benefits of different ecosystems in reducing pollution by particulates and other air pollutants in the Netherlands. Their figures suggest that the annual value of benefits provided by ecosystems in regulating air quality are very high, at €9,800 - €61,400 per hectare for deciduous forest, €17,500 – €118,400 per hectare for coniferous forest, €4,200 – €16,200 per hectare for heathland and €770 – €3,120 per hectare for reedbed and scrub – see table below.

Table 5.20: **Benefits of Ecosystems in Air Quality Regulation in the Netherlands**

Ecosystem	Quantity captured (kg/ha/year)	Value € per kg		Value per ha (€)	
		Rural	Urban	Min	Max
PM10					
Deciduous forest	110-190	70	300	7,700	57,000
Coniferous forest	220-380	70	300	15,400	114,000
Heathland	50	70	300	3,500	15,000
Reedbed/ scrub	10	70	300	700	3,000
NOx					
Deciduous forest	205	7	12	1,435	2,460
Coniferous forest	205	7	12	1,435	2,460
Heathland	100	7	12	700	1,200
Reedbed/ scrub	10	7	12	70	120
SO2					
Deciduous forest	178	4	11	712	1,958
Coniferous forest	178	4	11	712	1,958
Heathland	n/a	4	11	-	-
Reedbed/ scrub	n/a	4	11	-	-
Total benefits					
Deciduous forest				9,847	61,418
Coniferous forest				17,547	118,418
Heathland				4,200	16,200
Reedbed/ scrub				770	3,120

Source: Ruijgrok et al (2006)

In contrast a study by Powe and Willis (2002) gave much lower estimates of the net health effects and the reduction in economic costs attributable to woodland in Great Britain. Net pollution absorption by woodland was estimated to reduce the number of deaths brought forward by air pollution by between 59-88 deaths annually, and to result in between 40-62 fewer hospital admissions per year. These were valued at £124,998 (about €200,000)[47] for each death avoided by 1 year, and £602 (about €960) for an 11 day hospital stay avoided due to reduced respiratory illness. The net reduction in costs (or increase in benefits) attributable to pollution absorption by woodland was estimated to range between £199,367 and £11,373,707 (€317,000 – €18,000,000). This is equivalent to a value of between £0.07 and £4.21 (€0.11 - €6.70) per hectare per year.

The Powe and Willis study estimated that trees in Great Britain absorb 391,664 - 617,790 metric tonnes of PM10 and 714,158 - 1,199,840 metric tonnes of SO_2 per year. The estimated rate of absorption of air pollution per hectare of forest is broadly comparable to that used by Ruijgrok et al – the large difference in the benefit estimates can be explained by the much lower incidence of health effects estimated by Powe and Willis. Their study should also be seen an underestimate, as it considered only the benefits of forests of 2 hectares or more.

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47 Average exchange rate GB-€ in 2002: 1.59. Source: http://www.oanda.com/currency/average

5.8.3 Conclusions and recommendations for future analysis

The above evidence demonstrates that it is possible to estimate per hectare values for the benefits of forests and other habitats in regulating air quality. These values vary according to the location of habitats, and are highest in urban and urban fringe areas, and lower in rural areas. In theory, if it is possible to select appropriate per hectare values for different habitats, these can be multiplied by the area of those habitats covered by the Natura 2000 network to give overall benefit estimates.

However, existing evidence is limited and gives a very wide range of annual per hectare benefit values. Available estimates range from €0.11 per hectare of forest per year in the UK to up to €118,000 per hectare per year in the Netherlands. Note that the main areas of benefits (and hence higher values) would be in and near cities and an national average per hectare value would under-represent the potential specific benefits in high population density areas also facing air quality challenges. Further research to identify appropriate values that could be applied across the Natura 2000 network would therefore be required as well as spatially explicit modelling that can link agglomerations, population levels, income, air quality statistics and locational proximity of protected areas.

5.9 Human health impacts

5.9.1 What is the service: description of the support of ecosystems to human health

The role of ecosystems in supporting human health is manifold. Firstly, naturally functioning ecosystems can regulate the range and abundance of species that are hazardous to human health. For example, a number of species (e.g. birds and insects) are known to be vectors of human diseases (e.g. malaria, dengue fever, Lyme disease etc.). In a natural state the functioning of ecosystems (e.g. competition on resources and predation) keeps the populations of these species under control. However, in a changed situation the populations of these harmful species might increase exponentially causing an epidemic of the disease they carry.

In addition, natural ecosystems are also often best 'equipped' against the invasion of alien species with harmful health impacts, such as exotic pathogens, disease vectors and allergenic species. This is because, in comparison to disturbed areas, natural ecosystems tend to have a higher capacity to sustain their natural status under changed conditions. For example, several invasive alien species are known to cause allergies and skin damage, e.g. giant hogweed (*Heracleum mantegazzianum*), common ragweed (*Ambrosia artemisiifolia*) and silver wattle (*Acacia dealbata*) (Kettunen et al. 2008).

Secondly, natural ecosystems are known to play an important role in supporting physical and mental health by providing possibilities for outdoors activities, recreation and relaxation (see also the parallel report on the value for tourism and recreation – Bio et al, 2011 forthcoming). For example, the importance of urban green areas for human wellbeing has been demonstrated in several studies (See Box 5.13 below). Protecting the diversity of species and habitats helps to maintain a wider variety of possibilities for recreation and mental enjoyment, e.g. different natural settings to enjoy and more opportunities for wildlife watching.

Finally, it is to be noted that ecosystems also play a positive role in protecting human health via a number of other functions, e.g. mitigation of natural hazards and maintaining air quality (see e.g. chapters 5.3 and 5.8)

5.9.2 Considerations on benefit assessments: benefits of Natura 2000

Regulation of human health can be supported by all Natura 2000 sites. In particular, the following sites might have a specific contribution to maintaining this service:

- sites located in a reasonable distance from urban areas and therefore easily accessible for recreation;
- sites offering a variety of recreational possibilities and therefore being visited by different user groups, e.g. hiking, canoeing and climbing: and

- sites situated in an area otherwise heavily infested by allergenic plants, e.g. invasive alien species such as giant ragweed and giant hogweed, thus providing a recreational 'sanctuary' from these species.

Box 5.13 Examples of valuing human health regulation

Cost based estimates based on the negative health impacts of invasive alien species

Asian tiger mosquito (*Aedes albopictus*) in Italy (Emilia Romagna): species poses a health risk as it is a vector for Dengue and Chikunguna fever and it also has painful stings. Costs related to preventing negative health impacts (e.g. eradication program and communication) €1.1 million / year. (Kettunen et al. 2008 and the sources within)

Oak processionary moth (*Thaumetopoea processionea*) in the UK: Caterpillars have defensive bristles containing an urticating toxin. When this toxin becomes airborne it can cause epidemic caterpillar dermatitis (lepidopterism), with symptoms such as rash and respiratory distress. Costs of control this species in the UK estimated to be £20,000 - 30,000 / year. (Kettunen et al. 2008 and the sources within)

Giant hogweed (*Heracleum mantegazzianum*) in Germany: Plant can cause serious burns when in contact with human skin. Medical costs and costs related to controlling the plan are estimated to be around €11 million / year. (Kettunen et al. 2008 and the sources within)

Estimates based on stated preferences (see TEEB 2011 and 2010 for more detailed explanation of the method)

Health impacts in Denmark: when estimating the importance of urban green areas to human health (e.g. mental) in Denmark, over 90 per cent of survey respondents replied that green areas played a role in increasing their health (RSPB 2005, Nielsen & Hansen 2007).

'Health walks' initiatives in the UK: over 50 initiatives in the UK have taken place with 64 per cent of the participants saying that the 'health walks' have positively changed their habits and lifestyle (RSPB 2005).

Role of nature in human mental wellbeing in Finland: a survey assessing the role of nature and green areas in helping to recover from negative feelings, e.g. stress. (Tyrväinen et al. 2007)

5.10 Biological control

5.10.1 What is the service: description of the biological control service

Biological control is defined as the maintenance of natural enemies of plant and animal pests, regulating the populations of plant and animal disease vectors, etc. It relates to the abundance and species richness of biological control agents (e.g. predators, insects, etc.) and the local proximity of these predators with the pests - as each predator has a limited biological range as control agents.

The benefits of natural biological control is not just the reduction of pests and due positive benefits on biodiversity, but also on avoided output losses, avoided health impacts and also avoided need for pesticides against these pests. This can lead to significant savings in agriculture, for example.

Biological control is the process by which an organism reduces the population density of a plant / animal pest or a pathogen, for example through predation, parasitism or competition on resources. Biological control may be natural, without direct intervention from man, or it may be enhanced by humans through increasing the populations of natural enemies or by introducing a novel bio-control agent (e.g. predator) in the system (Bale et al. 2008).

In the case of ecosystem services, the focus is on ecosystem's natural ability to keep pest and pathogen populations under control. For example, (semi-) natural vegetation patches intermingled with crops provide an important habitat for many natural enemies of insect pests in agri- and silvicultural systems (Balmford et al. 2008). Similarly, agricultural areas hosting a variety of different habitats (e.g. agro-forestry systems) can be more resistant to the outbreaks of plant pathogens that monocultures.

Natural and semi-natural ecosystems play also an important role in suppressing the establishment of invasive alien species. For example, in Central Europe more invasive plant species can be found at nutrient rich locations created by human land use (such as fields and road sides) than in forests or fens. In addition, the reintroduction of large predators may help to control red deer populations, reducing so browsing damages to forests.

Ecosystems' natural ability to control pests and pathogens is (directly or indirectly) an added value to several provisioning services (e.g., food, fuel, biochemicals, natural medicines) and regulating services (e.g. water quality). Benefits may include:

- **suppressing damages** caused by pests, plants and animals;
- **improving yields** of crop, timber, raw material in general;
- **maintenance of an ecological equilibrium** that prevents, for example, herbivore insects from reaching pest status, or red deer population from

reaching a level where it can have major impacts on timber production (Zhang et al. 2007);

- **reduced costs** due to lesser use of chemical pesticides;
- **reduced impact** of chemical pesticides on water and soil due to reduced use of chemical products to combat pests;
- **positive impact on organic farming** due to increased opportunities of biological control; and
- **increased attractiveness of an area** for nature tourism due to preventing an invasion of a troublesome alien species (e.g. bushy and thorny plant species) or due to the reintroduction of large predators.

Box 5.14 Overview of the economic losses caused by agricultural pests

Agricultural pests cause significant economic losses worldwide. Globally, more than 40 per cent of food production is being lost to insect pests, plant pathogens, and weeds, despite the application of more than 3 billion kilograms of pesticides to crops, plus other means of control (Pimentel 2008). In the US alone, it is estimated that more than US$18 billion are lost due to insect damage (including more than US$ 3 billion spent in insecticides), of which about 40 per cent attributed to native species and the remaining to exotic pests (Losey & Vaughan 2006). These values, however, would be much higher if biological control was not in place. Losey & Vaughan (2006) estimate that 65 per cent of potential pest species are being suppressed in the US, with a total value of pest control by native ecosystems around US$ 13.60 billion. Through a predator removal experiment, Östman et al. (2003) showed that the presence of natural enemies increased barley yields 303 kg/ha, preventing 52 per cent of yield loss due to aphids.

Source: Balmford 2008 (and references within)

5.10.2 Considerations on benefit assessments: benefits of Natura 2000

Biological control is dependent on the abundance and diversity of natural enemies. Those, on the other hand, are again influenced by the number, area and quality of habitats that host natural biological control agents (e.g. predators). Also the diversity and connectivity of a landscape play an important role in maintaining the overall populations of natural enemies in the area. Natura 2000 sites can contribute significantly to all these aspects and, therefore, they can play an important role in maintaining natural biological control in an area.

Also, proximity of crop fields to semi-natural habitats highly influences the abundance and diversity of available natural enemies to crop pests (Balmford et al. 2008). Therefore, a Natura 2000 site situated in the vicinity of agricultural fields could play an important role in keeping crop pests in control.

Box 5.15 Examples of monetary estimates demonstrating the value of natural biological control - Cost based estimates

A study (Pimentel et al. 2001, Pimentel et al. 2005) on the assessment of known environmental and economic costs of invasive alien species in the United States (US), United

Kingdom (UK), Australia, South Africa, India and Brazil was carried out in 2001 and updated in 2005. This study estimated that invasions of non-native species in the six countries concerned cause over USD 314 billion in damage per year. This sum translates into USD 240 annual cost per capita in these six countries. Assuming similar costs worldwide, the author estimated that damage from invasive species would be more than USD 1.4 trillion per year, representing nearly 5 per cent of the world GDP.

In 2001, the total volume of pesticides sold in the EU15 amounted to 327,642 tonnes of active ingredients (Eurostat 2001).

5.11 Cultural & social services: Ecotourism and recreation

Insights on the impacts of the Natura 2000 network on ecotourism and recreation are provided by Contract No. ENV/B.3/SER/2010/0073r and are not here discussed – see BIO et al, 2011 forthcoming.

6 FOCUS: MARINE PROTECTED AREAS

Key message

Marine Protected areas / improved management of marine resources: Marine Protected Areas created through the network may have positive effects on overexploited fish stocks generally. A first cut estimate for the benefits of increasing marine protected area (MPA) coverage to 10% estimates that €2.5-3.8 bn per year improvement in 7 services and €1 bn per year off-site fisheries benefits.

In terms of annual equivalents, the values of the current area protected (4.7%) are approximately 1.4-1.5 € bn per year, 3.0-3.2 € bn per year for protection of 10% of sea area, and 6.0-6.5 € bn per year for protection of 20%. The higher figures apply to stronger protection measures.

This should be seen as a ball park value, illustrative of the importance of this issue. To obtain robust results would need an improved understanding of how protection will influence habitats, services and off-site fisheries; the level of benefits will depend on details of protection; need to know more about network effects.

The marine environment is subject to the Natura 2000 network of Special Protection Areas (under Birds Directive) and SACs (under Habitats Directive). The Habitats Directive (under Article 4) requires that Member States propose a list of sites that host habitat types listed in Annex I as SACs. These are areas where conservation measures should be put in place to avoid habitat deterioration. Once designated, special provisions apply to the consideration of projects proposed within the site boundaries that are not directly connected with the management of the site for conservation purposes; in order to ensure that carrying out any such project does not adversely affect the integrity of the site.

The Natura network is still developing in the marine environment, and has faced practical and conceptual challenges such as lack of data on seabed habitats and identifying representative areas for mobile species. Nevertheless Natura designations are in place in coastal, inshore and offshore areas, and some of these have been subject to different types of economic analysis.

The marine environment presents particular challenges in addition to those faced across the Natura 2000 network as a whole.

- Uncertainties regarding the extent of the Natura network and the actual restrictions on activities implied by designation;
- Lack of data regarding the extent and nature of marine habitats, their current status, and the services provided;
- Strong network effects;

- General lack of valuation evidence for most marine ecosystem goods and services.

Extent of the network: Fundamentally, what the Natura 2000 network will become in the marine environment is not yet clear. Its intended extent and the areas of habitats it will cover are not yet defined. Some designations have been made, largely in inshore waters. Measurements of the marine area protected can be difficult, because many sites include marine and terrestrial components. One source[48] estimated the area of marine SCI at 121,851 km^2 in 2009; another[49] gave for mid-2010 a figure of 198,760km^2 over 3,348 sites having a marine component of at least 5%. This is equivalent to 4.69% of EU EEZ areas, though the true proportion will be slightly lower since many of the coastal sites include a terrestrial component. The area protected is rising as the network is put into place, including for example the recent UK announcement[50] of plans for 127 Marine Conservation Zones totalling 37,000 km^2 for England (designations for Wales and Scotland are to follow).

Lack of data on habitats: As to what is being protected, the nature of the seabed, especially in offshore areas, is not fully known. The baseline condition of the value of the marine environment and the ecosystem services it supports is poorly understood. The baseline condition of the marine environment is dynamic overtime due both to its mobility and to the influence of climate change, most of which is not fully understood.

Specifically with reference to the Natura network, this means that the extent of Annex 1 habitats in European waters is not fully known. Furthermore, the original list of marine Annex 1 habitats appears to have an inshore bias, possibly due to uncertainty at the time (since clarified) over the extent to which the Natura network should extend across Member State's EEZs, or possibly due to lack of knowledge about offshore habitats. Current work means that an assessment of the habitat areas covered by a complete marine Natura network may be possible in 5 years.[51]

Therefore the potential area and location of these habitats within a 'representative' set of sites is not known and is difficult to deduce from the available data. As an alternative assumption, estimates could be based on designation of 10% of each habitat, although this proportion originates from the CBD rather than the Habitats Directive.

Network effects: though important for all protected areas, there are reasons why network effects are likely to be particularly important in the marine environment. These include:

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48 Conservation status of the Marine Habitats Directive Special Area of Conservation (SAC) Network (2009) D Evans, B McSharry, O Opermanis.Progress in Natura Conservation in Europe, 2009, 41.

49 http://ec.europa.eu/environment/nature/natura2000/db_gis/pdf/area_calc.pdf

50 http://www.guardian.co.uk/environment/2011/sep/08/england-marine-conservation-zones

51 Doug Evans, European Topic Centre for Biodiversity, pers comm. 20/7/11

- High mobility of many species, especially pelagic fish, due to natural migratory patterns and to responses to environmental fluctuations.
- Mobility of habitats, such as sandbanks, through natural processes and events.
- Mobility of ecosystem functions, due to the above shifts in species and habitats, and to seasonal and/or inter-annual variations in conditions such as water temperature.
- For all of the above, climate change is further influencing these movements, in ways that are not yet well understood.

Limited valuation evidence: Compared to terrestrial environments, marine environments are relatively unstudied insofar as economic value is concerned, with the exception of fisheries and fossil fuel extraction, and some specific services such as coastal protection from mangroves and other coastal habitats. There are several recent studies that consider marine ecosystems and their services on a broad scale, including studies of UK oceans (Beaumont *et al.*'s 2008, Saunders *et al.* 2010, 2010b), the Baltic sea report "What is in the Sea for me?" (Swedish EPA, 2009), the Guinea Current Large Marine Ecosystem (GCLME) valuation project (Interwies, 2010), and the valuation of Mediterranean marine services by Plan Bleu (2010). The coastal zone, and its role in linking marine and terrestrial systems, is a particular current focus of valuation research, as set out in the UNEP report "Framing the Flow" (Silvestri and Kershaw 2010). Valuation for open ocean and deep sea services is much less advanced, though also receiving attention, for example through the EU FP7 project HERMIONE (see Armstrong et al 2010). Ruckelshaus &Guerry (2009) present the developing Marine InVEST toolkit, with spatially explicit, process based scenario models for mapping and valuing services provided by coastal and ocean ecosystems.

The increasing effort in marine valuation is creating an evidence base which can be used, along with appropriate assumptions and judgement, to assess the values attributable to the marine Natura network. Nevertheless, the lack of monetary evidence for many impacts, and even the lack of non-monetary quantitative evidence, remains a major challenge, in particular for individual sites. One approach to the lack of evidence on impacts has been to use expert judgement to plug data gaps (as in the Impact Assessment for the UK Marine Bill); other impact assessments have focused on quantifiable costs and limited consideration of benefits primarily to qualitative descriptions (as in the individual Impact Assessments for specific UK MPAs).

At the territorial scale, useful sources include the impact assessment for the UK Marine Bill, and supporting studies, for example, offer a national level assessment that could be extended to the European level (Defra, 2009; Hussain et al., 2010; ABPMer et al., 2007; McVittie and Moran, 2008; Moran et al., 2008).

6.1 Site based - estimating and upscaling per ha estimates from site studies

The site approach relies on the availability of studies that value individual Natura 2000 sites. The number of such studies for Marine Natura sites is very low. One study exists for a UK site (Lyme Bay) and the study team is aware of unpublished Dutch work (Brouwer et al – permission to use this has not yet been obtained). Individual site studies were carried out by eftec for the Impact Assessments of specific UK designations to date[52]. These studies include the framework for application of value transfer methods, but actual transfer is not attempted. For example eftec (2010) applies the framework to Haig Fras, one of the first five cSAC sites submitted by the UK. However monetary valuations are not possible, on the basis of evidence available, and the study is restricted to qualitative assessments of changes and their significance

The lack of appropriate evidence mean that it is not at present feasible to apply site-based methods to valuation of marine Natura sites.

6.2 Territorial based estimate: upscaling available estimates of regional benefits of Natura 2000

Attempting to value marine Natura sites based on direct scaling up of existing regional studies can only be very approximate, due to the challenges noted above, lack of understanding of what the marine Natura network will entail, and the imperfect correlation between existing studies and the likely configuration of the network.

The work cited above in relation to the UK Marine Bill (Moran et.al. 2008, Hussain et al. 2010, and see below) is the closest to a suitable territorial study. It applies valuation techniques to three possible networks of marine protected areas in UK waters, of which UK marine Natura sites would be expected to be a significant subset. The theoretical UK networks of MPAs analysed by Moran et al. include a variety of habitats and consider two levels of protection which may not correspond with likely actual protection under Natura. Extrapolating from this study at the territorial level represents the simplest approach to achieving an approximate value estimate; more detailed calculations taking into account the different habitats and services allow a more sophisticated analysis, but require more extensive data.

The UK study considered three different network structures. Network A included 10% of UK marine landscapes and 20% of OSPAR species and habitats. Networks G and J increased this to 60% of OSPAR species and habitats, with Network G aiming in particular for protection of commercial fisheries spawning and nursery grounds; network J offered the greatest general biodiversity protection.

Extrapolating from these results to the EU level can only be very approximate, because the figures are based on value estimates for UK seas, and because we do

52 http://www.naturalengland.org.uk/ourwork/marine/sacconsultation/default.aspx

not have information about the specific network and its habitats. The UK results show that the final estimate is quite sensitive to the details of network configuration: the values estimated were lowest for A (≈71 €/ha.yr) and highest for J (≈132 €/ha.yr), with G intermediate (≈97 €/ha.yr) though it should be noted that off-site fisheries benefits were not estimated, and therefore one of the main benefits of G, enhancement of fisheries, is not included in these figures.

To be conservative, we extrapolate based on the lowest value network, which provides general protection with somewhat increased representation of OSPAR habitats. Results are presented in Table below, showing the present values over 20 years of the expected increase in ecosystem service values from the protected areas. In terms of annual equivalents, the values are approximately 1.4-1.5 € bn per year for the current area of protection (4.7%), 3.0-3.2 € bn per year for protection of 10% of sea area, and 6.0-6.5 € bn per year for protection of 20%. The higher figures apply to stronger protection measures. They are only approximate annual equivalents and in fact the initial annual values would be lower, rising to higher values as the protection reaches its full impact on habitats and services. An EU network with stronger focus on particularly valuable habitats would be expected to give higher values.

Table 6.1: Projected present values of increased ecosystem services over 20 years

Scale	% of EEZ	Area (km^2)	Low € bn	High € bn	Ave €/ha.yr
UK option A	16.25%	125700	13.5 € bn	14.6 € bn	71 €/ha.yr
UK option G	20.16%	156000	23.0 € bn	25.2 € bn	97 €/ha.yr
UK option J	19.03%	147200	29.7 € bn	31.1 € bn	132 €/ha.yr
EU current	4.7%	198627	21.3 € bn	23.0 € bn	71 €/ha.yr
EU at 10%	10.00%	423825	45.6 € bn	49.1 € bn	71 €/ha.yr
EU at 20%	20.00%	847650	91.1 € bn	98.2 € bn	71 €/ha.yr

To go beyond these simple extrapolations, it is necessary to extend the data to consider the differences between the conditions of the UK study, and the conditions for the policy context (i.e. Natura at EU scale). There are three main desirable improvements:

- use data for the habitats present in the EU sea areas. This is possible to a large extent, but not for all areas, as described below.
- even better, use data for specific habitat types that will be protected. This is not at present feasible because the network is far from complete, though it could be possible to develop different scenarios for protection focusing on certain habitat types.
- incorporate value evidence for the other sea areas, instead of relying on the values estimated at UK level. However this evidence is extremely patchy and does not cover all the areas, nor all the service categories.

6.3 Ecosystem service based – detailed analysis of benefits of each service

Most existing economic analyses of the value of the marine environment (cited above) have sought to describe, measure and (for some services) value the ecosystem goods and services provided by the marine environment. The framework is generally total valuation of the services, not consideration of the marginal values associated with change of status (as would be appropriate for valuing Natura designation).

There is however one set of studies (Moran et al 2008, Hussain et al 2010) that explicitly seek to value the marginal impacts of marine protection in UK waters, and this offers the most promising route for valuing the marine Natura network. The method involves attributing ecosystem goods and services to different marine habitats, and assessing the proportion increase in value as a result of different levels of protection. This approach combines the ecosystem service framework with a detailed assessment of habitats, and what we propose is really a combination of these two approaches to valuing the Natura network. This is discussed below under the 'Habitat based' heading. The results are subject to uncertainty due to significant gaps in knowledge about marine ecosystem goods and services, and how Natura designation will influence their provision. However, some analysis of these issues exists, and can be added to through expert judgement.

One key ecosystem service warranting separate analysis is that of food provision from the marine environment. The influence of marine protected areas on fisheries is a controversial topic. Natura 2000 management measures are likely to lead to a reduction and/or change, but in most cases not elimination, of fishing pressures. This will have impacts on fisheries production within the sites, but also off-site. The implications for fisheries values of the impact of these measures on fish stocks will also depend on the associated policy framework, primarily the EU CFP, which is currently undergoing a major review.

The values estimated below do not include any non-use values for biodiversity conservation. A separate study (McVittie and Moran 2008) used CV and CE methods to explore this and estimated €645-€1589 million per annum or €9.14-€22.0 billion present value over 20 years. They stress that this may well include some use component, and to avoid double counting they reject adding this to the use value estimates. Instead, they present it as an alternative argument for conservation: i.e. it might be used in place of the ecosystem service values presented here. This would show that the protection was justified by the use values alone, or by the non-use values alone. We can not expect that to hold across the whole Natura network (for example the Jacobs (2003) study for Scottish terrestrial sites has very different implications) but this may be the case for marine sites. Transfer of non-use values on a territorial basis or to the whole EU population would be possible but highly uncertain, since the attitudes and values of different populations may be quite different from those of the UK population. The authors of the original studies did not feel justified in adding their use and non-use estimates and it seems prudent and conservative to take a similar line here, focusing on the use values for the analysis, and noting the likely existence of additional non-use values that we do not attempt to calculate.

6.4 Habitat based – estimating per ha values for habitats from site studies

This approach relies on data on the extent of different types of seabed[53] likely to be designated, at least at a broad habitat level, and this limits applicability because of the lack of comprehensive data about marine habitats and what might be conserved within a marine Natura 2000 network inhibits the application of this approach. The Annex 1 habitat list is both biased towards inshore habitats (e.g. not including deep sea vents and sea mounts) and too detailed for this type of assessment.

The latest results from efforts to map EU seabed habitats are shown in Figure 6.1 below. This illustrates the partial coverage of EU waters, and the complex patterns of habitats obtained from based on a relatively simple classification.

These data are extrapolated using predictive modelling by the EUSeaMap project, in an interactive mapping portal with predicted broadscale seabed habitat maps under the EUNIS classification for over 2 million square kilometres in the Celtic, North, Baltic and western Mediterranean Seas. This gives better coverage (Figure 6.2) although there are still gaps compared to the area of EU waters (Figure 6.3), as well as some coverage of waters that are not EU (around Norway, and on the southern side of the western Med).

We do not have information on the likely extent of different habitats protected via the Natura network, which is still in the process of designation. Current work means that an assessment of the habitat areas covered by a complete marine Natura network may be possible in 5 years.[54] For the time being, the best approach is to assume that a flat proportion of each habitat type is protected. We use 4.7%% (current), 10% and 20%, the same proportions as considered under the territorial-based calculations above.

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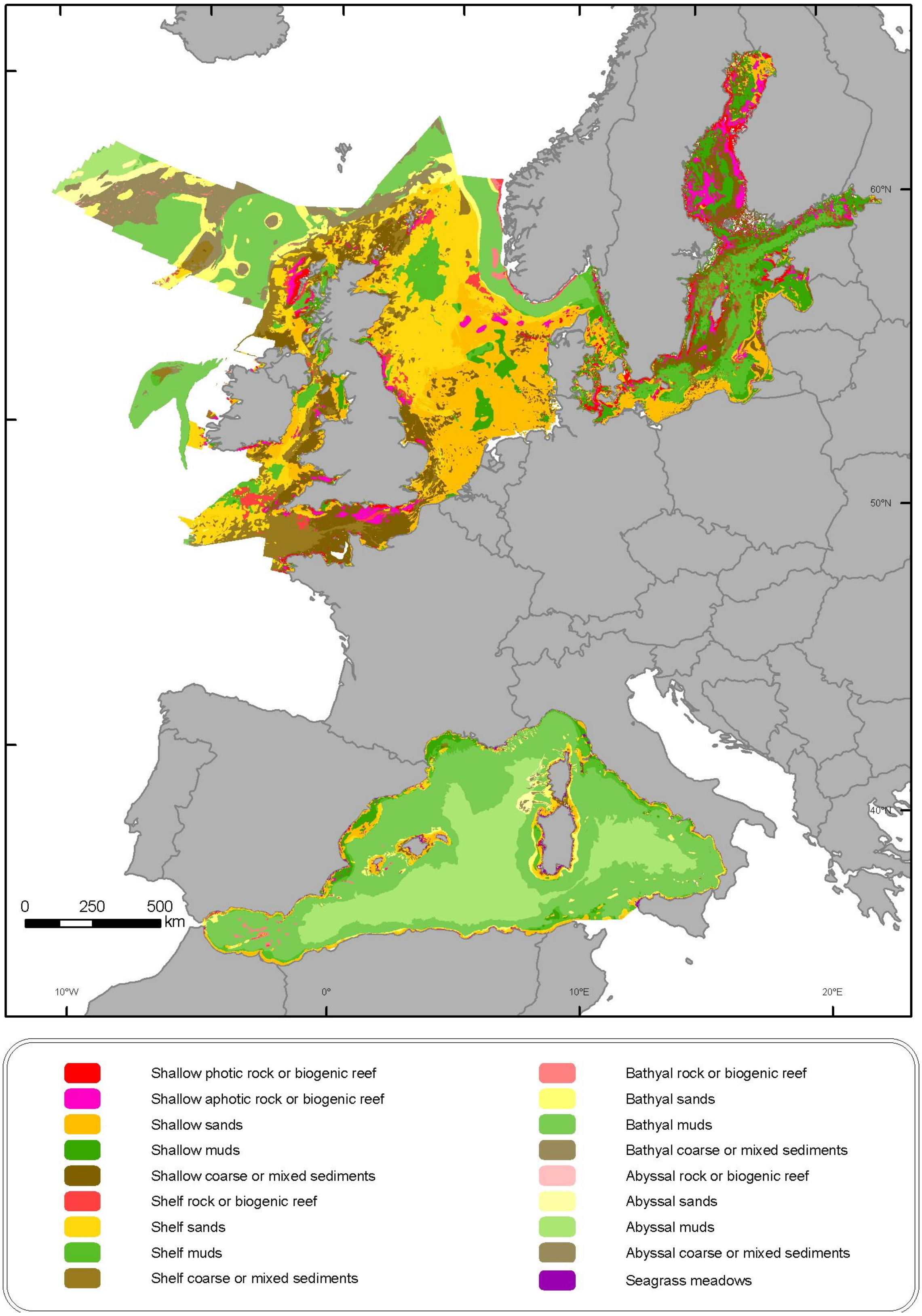
53 Seabed types can be defined as habitats or as landscapes. While habitats can correspond to the designations within the Natura 2000 network, data for landscapes (e.g. sediment types, photic/aphotic) may be easier to obtain and provide a better basis for analysis.

54 Doug Evans, European Topic Centre for Biodiversity, pers comm. 20/7/11

Figure 6.1: Map of Available Seabed Data in European Waters



Source: EUSeaMap. in prep, Andy Cameron, JNCC, pers. comm. 21/07/2011

Figure 6.2: Sea areas covered by extrapolated data (http://jncc.defra.gov.uk/page-5040)

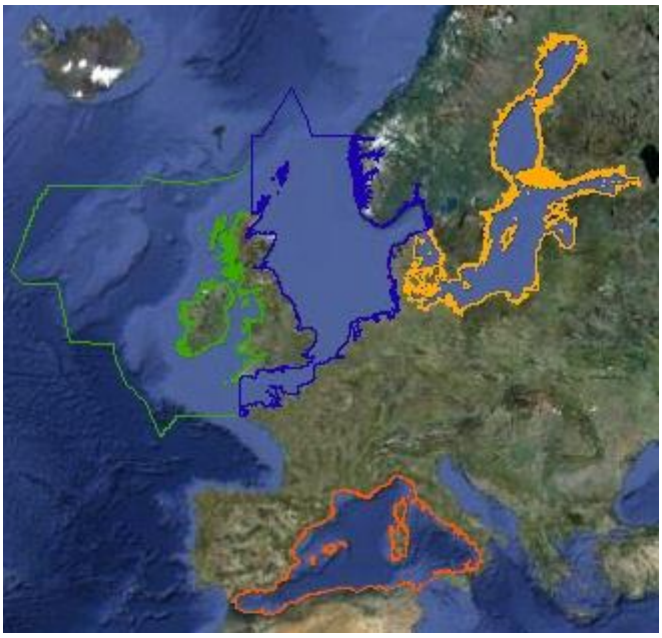
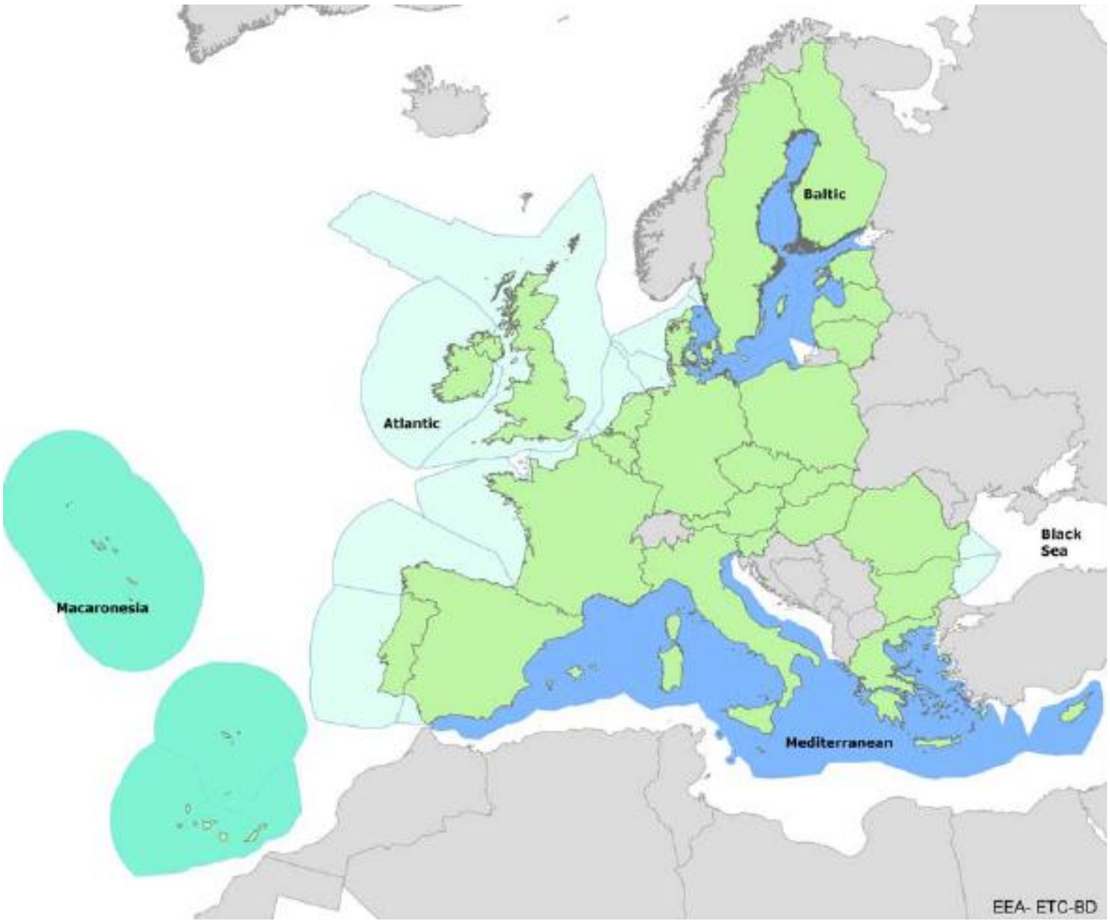


Figure 6.3: Marine regions of the EU (Evans et al, 2009)



Estimating EU marine habitats areas

The first step in extending the analysis to the EU level was to extract area data from GIS files which covered a significant portion of the EU's sea waters along with some portions of the high seas and non-EU jurisdiction seas such as Norway's. These GIS files presented the areas by EUNIS sea-scape definition and came from EU-SEA map[55]. The following shape files are available from the JNCC website:

- EUSeaMap - Modelled Seabed Habitats in the Celtic Sea and North Sea 20110204.shp
- EUSeaMap - Modelled Seabed Habitats in the Baltic Sea 20110204.shp
- EUSeaMap - Modelled Seabed Habitats in the western Mediterranean 20110209.shp

These shapefiles were imported into Grass, software used to calculate the area of each data-point described. Areas were collated by Landscape type, combining whatever information on the area was available at EUNIS classification levels 2-4. Having done this a small area of 3350 hectares from the Baltic region remained unclassified as "blank".

The landscape types valued in the Moran and Hussain papers were based on an older UK classification system. To convert the areas from EUNIS to UK Landscapes typology we used the file "EUNIS 2004 to UK Landscapes v2.xls" provided by Helen Ellwood at the JNCC. The two typologies do not provide precise matches and there are overlaps in the definitions meaning that a type from one typology is likely to match more than one from the other typology. Matches are listed as either definite matches, possible matches, definite non-matches and no UK equivalent.

Where definite matches were available these took priority and all other matches were ignored. Where the highest available comparator was one or more possible matches these were used. Remaining areas, where there is no UK waters match, were linked by estimating the most appropriate habitat using our own judgement: this is clearly one of the weaker points in our method: a fuller assessment would involve re-estimating parameters for use in the Hussain et al model specifically for these new habitat types, but this would be a significant undertaking requiring input from marine ecological experts. With our approximate method, each EUNIS code was matched to one or more UK types. Where more than one match was available the area under the EUNIS code was split equally across the possible landscapes. The resulting habitat area estimates are shown in Table below.

55 http://jncc.defra.gov.uk/page-5201

Table 6.2: Areas of habitat in the three sea area GIS coverage by seascape type (km^2)

Seascape Type	West Med	Atlantic	Baltic	TOTAL
Aphotic reef	4159	193802	5471	203432
Oceanic cold water coarse sediment	19589	59040	0	78629
Oceanic cold water mixed sediment	20739	97905	37	118681
Oceanic cold water mud	153807	189454	1500	344761
Oceanic cold water sand	31482	113167	7	144656
Oceanic warm water coarse sediment	19589	59040	0	78629
Oceanic warm water mixed sediment	20739	97905	37	118681
Oceanic warm water mud	421215	189454	1500	612168
Oceanic warm water sand	31482	113167	7	144656
Photic reef	1144	10052	4733	15929
Shallow strong tide stress coarse sediment	929	16251	4503	21683
Shallow moderate tide stress coarse sediment	929	16251	4503	21683
Shallow weak tide stress coarse sediment	929	16251	4503	21683
Shallow strong tide stress mixed sediment	662	15198	42561	58421
Shallow moderate tide stress mixed sediment	662	15198	42561	58421
Shallow weak tide stress mixed sediment	662	15198	42561	58421
Shallow mud	109240	47901	57	157199
Shallow sand	11859	248090	105190	365139
Shelf strong tide stress coarse sediment	0	36156	201	36357
Shelf moderate tide stress coarse sediment	0	36156	201	36357
Shelf weak tide stress coarse sediment	0	36156	201	36357
Shelf strong tide stress mixed sediment	0	14280	6146	20426
Shelf moderate tide stress mixed sediment	0	14280	6146	20426
Shelf weak tide stress mixed sediment	0	14280	6146	20426
Shelf mud	0	67754	63138	130892
Shelf sand	0	249351	33589	282940
Carbonate mounds	1471	0	0	1471
			TOTAL	3208521

Value per hectare of ecosystem service provision

Moran et al. (2008) / Hussain et al. (2010) begin with estimated values of the current yearly provision each ecosystem service from British waters, and then break this down across different areas based on weighting factors reflecting the relative contributions of different habitat types to each service. Conservation/protection of the marine environment is considered to improve these service values in different ways, depending on the service, the habitat, and the degree of protection. Based on widespread consultation with experts, Moran et al provide a code for each habitat type which describes three components of this improvement for each habitat-service combination:

- Number of years between implementing protection and realisation of the full extent of service gain.

- The impact of protection as a percentage of the service value for the habitat in unprotected state. Two levels of protection are considered: a strict protection scenario, and a less restrictive protection adequate for maintaining the status of the habitat.
- The functional form describing the increase in the value of the services provided from the start of protection to the maximum value: linear, exponential or logarithmic.

This enables calculation of the estimated impact of protection for a given area of any habitat. Estimating the marginal benefits of any given conservation network is then possible through calculating the total area of each habitat in the network, and multiplying this by the estimated marginal values.

Clearly this is a very approximate procedure. However it is the best that is possible, under conditions of severe uncertainty regarding the value of service provision and the response to protection.

Application to EU
As noted above, the area for which we have been able to source data does not match the waters of the EU. For instance the whole Mediterranean is 2.5 million hectares but the Western Mediterranean data available only cover 0.85 million hectares. And some sea areas included in the data are not exclusively EU, notably in the Mediterranean and around Norway, so not all areas will be within the scope of Natura. Comparing Figure 6.2 (extrapolated habitats data) and Figure 6.3 (EU waters) shows that the EU areas missing are substantially greater than the non-EU areas included, so it remains possible to work with this data set and consider the results to be conservative. It should be noted however that in the case of the Mediterranean EEZs have not been formally declared and protection outside of territorial waters here will require negotiation and agreement with third countries.

We do not have data for the Azores, Canary Islands and other EU territories away from continental Europe. This is an important omission, but even if data were available for the marine habitats in these areas, it would be stretching the method too far to transfer the estimates of values and impacts from UK waters to these very different situations.

The results of carrying out these calculations are presented in Table below. This shows present values for protecting 10% of the waters modelled ranging from €26.7bn (less restrictive protection) to €39.3bn (highly restrictive protection).

Table 6.3: Present values over 20 years of increase in ecosystem services arising from conserving 10% of assessed waters with different levels of protection.

Ecosystem Service	Highly restrictive	Less restrictive
Nutrient recycling [56]	4.69 € bn	2.38 € bn
Gas and climate regulation	26.79 € bn	14.59 € bn
Leisure and recreation	5.26 € bn	4.78 € bn
Food provision	0.43 € bn	2.59 € bn
Raw materials	0.07 € bn	0.49 € bn
Disturbance prevention and alleviation	0.23 € bn	0.23 € bn
Cognitive values	1.87 € bn	1.68 € bn
TOTAL	39.34 € bn	26.73 € bn

Source: own calculations, extrapolating from values in UK Marine Bill studies, as explained in the text

The annual equivalent values are approximately 2.7 € bn for highly restrictive protection and 1.8 € bn less restrictive protection. However these annual values are predicted to start lower, then increase gradually over the 20 years following protection, reaching approximately 2.5 € bn and 3.8 € bn per year respectively by the end of that period, as shown in (Figure 6.4 and Figure 6.5). The total values are somewhat lower than in the territorial-based analysis reported above, which is partly because here we assume 10% protection of all habitats, while the territorial analysis inherits the UK study's assumption of greater focus on OSPAR species and habitats.

[56] Nutrient recycling is a supporting services and care is needed to avoid double counting. Only those aspects of the value that are not captured by final ecosystem services and benefits should be included. See original text for how potential overlaps were addressed.

Figure 6.4: Additional service value per year, less restrictive protection (undiscounted)

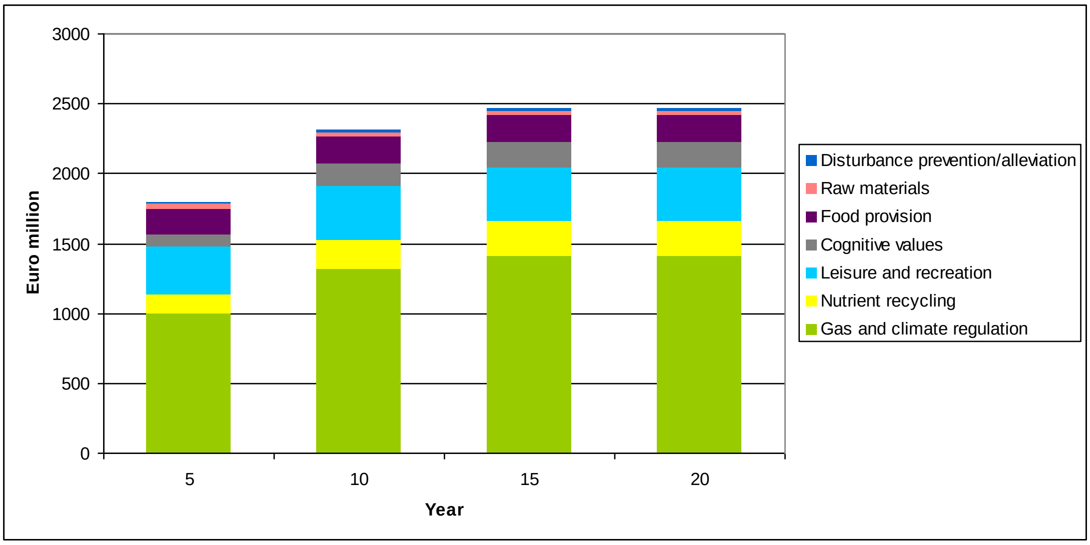
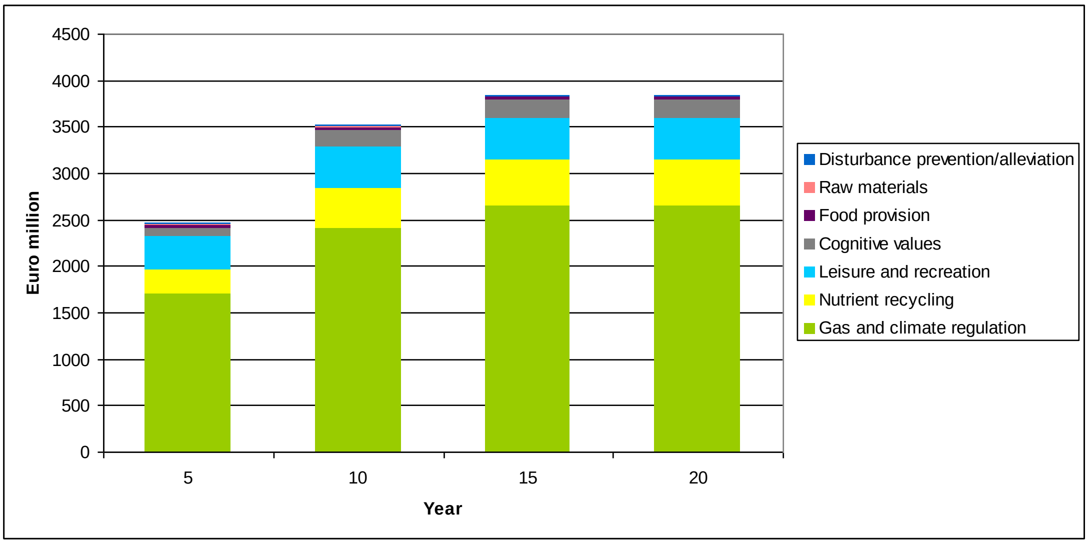


Figure 6.5: Additional service value per year, highly restrictive protection (undiscounted)



It is noteworthy that gas and climate regulation is by far the largest component of these estimates. The value per tonne of carbon used in the original study, converted to 2010 Euro values, is €155.9. Adjusting this value to match the values used in this study would be a little complex, because those values for 2010 and 2020 are different. Noting that this €155.9 value is rather higher than the 2010 figures (€63.1-€117.4) but on the low end of the 2020 range (€143.1-€205.5), given that the values are already very rough approximations, and recognising that 2010 is behind us and the marine Natura network is not yet fully implemented, it seems reasonable to consider the carbon value used here as broadly consistent with those used in other sections of the report.

The values estimated in this habitat/services based assessment are somewhat lower than those arising in the territorial analysis, reflecting the fact that we have considered a flat 10% of each habitat type, and considered the actual distribution of habitats, whereas the territorial analysis is based on an assumed network for the UK that has greater representation of more important habitats. In practice the Natura network will also have variable proportions of different habitats, and to the extent that the more important conservation targets also contribute more than average to ecosystem services, this suggests that the estimates above are likely to be conservative in comparison to any real conservation network of equivalent area.

6.5 Provisioning: Fish provision

The influence of marine protected areas on fisheries is a controversial topic. The primary aims of the of the Natura 2000 network are to protect threatened, endangered and/or declining species and habitats. MPAs that restrict fishing and other human activities conserve habitats and populations but also, by exporting biomass and by effects on carrying capacities or recruitment processes, may sustain or increase yields of nearby fisheries. So the Marine Protected Areas created through the network may have positive effects on overexploited fish stocks generally. Closed areas can already be used in fisheries management as a means of allowing overexploited stocks to recover and enhancing fishery productivity.

This is partly included in the value estimates above: note that very modest improvements in food provision are expected under the highly restrictive scenario, which would involve an end to most forms of fishing within protected areas, whereas the less restrictive protection, which would allow continuation of many fishing methods, is predicted to yield more substantial increases. However these figures relate only to on-site benefits: one major possible impact of marine protection is to improve fisheries values off-site, and the above estimates do not consider that.

Mangos et al. (2010) presents an attempt at evaluating the benefits related to the provision of food resources by five main marine habitats in the Mediterranean Sea including Posidonia meadows, soft and hard substrate areas, Corallogenic areas and open water; their main findings are presented in Table 6.4 Using these numbers, it would be possible to improve the transfer based on UK values (i.e. combine the Mediterranean value estimates with the UK estimates of proportion improvements expected from protection).

Table 6.4: Value of the benefits relating to the provision of food resources (fishery resources) by ecosystems

		Total	Posidonia meadows areas	Soft substrate areas	Hard substrate areas	Corallogenic areas	Open water
A	Catches (in t)	1 070 993	27 210	133 746	48 003	37 483	710 542
B	Catch distribution(in %)	100%	3%	14%	5%	4%	74%

C	Value of the benefits (in millions of Euros) (total benefits*B)	2 871	83	399	144	112	2 133
D	Area covered (km²)	2 500 000	35 000	217 000	108 500	108 500	2031000
E	Area distribution (%)	100%	1%	9%	4%	4%	81%
F	Value of benefits per unit of area covered (in €/km²) (C/D)	1 148	2 379	1 839	1 323	1 032	1 050
G	Quantitative productivity (t/Km²) (A/D)	0.4	0.8	0.6	0.4	0.3	0.3
H	Economic productivity (€/km²) (C/D)	1.1	2.4	1.8	1.3	1	1.1

Source: Adapted from Mangos et al. (2010).

However, there would be limited benefit in attempting this because the main fisheries benefit of Natura 2000 measures is likely to be on off-site fishing potential. Natura 2000 management measures are likely to lead to a reduction and/or change (but in most cases not elimination) of fishing pressures. The impact of these measures on the fisheries sector and on fish stocks depend on the associated policy framework, which in the form of the EU CFP is currently undergoing a major review. The optimization of fisheries yields is a very different target from the nature conservation objectives of Natura 2000, however Natura and fisheries policies are potentially complementary, with the protected area network contributing to fisheries conservation, protecting key spawning and nursery grounds, and allowing biomass to build in certain areas resulting in improved spawning, improved stock age-structure, and export of biomass to adjacent fisheries.

The extent of these impacts is extremely difficult to predict, because of uncertainty about four key factors:

- the extent and location of the network;
- the level of protection, and in particular the types of fishing that will/will not be allowed in certain areas, and the efficacy of enforcement;
- the ecological relationships governing the resulting impact on fisheries, including the importance of reserve sizes and network effects; and
- the effectiveness of the revised CFP in controlling any displacement of fishing effort from protected areas, and more generally returning stocks to MSY levels.

The Natura network protects areas of importance to the lifecycles of commercial fish and shellfish species. For sedentary species (e.g. shellfish), Natura site management may lead to controls that increase the longevity of shellfish resulting in greater numbers of larger individuals that produce proportionately more young, thereby benefiting population recruitment. However, the full potential of this impact will only be realised if the associated fisheries policy framework establishes an appropriate harvesting regime to exploit the enhanced ecosystem service.

The benefits to mobile species populations are even more complex. Natura designations may protect spawning and nursery areas (e.g. such as the Dogger Bank for Plaice). These protections may make a contribution to achieving maximum sustainable yields from fisheries, but this may be contingent on other policy measures designed to achieve this end (like short term fishing effort reduction). Furthermore, if protections simply lead to displacement of fishing effort, the designations alone may not alter commercial fish populations.

These complexities are compounded by potential fish-species range shifts in response to climate change. Although fisheries productivity can be valued at regional or national levels, identifying the contribution of specific sites is difficult. There have been some attempts to quantify the contribution of nursery habitats via production function methods (see e.g. Tinch 2004, Stevenson 2002) but the results are patchy, relating to certain coastal areas, and the explanatory power of the production functions is weak. Valuation evidence for commercial and recreational fisheries is considered for the Severn Estuary (Tinch and Provins 2009) including possible impacts on 4 SACs, in the context of possible options for a Severn barrage, however it is not possible to draw firm conclusions on the marginal impact of protecting sites.

While the effects of marine Natura designations on fisheries are difficult to predict, some knowledge about the factors determining those effects is available. Analysis by Sumalia (1998), using a dynamic bio-economic model of the North East Atlantic cod stock, suggests that the size of protected areas and transfer rates between protected and unprotected areas are important variables in determining the scale and nature of any beneficial impacts on fish stocks. Large reserves provide good protection for stocks over time and high transfer rates make the protected fish more likely to be available for harvesting. Optimally chosen reserve size when net transfer rates are high also mitigates against biological losses. When net transfer rates are low, the establishment of marine reserves does not mitigate against losses in the discounted economic rent from fisheries, and so imposes a net cost in terms of fisheries values.

Generally, the fisheries benefits (or costs) of marine reserves will depend on management outside the reserves. Sanchirico and Wilen (1999, 2001) show that with open access outside reserve patches, there may be biological benefits from reserves, but few combinations of biological and economic parameters give both increased total harvests and total biomass. Generally, benefits arise in particular where there is high effort prior to reserve implementation: if there are effective effort control mechanisms in place, fisheries' benefits from reserves may be small.

This complicates assessment, not least because fisheries management is dynamic: in particular, it is difficult to estimate how successful current attempts to reform the CFP, and allow European fisheries to recover from decades of overexploitation, may be. However, the management-dependent nature of fisheries benefits can be considered in a rather simple form by basic bioeconomic modelling of fishery production, for example as assessed at the European level in the context of avoiding IUU fishing by Tinch et al 2008. It could be possible to use similar methods combined with evidence on the extent of protection of stocks afforded by the Natura network.

For more complete analysis, we would need to account for spatial impacts. Most standard bioeconomic models are not explicitly spatial, but spatial considerations can be introduced in a number of ways. Some models just have ‘inside’ and ‘outside’ the MPA, while others have finer grids within and around the area, and take more detailed account of spatial interactions. MPA models tend to focus on adult stocks, though larval dispersal is sometimes considered. Most models are driven by density dependent migration. In general, models of single-species population dynamics indicate that the effectiveness of MPAs in rebuilding or maintaining populations depends on the rates of immigration and emigration, and on the fishing effort outside the reserve (Gerber et al., 2003); heterogeneity between the reserve and non-reserve areas can also be important (Schnier, 2005). A general finding of bioeconomic models focusing on fisheries benefits is that the reserve size is a key determinant of benefits. Sumaila (1998) for example models Barents sea cod and finds that marine reserves bring benefits and protection from external shocks provided that: (a) net transfer rates for cod are ‘reasonably high’ and (b) reserve sizes are large.

Babcock et al. (2005) report studies suggesting that, in the presence of uncertainty, marine reserves increase persistence by maintaining higher levels of spawner biomass and by raising recruitment success with high rates of exploitation. Generally, MPAs can be expected to buffer against shocks, though not necessarily to increase expected returns. Details will depend on other management and ecological factors, but where uncertainty is thought to be important (which is probably true for most fisheries) then this could be an important source of benefit.

Most models of MPAs focus on stocks and associated parameters without directly considering the role of habitat. However, a key impact of MPAs can be recovery or enhancement of habitat supporting fish populations. Armstrong (2007) presents a model including (‘relatively limited’) carrying capacity improvements due to habitat improvements within a reserve, resulting in increases in stock and harvest. Armstrong and Skonhoft (2006) examine asymmetry in the migration coefficients resulting from different habitat conditions, showing that over-harvesting could arise if this is not taken into account.

The degradation of marine fisheries can be defined in terms of the difference between the current status of fish stocks and their potential un-degraded condition. What exactly ‘un-degraded’ condition involves in environmental terms is difficult to define, but in economic terms it can be characterised in terms of fisheries producing the ‘maximum sustainable yield’ (MSY) across the fishery as a whole.

Beare et al (2010) documents the change to fish stocks in the North Sea as a result of the effective suspension of commercial fisheries during World War II. The effective closed period involved is shorter than the life cycle of the gadoid species (e.g. cod, hake) studied, but a dramatic change in age composition is observed. As the paper states: “This has clear implications for the economics of the fishing industry, older fish generally being disproportionately more valuable”. This evidence suggests that the ‘degradation’ of fish stocks as a result of commercial fishing has two types of costs. Firstly, by depressing populations and preventing landings in line with MSY, and secondly by reducing the numbers of older fish within populations. The economic cost to this change in age structure arises as the biomass of younger fish is worth less than if it were composed of a greater proportion of older fish.

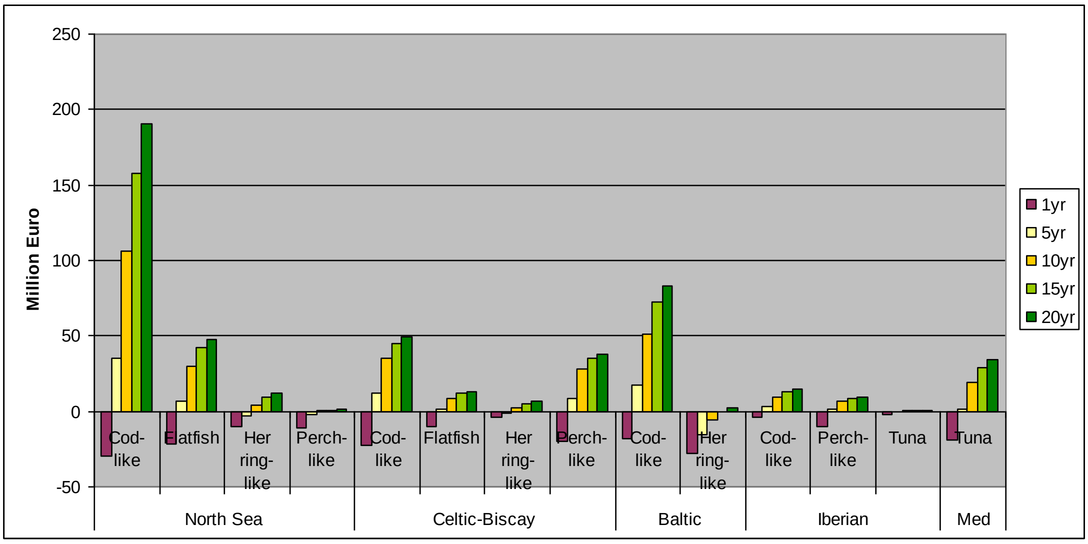
The analysis shows that recruitment to fish populations does not respond as dramatically as age structure, which is likely because other environmental conditions also influence it, and the effective closed period was not long enough for fish age structures to take effective on reproduction. The paper concludes that, had fishing been prohibited for a longer period of time than the six years of the Second World War, a population equilibrium with a higher proportion of older fish would have been established. Maintaining such an equilibrium would have likely allowed a higher sustainable yield value, even if the total biomass catch was the same. A secondary benefit would also be the reduction in the discarding of small non-marketable fish, whose proportion within the fish population would have declined as a result of the change in the population distribution, and is a current target of EU fisheries policy.

Eftec (2008) focuses on the influence of IUU fishing on fish stocks in European Waters. IUU fishing levels of 30–40% of total catch, and sometimes more, appear to be commonplace, although various measures are being taken to combat this problem, with some apparent success. The research models the influence on fisheries of IUU fishing, through dynamic bio-economic models specified across Large Marine Ecosystems (LMEs; e.g. North Sea, Celtic-Biscay Shelf), for commercial groups of fish species (e.g. Tuna and Billfishes, Cod-likes).This specification for LMEs and commercial groups avoids some (but not all) of the problems associated with competition among stocks and questions of achieving MSY for individual stocks simultaneously. The model does not cover all commercial fish stocks due to a lack of available data, covering for example 73% of those in the North Sea, and 46% on the Celtic-Biscay Shelf.

Although the focus is on IUU fishing, it is possible to adapt the eftec method to assess the impacts of reducing effort, allowing stocks to recover. Broadly, this comparison represents an analysis of conditions where current fisheries exploitation prevents stocks recovering (a scenario similar to the baseline described under the CFP assumptions in Section 2) versus conditions where some management measures enable stocks to recover towards MSY.

If we assume that protection of the Natura network can be represented by a 10% reduction in fishing effort – i.e. that fishing effort falls in the protected areas and is not simply displaced outside – then the eftec (2008) models predict the results presented in Figure 6.6. Catches at first fall (due to lower effort) but rapidly increase (due to increased stock sizes). Not all fish stocks are modelled – those included represent 46% of EU landings. If the non-modelled stocks respond in similar fashion, we might expect roughly double the value, i.e. a total of approximately €1bn per year after 20 years.

Figure 6.6: Possible change in annual fishing values arising from reduced fishing effort associated with Natura protection



These estimates can be criticised on a number of grounds. They assume that the only source of reduction in fishing effort arises through Natura protection, and this is unrealistic given the on-going reform of the CFP. Further, they do not address the possible impacts of changes in carrying capacities or improvements in age structure. Off-site export of fish biomass is considered, but only approximately, in that the models effectively assume perfectly mixed stocks (the models are not spatial). Possible price changes are ignored. At best, therefore, these results might be viewed as indicative of the order of magnitude of potential for fisheries benefits to be achieved through Natura designations. To derive better estimates, it would be necessary to consider spatial models with more detailed representation of fish stocks and reproduction, as well as the spatial distribution of fishing effort, in conjunction with consideration of the reformed CFP. This would be a major undertaking, well beyond the scope of the present work. Perhaps the best approach would be to use EcopathWithEcosim models (www.ecopath.org) for the marine systems.

6.6 Supporting services

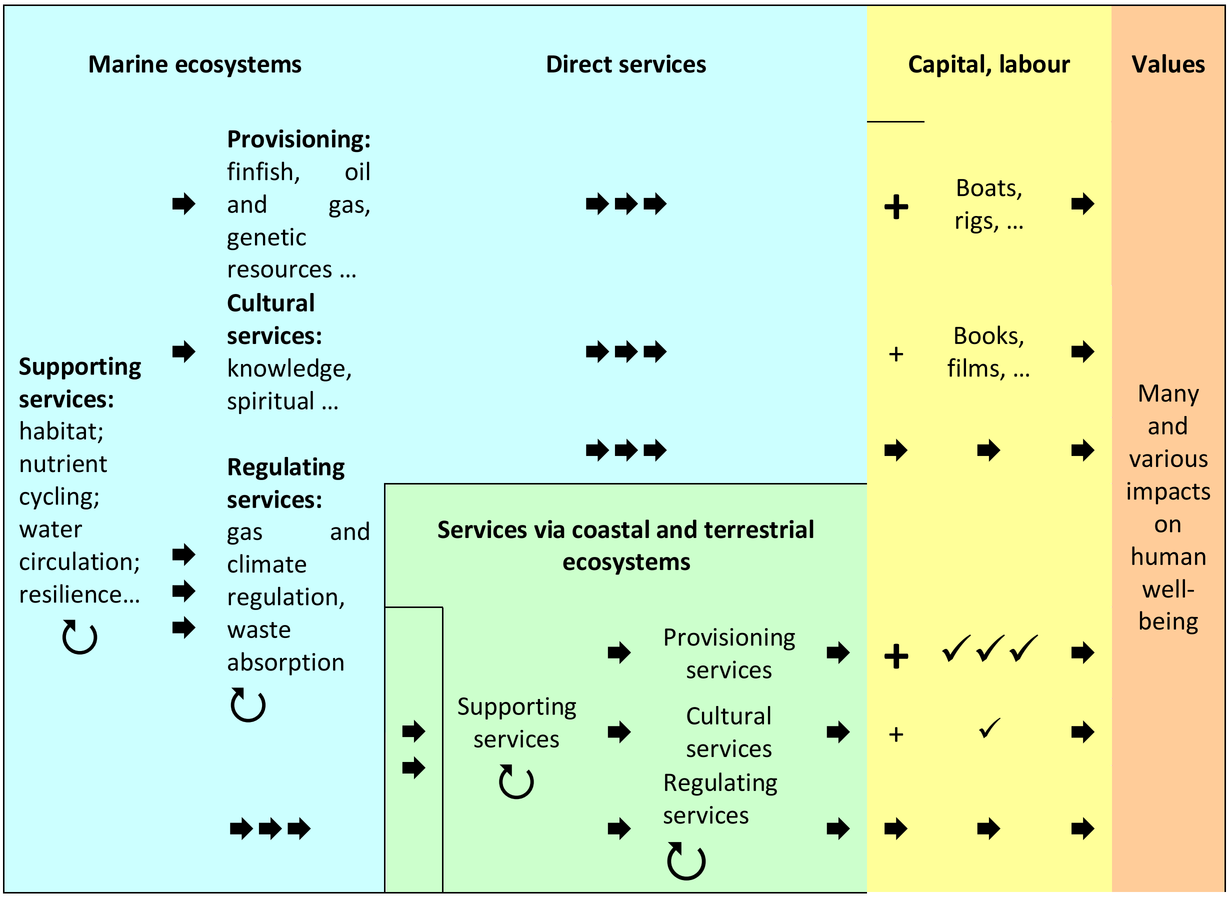
Supporting services are those functions that are necessary for the production of all other ecosystem services, i.e. they feed into provisioning, regulating and cultural services, and thereby only enter into human well-being indirectly. They differ from regulating, provisioning, and cultural services in that their impacts on people are usually indirect, both physically and temporally, whereas changes in the other categories have relatively direct impacts on people. Some services can be categorized as either a supporting or a regulating service, depending on the time scale and immediacy of their impact on people, this is the case for instance with nutrient cycling as explained below. Examples of supporting services are habitat, nutrient cycling, water circulation and exchange, primary production, and resilience.

Any ecosystem processes or service contributing to the maintenance of healthy ecosystems and human well-being can be considered 'valuable' to humans. Nevertheless, when assessing the value to humans of changes in the marine environment, we would typically focus only on the final services *directly* influencing human welfare, because the values of the intermediate services are already reflected via the final services or benefits that they support. Thus, Defra (2010) assessed the cSAC for the Dogger Bank and notes "following Defra's guidance on the valuation of ecosystem services, the relevant benefits gained from supporting services (such as cycling of nutrients and photosynthesis) are viewed as essentially being captured by the other benefits listed and so are not examined separately."

Of course, the measurement of basic ecosystem processes can be necessary for other reasons than valuation: providing data for management decisions (for example, measuring fish stocks for setting quotas), or for monitoring change (for example, measures of nutrient concentrations).But for any appraisals in which we will add up values across different service categories, focusing on final services means we avoid 'double counting' the same values twice.

That said, the specific ecosystem goods and services we need to consider in a practical valuation exercise do depend on the boundaries in space and time of that specific assessment. Often, values within these boundaries will influence ecological processes and/or human activities occurring outside the boundaries (and vice versa).The clearest example is climate regulation, because climate change will impact all ecosystems and their services, across the globe, from now into the distant future. When considering the role of a particular management change impacting on climate regulation, it would be impossible to follow through and value all these final effects. Instead, we would focus on the change in carbon emissions and sequestration, and value that. Similarly, in the case of valuing Natura 2000 sites, this may mean that supporting services should be valued, if the services being supported are arising off-site and outside the boundaries of the direct assessment.

Figure 6.7: Marine ecosystem services and human well-being



Source: Armstrong, C.W., Foley, N., Tinch, R., van den Hove, S. (2010) Ecosystem Goods and Services of the Deep Sea. Deliverable D6.2 under the FP7 HERMIONE project, Hotspot Ecosystem Research and Man's impact on European Seas. http://www.eu-hermione.net/images/content/documents/policy/ecosystem_goods_and_services.pdf

Intermediate or supporting services do not necessarily need to be valued. However this depends on the boundaries of the assessment:

- Where the final services supported by the intermediate services are also "in scope", in the sense of being separately included for valuation within the boundaries of the assessment, then applying valuation to the intermediate services would involve double counting and should be avoided.
- On the other hand where the final services are "out of scope" – where distance in space or time means they are not included directly in the assessment – then the supporting services do need to be valued separately. For example, if the role of the marine environment is in supporting fish populations that are 'used' outside the sea (for example, salmon that provide angling benefits in rivers, or the fish that feed seabird populations that provide a tourism/recreation attraction on land) then the intermediate service (the contribution of the sea to supporting salmon and birds, and thereby recreation on land) should be counted in an assessment focusing on the sea.

In principle, therefore, non-market valuation can be applied to changes in final or intermediate services, to changes in entire habitats or ecosystems, or even directly to changes in management practices. But the potential for valuation, and its accuracy, are crucially dependent on individuals' awareness of the ways in which the object of valuation influences their personal welfare. The closer we can get to final services, the better the valuation is likely to be. Where there is uncertainty about how a management change will influence services, deciding to apply non-market valuation techniques directly to the management change does not remove that uncertainty, but merely shifts it to the valuation exercise, and its respondents. So the first important step in appraisal is to use the best scientific information available to assess the likely physical and ecological impacts of the option under consideration.

7 NATURA 2000 THE BENEFITS OF NATURA 2000: KEY RESULTS AND A ROAD MAP FOR FUTURE EVALUATION TO IMPROVE FURTHER UNDERSTANDING OF THE BENEFITS

The prime focus of the Natura 2000 protected area (PA) network is on the conservation of the unique and endangered biodiversity in Europe; this includes rare habitats (e.g. cold water coral reefs), species (from keystone species to iconic charismatic species such as the Iberian Lynx) and genetic diversity (e.g. number of endemic species).

In addition to its biodiversity value, the Natura 2000 network provides a range of benefits to society and the economy via the flow of ecosystem services (provisioning, regulating, cultural and supporting services). These also support policy objectives beyond biodiversity, in particular climate change mitigation and adaptation, water quality and provision, food provision, jobs and livelihoods, cost savings, science and education, social cohesion and identity.

It is important to assess the benefits currently associated with the Natura 2000 network, the potential additional benefits from improving its conservation status, and also the avoided loss of services from avoiding the degradation of protected habitats and species considered of Community interest. This will help communicate the need for funding, help address stakeholders' (mis)perceptions on the importance of the sites, and help integrate the sites into the wider ecological-social-economic fabric of the regions.

This study derived a first illustrative economic estimate for the ecosystem services that flow from the EU's Natura 2000 network as a whole. This estimated range of overall values for the network builds on studies that focus on a subset of ecosystem services; these estimated values should be seen as conservative indicative ranges, which is broadly correct as an order of magnitude estimate, but which will require more work in the future to render robustness. In addition, a selected ecosystem services were looked at individually, to derive a range of service-specific values. These are relatively robust for carbon storage and tourism, but more illustrative/experimental for other ecosystem services.

In Nagoya the EU and its Member States committed to the Convention on Biological Diversity (CBD) Strategic Plan 2011-2020 and also launched an EU Biodiversity Action Plan (See Box 7.1). The assessment of Natura 2000 benefits, as well as wider green infrastructure and other living natural capital, will be essential for these commitments to be achieved and ensure that policy makers at local, national and international level have the full evidence-base available to take the value of nature into account in their decisions.

There is a need for a road map on future needs for ecosystem valuation and how these could be fulfilled. Such a road map should address how robustness of the assessments might improve over time with due investment in assessments and data. This will be valuable for improving the information base for improving the governance of our natural assets and also necessary to meet EU and Member State commitments.

Section 7.1 presents a summary of the study key results. Section 7.2 presents the proposed valuation road map, and section 7.3 focuses on how to realise the road map and ensure that, where possible and needed, the economic values of Natura 2000 are understood.

Box 7.1: Contexts and Commitments for valuation

Global level: The new CBD Strategic Plan 2011-2020 ('Aichi Protocol') , agreed in October 2010 in Nagoya, should prove to be a valuable driver for assessing the values of nature - a range of targets focus specifically on ecosystem services and the value of nature:

Under *Strategic goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society,* there are two targets of particular relevance*:*

- *Target 1*: By 2020, at the latest, people are **aware of the values of biodiversity** and the steps they can take to conserve and use it sustainably.
- *Target 2*: By 2020, at the latest, **biodiversity values have been integrated** into **national and local development and poverty reduction strategies and planning processes** and are being incorporated into **national accounting**, as appropriate, and **reporting systems**.

In addition, an improved understanding of ecosystem services will also directly benefit a wide range of other targets, including Targets 14 ('*….ecosystems that provide essential services to be restored and safeguarded…'*) and 15 ('*… contribution of biodiversity to carbon stocks has been enhanced…*).

Furthermore, the recently agreed Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) has the potential to be a key institutional platform which may help orchestrate demand for ecosystem valuation in the future._The Economics of Ecosystems and Biodiversity (TEEB) has also presented arguments and evidence-base on the utility of assessing the value of nature (TEEB 2010 and TEEB 2011).

EU level: At the EU level, the *EU Biodiversity Strategy*[57] makes specific reference to ecosystem services in both the 2050 vision and the 2020 target. In particular, *Target 2: Maintain and Restore Ecosystems and their Services, Action 5* is specifically focused on valuing services:

- *Action 5*: **Improve knowledge of ecosystems and their services** in the EU. Member Sates, with the assistance of the Commission, will **map and assess the state of ecosystems and their services in their national territory by 2014**, **assess the economic value of such services**, and **promote the integration of these values into accounting** and reporting systems at EU and national level by 2020.

7.1 Summary Results

Given existing data and methods it has been possible to derive some estimates for the economic value of the wider Natura 2000 network. This represents a step forward in the understanding of the benefits, but there remain a range of further steps to take if we are to understand the full importance and value of the network.

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[57] COM (2011) 244 final. 3 May 2011

A first assessment of the Natural 2000 network's economic benefits

A first estimate of the value of the Natura 2000 network suggests **that the value of the flow of ecosystem services from the (terrestrial) Natura 2000 network would be between €200 and €300 billion per year**. The value has been derived by scaling up from an existing pool of site-based assessments of the value of Natura 2000. This pool was limited in both number (30 values from 20 studies were useable), and geographic focus (more valuations from the 'EU-15'). The values also relate to a subset of the ecosystem services from the protected area network, and should be seen as a conservative estimate of its 'gross benefits' (benefits from the ecosystem within protected areas) rather than benefits directly relating to the Natura 2000 designation and associated conservation measures ('additionality' of Natura 2000). This is therefore a first estimate and should not be taken as fully robust, but rather as an indicative first estimate.

Further investment in site studies is needed – both for the own merits of demonstrating benefits for the local, national and EU stakeholders, and also to improve the evidence -base to allow a more sophisticated understanding of the benefits (see further below) to take these duly into account in decision making.

The estimated value of benefits of €200-300 billion per year is equivalent in scale to between 2% and 3% of the GDP of the EU27, and roughly equal to the GDP of a middle sized EU economy such as Denmark or Austria. Note, however, that the €200-300 billion includes both market and welfare values, so the comparison to GDP should be seen only as an illustration of scale.

Complementing this bottom up assessment, ecosystem service specific analysis has also been carried out and presented below, service by service. Both these bottom up and service-based approaches have merits and limitations, enabling the results of one approach to be seen in context of the other, and both deserve further development in the future (see Section 7.2 on the road map).

Ecosystem service specific analysis

Key results from the ecosystem services specific analysis are presented in turn below (and in Table 7.1) for carbon storage (both terrestrial and marine), water provision and purification, pollination, natural hazards management for terrestrial protected areas, and biomass production from marine protected areas. While not the specific focus of this study, benefits from tourism and recreation assessed in a parallel study for the European Commission[58] are also presented.

The values here presented have resulted from specific calculations for the services and are not part of the above noted 'scaling up' exercise. We start by presenting the key results for carbon, as this service is of particularly high policy interest and the values assessed are relatively robust.

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58 Arcadis et al, 2011.

Carbon: The Natura 2000 network plays a critical important service of storing carbon, and improvements in land management will increase the carbon benefits

Thanks to the data and methodologies already available, the benefits of Natura 2000 associated with carbon storage are the most amenable to a quantitative and monetary assessment.

In general carbon stock density appears to be relatively high across the European Natura 2000 sites. Many of the sites harbour several types of ecosystem that are important storages of carbon and offer significant opportunities for further carbon sequestration, including sites located on forested lands, wetlands, agricultural lands, and marine and coastal ecosystems.

It is estimated that the Natura 2000 network currently stores around 9.6 billion tonnes of carbon, equivalent to 35 billion tonnes of CO_2, which is estimated to be worth between €607 and €1,130 billion (stock value in 2010), depending on the price attached to a tonne of carbon (the assessment used €17 to €32 per tonne of CO_2 in 2010 values for carbon stored in 2010[59]). These values can be seen as very conservative as they build on smaller Natura 2000 coverage than is in place now (given data availability) Note that the above mentioned Natura 2000 estimate based on site-based scaling up (€200 and €300 billion per year) was a measure of the annual flow of ecosystem services and not stock. In this ecosystem service-based estimate, instead, there was too little data to do an annual sequestration value for carbon, therefore the figures refer to stock values only. These should be seen as an illustrative snapshot, as the value would increase with higher unit carbon values[60], growth in area coverage, and carbon stored via additional sequestration related to conservation measures (see further below) . Care should be exercised in comparing the stock and flow numbers.

Of the different ecosystems, the forest habitats contain the highest carbon value in the network, ranging between €318 and €610 billion in 2010 (stock value). The second highest carbon value is contained in the dryland (grassland) system, ranging between €106 and €197 billion in 2010, followed by marine and inland water ecosystem, which account for €92 - €171 billion and €84 -157 billion, respectively. These numbers can also be seen as a very conservative estimate, as noted above.

It can be expected that in the future these carbon values will increase, especially if the conservation status of the network improves. A policy action scenario (Policy ON), where full protected area coverage (terrestrial and marine) is achieved with a move to full favourable conservation status, is estimated to generate a gain of at least a total of 1.71-2.86% by 2020 compared to a policy inaction scenario (Policy OFF), where no additional action is taken to conserve the current Natura 2000 sites over the next decade, and which takes the arguably conservative estimate that there will be no loss of carbon storage over the period. The result, while a small percentage gain, nevertheless represents a far from insignificant gain in carbon storage.

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59 *DECC (2009) and Centre d'analyse stratégique (2009)*

Note: the conversion between Euro/tCO2eq and Euro/tC is: 1€/tCO_2=3.67€/tC, based on the conversion to CO_2 from C using the ratio of molecular weights (44/12).

60 Note that the carbon values used here are not carbon prices in the ETS as the benefit of carbon storage relates to the benefits of avoided damage (measured by marginal cost); some guidance values also use is estimated costs for mitigation for the economy as a whole as a measure of the value of carbon..

Overall, the increase in carbon storage benefits between 2010 and 2020 amounts to around €793 to €881 billion (lower and upper bound estimates for increase in value of carbon stock), partly due to the improved land management measures and partly due to the increase in the unit-value of carbon itself, which applies to both existing stock in 2010 and gains over the period to 2020 from land management measures. The underlying values of carbon used were €17 to €32 per tonne of CO_2 in 2010, as noted above, and €39 to €59 in 2020[61].

In addition, it is estimated that efforts in terms of enlarging the total area of protected forest habitats (i.e. a version of the Policy ON scenario that leads to **quantity improvement of the Natura 2000 sites**) could generate at least €16 to €23 billion additional immediate benefits than a policy that focuses only on the improvement of on-site quality (for the period to 2020). The enlargement considered in the analysis was a 10% increase in forest-protected areas in all Member States by 2020 with respect to their national forest coverage in 2010. Both quality gains and areas coverage increases offer carbon storage benefits.

Natural hazards management - potential for saving money via ecosystem based adaptation to climate change

For **natural hazards management**, there is potential for ecosystem-based adaptation to climate change, with significant savings via avoided costs of impacts, lower costs of meeting risk objectives, as well as for obtaining additional co-benefits from Natura 2000 and the wider green infrastructure in terms of natural hazard management. Historically, losses from flooding in the EU have been estimated at €160 billion over the period 1980 to 2010, equivalent to around €5 billion losses per year. Given the limitations in existing data, it has not been possible to assess what share of these losses could be avoided by Natura 2000, or indeed what costs are already avoided thanks to the network (as these are damages not occurred and hence not measured). As an illustrative example, in the Slovak Republic an exploratory assessment estimated that costs in the order of €3.75 billion could be avoided by restoration and planning. This relates to the use of wider green infrastructure, including protected areas. In general, it is also very difficult to separate out the contributions of Natura 2000, wider green infrastructure, planning, response to emergencies and grey infrastructure, as they all work together to avoid costs.

Water: Money can be saved via working with natural capital, saving water purification and provisioning costs

Several European cities depend on protected areas for their drinking water supply. Municipalities and private water companies can save money on water treatment thanks to natural treatment from protected ecosystems. These savings can be passed on to consumers, resulting in lower utility costs for EU residents.

While it has not been methodologically feasible to develop an EU wide assessment of the benefits of Natura network for water purification and provision, given the site-specific nature of the benefits, it is clear from case examples that the Natura 2000 network can lead to cost-effective means of water purification and supply, offering significant savings over man-made substitutes.

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61 *EC (2008) and Centre d'analyse stratégique (2009)*

To cite an example from central and northern Europe, for the four European cities of Berlin, Vienna, Oslo and Munich, protected areas were estimated to lead to average benefits ranging between €15 and €45 per capita per year, for both water purification and provision combined. This compares, for example, to average household water bills of €200 per year in the case of Germany. This underlines that benefits can be indeed significant, and lead to substantial actual and potential cost savings from ecosystem-based water purification and provision, both for companies (reduced operational costs) and citizens (reduced water bills). It will be important for cities to explore the role of natural capital (protected areas, wider green infrastructure) in the purification and provision of water, and ensure that such considerations are integrated in the water management plans required under the EU Water Framework Directive (WFD)[62].

Other services: well managed protected areas can lead to substantial revenues and costs savings and avoid potential damage

For **pollination** it is clear that this has a critically important value in Europe. Existing estimates suggest an overall value from insect pollination of €14 billion per year in Europe, which is 10% of agriculture production used for human food production[63]. However, the existing data does not allow us to identify which share of this is from Nature 2000 and which share is from wider green infrastructure (e.g. hedgerows in agricultural landscapes).

Many Natura 2000 sites are also important for **agricultural production**. Farmland covers almost 50% of the EU territory and agro-ecosystems represent 38% the surface of Natura 2000 sites. High Nature value farming in Natura 2000 sites can offer significant benefits for biodiversity as well as helping support local breeds, support genetic diversity and hence be part of the insurance value of the agricultural sector, supporting its resilience. However, the data currently available are unable to allow an estimate of values from Natura 2000 sites for these benefits.

Marine Protected areas: Marine Protected Areas as part of a wider network of connected areas may have positive effects on overexploited fish stocks generally.

A very approximate estimate for the benefits of increasing Marine Protected Area (MPA) coverage to 10% gives around €2.5-3.8 billion per year improvement in 7 services and €1 billion per year off-site fisheries benefits, after 20 years. The higher value relates to more restrictive protection measures. Initial annual values are somewhat lower as the ecosystems take time to recover from past exploitation. This estimate is based on 10% conservation of all habitat types – in practice, protection will focus more on high-value areas and this will increase the total benefits of protection. Protecting an area larger (smaller) than 10% overall would lead to correspondingly greater (smaller) values.

It is important to stress that these are very rough estimates. They should be seen as ball park values, illustrative of the importance of this issue. More robust results would need an improved understanding of how protection will influence habitats, services and off-site fisheries, and of the network effect. The level of benefits will also depend on details of protection.

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62 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy. OJ L 327, 22.12.2000

63 Gallai et al., 2009

Tourism: Natura 2000 is already proving to be an important motor of many local economies by attracting tourists whose spending supports local economies.

The expenditure by visitors to Natura 2000 is around €50-85 billion /year (in 2006) for 1.7 million visitor days, considering all visitors. Only a share of the visitors is explicitly attracted by the Natura 2000 designation (i.e. directly attracted by the site, landscape, biodiversity). If only the expenditure of those visitors who have affinity for Natura 2000 designation is taken, the range becomes €9-20 billion/year for 230-520,000 visitor days. The estimated value of the benefits that these visitors derive from their visits to Natura 2000 sites is estimated at €5-9 billion per annum.

Protected areas can be a motor for the **local and regional economy,** both through their attraction of tourists and their spending, but also in their potential to attract inward investment and support jobs both in relation to tourism (hotels, recreation activities) and generally for the tertiary sector (service sector), as protected areas help enhance the locational quality image of the region.

Table 7.1 Summary of results, what they relate to, the level of robustness and further needs in the area

Key:

Deep green	**Robust numbers – fine for publication, citation, without need for significant context.**	**Orange**	Illustrative/indicative numbers but use with care and not out of context of the being a first assessment
Light green	Illustrative/indicative – useable with due caveats.	**Red**	Weak / very experimental. Do not use
Italics text	*Experimental or illustrative*	**Bold text**	Key point, result
Abbreviations:	Bn = billion;		yr = year

Approach	Numbers	What they relate to	Level of robustness / usability	Needs
Site Based	**€223 – 314 bn /yr** *€251 – 360 bn /yr*	Grossing up from 35 values from 21 studies. - GDP adjusted site based - *Non adjusted site based*	**Best currently possible preliminary indicative value.** Use with care/lot of caveats. High dependence on studies from UK and Netherlands.	***Future needs:*** To have robust order of magnitude ~ ideally a minimum of 200 comparable studies should be available– across biogeographic regions. A priority would be to get wider geographic focus. ***Future needs:*** bottom up survey of ecosystem services (ESs) from sites and beneficiaries to help assess factors driving benefits
Habitats Based	**€189 – 308 bn /yr**	Grossing up from 33 study numbers for 7 habitats - coastal, freshwater, heath and sand, grasslands, bogs and mires, forests.		
Territorial (extrapolation from national based studies)	*n/a as rejected for this study*	*Grossing up from Scotland, E&W and NL to rest of the EU*	*Not robust/useable. Was useful as a Straw man in the study*	A possible way forward would be to focus on smaller territorial scale. ***Future needs****:* significant increase in studies, noting biogeographic regions as well as range of key site and context indicators.

Carbon sequestration / storage	**Current Stock: €600 bn - €1130 bn** for the Natura 2000 network. **Policy On:** Over next **10 years,** there will be an **increase of €79-88** bn in carbon value if **ecosystem quality** is improved**; or €82-92 bn** if there is a 10% increase in **forest area.**	Stock value from carbon storage (living + dead carbon) and CO_2 value range 17.3 and 32 EUR/tCO_2 for 2010. Annual sequestration building on sequestration rates. Stock values are gross values. Policy-on values: increment.	**Relatively robust estimate for the value of the stock of (living) carbon.** Is an underestimate of the total value given that sequestration not addressed.	***Future needs:* further breakdown, site corroboration. More an annual natural gains – sequestration.** **Look also more at soil carbon given that this is a complex issue.**
Natural hazards	*Context values:* €160 Bn over 1980 to 2010 i.e. ~€5bn year losses SR: country indicative estimate: EUR 3.75 bn from restoration/planning	Country example: Slovak Republic: the national Landscape Revitalisation and Integrated River Basin Management Programme > ~ benefits of EUR 3.75 bn, mainly related to avoiding the costs of flood protection measures (Gov't of Slovak Republic, 2010).	Unable to produce numbers related to Natura 2000. Note that the losses noted in the left column do not represent current costs avoided by Natura 2000 or green infrastructure. It is currently not possible to say what these would be.	***Wider:*** Geographic Information Systems (GIS), survey of sites risks, impacts, role of Natura 2000, benefits.
Water – provision and purification	***<u>Provision</u>*** *Experimental ~ €22 billion/year* ***<u>Purification</u>*** *Experimental* €2.2 - €25 billion / year	***<u>Provision</u>*** Grossing up from 9 studies / values – but only 1 from the EU. ***<u>Purification</u>*** Grossing up from 3 values	**EU values currently experimental;** **use case examples as these communicate the benefits**	***For Future:*** survey / analysis of cities and beneficiaries .

Pollination	*Context values:* EU: Total €14 bn / year, which is 10% of agriculture productivity. World Pollination: €153bn/yr	General value of insect pollination	Order of magnitude robust, but not for Natura 2000 share. While it is clear that Natura 2000 sites are habitats for a wide range of wild pollinators for onsite agricultural activity and for nearby agricultural production, there is Insufficient data to be able to allocate share to Natura.	***Future:*** explore what the direct role of Natura 2000 is in wild pollination and the overall share. Useful to identify and assess specific sites that offer particular pollination value and output gains / input savings.
Marine	***Production services: food: fish*** €1 Bn per year off-site fisheries benefits ***Wider set of Marine ESS:*** €2.5-3.8 Bn per year improvement in 7 services	Approximate marginal benefits associated with protecting 10% of EU marine environment; range is for less-more restrictive protection. Based on transfer of expert judgement.	*Highly uncertain, order of magnitude estimates. Fisheries value only ballpark, dependent on CFP reform.*	*Full habitat data (5years); research and monitoring to understand the impacts of protection on services.*
Tourism expenditures	Around € 50-85 billion /year (in 2006) for 1.7 billion visitor days (~466,000 visitors/day average) considering all visitors Between € 9-20 billion/year considering visitors with affinity for Natura 2000 designation	Scaling up from a representative sample of 47 Natura 2000 sites	Order of magnitude rather than precise estimate (margin of error), comparable with economic indicators of tourism (e.g. the estimated value added of tourism and recreation for EU-27 is €505 bn)	*More data on tourism at site level (number of visitors and tourism spending)* *Better determination of the affinity of visitors for Natura 2000 designation*
Recreation (non market benefits)	4 € / visit i.e. between € 5-9 billion over the overall Natura 2000 network	Scaling up from a list of recreational values taken from the literature (National parks, Natura 2000 sites, habitats)	Rough order of magnitude rather than precise estimate, comparable with other recreational values for Natura 2000 sites	*More values from Natura 2000 case studies developed under a comparable protocol ; values on activities and attractiveness of sites*

The above numbers are a first partial estimate and a mix of relatively robust first-cut order-of-magnitude estimates and exploratory experimental assessments. The number of services covered is but a subset of the services that the network offers. The overall benefits assessment of €200 to 300 billion/year seems very broadly to match the mix of ecosystems service specific estimates. Note however, that the €200-300 billion figure also includes non-use values and hence covers a slightly wider set of issues that the pure ecosystem service approach. Much more work is clearly needed to derive a robust order-of-magnitude estimate (see road map in section 7.2) and the services contribution to the whole.

Interpreting the results: Connectivity, resilience, insurance value; issues of synergy and competition

While it is understood that the connectivity between Nature 2000 sites in the wider network, and between wider green infrastructures, can improve the health, conservation status and resilience of the protected areas as well as the provision of some of the ecosystem services, it has not been possible to derive a value for connectivity. It is clear that the value of the Natura 2000 network is worth more than the sum of the parts, but unfortunately, the existing data and methods have not enabled this added value to be calculated. At the most basic level this would require to be able to measure the impact of one site on the level of service provision for another (in the case of two connected sites) and impacts of connectivity to green infrastructure on the services from the wider green infrastructure (pollination and bio-control address this someway).

The improved ecosystems' health and conservation status of a protected areas and of the wider network is understood to improve the resilience of the functioning of the ecosystems – i.e. their ability to withstand pressures (e.g. climate change, pollution). This is expected to improve service provision (with improved health/connectivity) or reduce the loss of service provision (in light of climate change or other pressures risking degrading the ecosystem health). Again, this insurance value could not be measured within the above analysis. Future research and data should strive to provide a better understanding of the role and level of benefits, especially as regards climate adaptation benefits.

Furthermore, the above scaling up exercise of benefits de facto assumes that there all site benefits are additive and there is no additional synergy 'premium' , or indeed competition between sites (recall discussion in chapter 3).This is clearly a simplification, but a unavoidable one given the data.

Interpreting the results: what do the numbers mean and will it mean money for protected areas?

As noted in Chapter 3 there are a range of methods to ascertain value, and the values derived themselves can be of different types – from real market values that can feature in companies' 'bottom lines', national accounts and GDP, to values representing wellbeing, which are meaningful at a social level, but invisible to the cash economy. The values also accrue to a wide set of beneficiaries and will have very different implications for protected areas funding. Only a small proportion of the estimated benefits of €200-300 billion are reflected in cash transactions, and in reality very little actually accrues directly to protected areas. This underscores a fundamental issue: while protected areas have value to economies and societies, this value are generally not visible directly (hence the need for assessment) and their related benefits rarely pay the site manager. The protected areas are important public goods, creating many private benefits, but generally provide far less return for their ongoing management, maintenance or improvement of conservation status. To be more precise:

- Some values are reflected in 'real money' transactions: 'cash-in-hand', i.e. that can be seen in bank accounts and national accounts – e.g. tourism spend in sites or related to visits (although these expenses have not been included in the benefits estimates, as they reflect a consequence of rather than a measure of the values that people derive from visits to the sites). While this real money can come to the protected areas, in general a great element of the value goes to others - hotels, restaurants, travel. So this does not generally translate into significant money for protected areas.
- 'Real value' – avoided real costs: e.g the value of water purification is real money in the sense of avoided real costs (e.g. to water company or drink company) and can influence companies' profitability and hence GDP, but is not (currently) visible in accounts nor are the focus of market transactions – apart from where the water purification service benefits is captured via a payment for ecosystem service (PES) scheme. Developments as regards the Water Framework Directive and policy ambitions for full cost recovery and resource pricing, as well as potential developments in the area of public payment for public goods in agriculture, have the potential to change the level of support to protected areas over time, e.g. if due political support is given to WFD implementation and CAP reform.
- For carbon storage, there is not yet a market that pays for carbon storage in protected areas, so the values assessed are real in terms of avoided cost of damage, but not yet real in terms of 'money in pockets'; the climate change mitigation related public goods benefits do not yet directly bring in funds for Natura 2000 sites, or indeed directly noticeable in GDP statistics.
- For flood control, again generally there are no PES schemes to makes the value real in accounts and market transactions. The value perceived is typically the value of avoided damage to assets and loss of wellbeing, and the benefits go to those holding the assets that do not get damaged, or those whose wellbeing is not compromised. The share of money that can be raised from the benefits for the protected areas is quite small, though with future PES or direct investments to reflect the benefits there is the potential of changing.
- On recreation, benefits are real but these are welfare benefits (i.e. type of 'consumer surplus') and not real in cash terms, with the exception of paid recreation and the often considerable sums that flow to equipment and goods for recreation. This expenditure does not generally flow to the Natura 2000 sites

In summary, while the €200-300 billion is a representation of real benefits, only a share is money and picked up directly in national accounts, and only a fraction flows to the sites itself directly from the appreciation of the services.

7.2 The road map for valuation.

Table 7.2 present an overview of what is likely to be possible over what timescale for the different approaches. The time scales have been chosen to ensure relevance for the above mentioned 2014 and 2020 target years under the EU commitments, and sufficiently spread over time to allow differentiation as to what progress is possible over the time period - hence having a reference point (now, i.e. 2011), 2014, 2020, and the additional 2030 target. By 2050 (not included in the table), the values should be fully appreciated, even if many values will be site specific and dynamic (i.e. changing with population/demography, wealth, and a range of other factors) and methodological issues will naturally remain (e.g. on how to deal with migratory fish populations that go beyond EU waters). Note that progress on economic valuation does not mean that other techniques (e.g. biophysical valuation, assessments or stakeholder assessments) become less relevant. On the contrary, what is needed is progress with the range of tools to appropriate the contribution of nature to society and the economy as well as its intrinsic value. Also, this study confirms that, while identifying the values of ecosystem services, although not always easy, may be relatively feasible, measuring the ecosystem services delivered by Natura 2000 sites remain the greatest barrier to economic valuation – e.g. assessing effect of Natura 2000 on water quality is harder than valuing a measured change in water quality. This will be worth further efforts in future analysis.

While currently only a few services can be assessed for the Natura 2000 network as a whole, given data and method issues, with additional investment in data and studies it is expected that a fuller and more robust assessment of the benefits of Natura 2000 network in the EU can be achieved in the next ten to twenty years. Already by 2014 good progress can be achieved.

Table 7.2: Road map for valuation of the benefits of Natura 2000 network. The nature of current estimates, change in confidence levels and needs/developments over time.

Key:

Deep green	**Robust method – should lead to robust numbers, fine for publication, citation, without need for significant context.**	**Orange**	Methods to be used with care, but can lead to illustrative/indicative numbers; results not to be presented out of context of the being a first assessment
Light green	Fairly robust tools leading to Illustrative/indicative – useable with due caveats, transparent presentation of limits and what the numbers mean.	**Red**	Weak / very experimental methods, to explore ways forward. Do not use the results for decision making;
Italics text	*Experimental or illustrative*	**Bold text**	Key point, result
Abbreviations:	Bn = billion;		yr = year

	Now (2011)	2014 (Biodiversity strategy target)	2020 (BD strategy and CBD Strategic Plan target year)	2030
Multi-ecosystem services scaling up approaches – bottom-up approaches				
Territorial approach (ie country to country; eventually region to region)	**Not useable**	Unlikely to have enough information	Even with wider information, country differences likely too large for acceptable benefits transfer; unlikely that insufficient regionally specific information.	If done at a small regional basis with broadly similar contexts then this could be doable and valuable. [would be fully operational by 2050 – the 'vision' year]
Site Based	**Indicative/Illustrative values** – a bit better than experimental	More case examples – following protocol to allow comparability and urgent need for more geographic spread	More cases needed using common framework to allow a meta analysis to be carried and a benefits production function developed. Need broadening of geographic focus	**200 comparable site study values needed as a minimum**– for a robust meta analysis: according to a common protocol to allow comparability, meta analysis and proper scaling up.

Habitats Based - terrestrial	**Indicative/Illustrative values** – a bit better than experimental	More case examples needed – following protocol to allow comparability. Need for wider set of habitats.	More cases needed: meta-analysis, develop production function (can build on site survey: qualitative / quantitative). Need representative coverage of key habitats.	**200 comparable site study values** needed allowing meta analysis and proper scaling up to derive robust order of magnitude range.
Habitats Based - marine	*Fundamental uncertainties make valuation ballpark at best.*	Scope for expanding use of expert knowledge (eg improve the method by using expert judgement for specific marine areas) plus increasing knowledge of where the marine sites will be. Need more case examples, strong research effort on particular sites, chosen strategically (most important services, treatable uncertainties)	Habitat data plus monitoring evidence of how habitat is responding to protection, better understanding of habitat ecosystem service links. More cases of strategic sites: do a first meta analysis develop production function (can build on site survey: qualitative / quantitative)	**100 MPA studies with 200 site study values –** to create a due basis for a constructive meta analysis: according to a protocol…to allow comparability, meta analysis and proper scaling up
Individual Ecosystem Services approaches				
ESS approach – overall	**Currently only order-of-magnitude for 2 or 3 services (see below)**	For carbon storage, recreation and tourism, can be increasingly robust.	New primary valuation, and new spatial (e.g. GIS) data and methods should allow significant improvements First generation natural capital accounts will also help	Full integration into environmental accounts (natural capital and SEEA) will offer critical improvements Cover increasing number of services – at local, regional, national and EU scales.
1. Carbon storage	Relatively robust, through limits in precision (as soil carbon and sequestration rates still not understood sufficiently); use of past	Increasingly precise Some progress on sequestration rates (i.e. not just stock of carbon), data	Progress on carbon storage in soils; increasing knowledge of sequestration rates. Development of carbon accounts will	Good understanding. Full natural capital accounts as well as strong links to national accounts, supported by extensive valuation efforts.

	Natura 2000 coverage and wide EUR/tCO2 value ranges	availability in suitable for form entire Natura 2000 networks and dealing with overlap between SACs/SCIs and SPAs	support valuation. Will be robust overall, but still limits regards soil carbon.	
2. Water provisioning	*Complicated has to go through the site approach; top down 'benefits to the sector' approach complicated by data availability / confidentiality. Useful case evidence.*	More studies; city priority for studies give practical usefulness.	Include city survey and also water company survey/analysis as to 'free' inputs. Integration of ESS water provisioning in management plans under WFD will help. Probably still focused only on key areas that benefit	Cities/towns and water company value from Natura 2000 clear Demonstrated, inter alia, via PES schemes and investments. National water accounts (physical) and good integration in SEEA
3. Water purification	*Complicated has to go through the site approach. Useful case evidence.*	Studies on ecological functions, services and values.	Experimental integration in management plans under WFD?	Full integration in management plans under WFD?
4. Flood control	*Context values and case examples*	Seek additional evidence on cost-effective use of Green Infrastructure /Natura 2000	Insights on capacity for Natura 2000 to benefit cities or others – where relevant. Increasing interest in from climate adaptation research.	Spatially modelled role of Natura 2000 as part of wider green (and grey) infrastructure in ecosystem based adaptation to climate change. Complications in estimate given that benefits are avoided losses.
5. Pollination	*The overall value can be calculated, but separating Natura 2000 from green infrastructure difficult*	Key issue; evidence increasing for selective site based examples –for biophysical functions, impacts on productivity and value	Scientific modelling + GIS ,complemented by questionnaire to / interviews with sites managers and farmers to clarify role and importance of different sources of pollination (Natura 2000, which sites; other green infrastructure) and type of wild pollinators. Focus on sites	Full appreciation of the value of wild pollinators for all key sites – bottom up assessment Appreciation of top down value – ie share of output benefitting from wild pollinators from Natura 2000.

			neighbouring agricultural sites.	
6. Organic produce	*Resources within study insufficient, need to look at gross and net*	Possible to create an indicative value; will be important to see in wider context of whole services	Good site specific understanding expected. More local and regional assessments. Data integration.	Value of Natura 2000 produce expected to be a well understood market and role in local economies.
7. Air pollution benefits	*Very site specific*	Some robust values for key cities potentially doable	GIS + population, proximity, and air quality + ESS indicators. Expect for major cities	Allocation issues to Natura 2000, green infrastructure broadly resolved given GIS and improved spatial techniques.
8. Marine: Biomass production	*Fundamental uncertainties make valuation ballpark at best.*	Clarity over reformed CFP and use of ecosystem models allows understanding of role for MPAs in supporting fisheries	Habitats data should be available for all European sea areas, scope for modelling benefits though uncertainties remain over ecological relationships. Off-site fisheries benefits remain a challenge to address	Monitoring of marine protected areas enables demonstration of measurable fisheries benefits. Work needed to model impact of climate change.
9. Tourism (and market based benefits of recreation)	The overall value of benefits can be calculated by a site-based approach, extrapolating data from a small and disparate sample of Natura 2000 sites Difficult to identify a relationship between Natura 2000 and tourism indicators ('top-down approach'). Net benefits cannot be	Design of a reporting tool and experimenting it in a few sites => data base for a representative set of sites Better understanding, identification and quantification of the drivers of the level of tourism in Natura 2000 sites Collection of data related to tourism for eligible Natura 2000 sites	Implementation of the reporting tool at EU level => data base for a large number of Natura 2000 sites Modelisation for same day visitors Collection of data for new elected Natura 2000 sites ; First comparison of before/after designation	EU database on tourism activities and benefits Calculation of net benefits on the basis of the before/after situation.

	calculated.			
10. Recreation (non market benefits)	site-based, very few sites with valuation data	More case studies at site level for Natura 2000- following protocol to allow comparability => a small sample of sites	More case studies at site level for Natura 2000 => a representative sample of sites	Methodological progress in the evaluation of non-market benefits

The above road map presents a realisable progression of valuation and its robustness, building on the fine tuning the tools for it, the improvement of data to feed into it, and the increased valuation work to create improved overall evidence base. While it will lead to valuable benefits for academic understanding and operational learning (which will be a driver for progress of elements in the road map), it should prove (and part driven by) the benefits of improved policy governance as policy makers have improved understanding of the values of the Natura 2000 network, and help policy makers have access to information that is fit for purpose for wider policy objectives:

- Ensure an (**political, public and stakeholders') appreciation** of the value of sites to help ensure that their positive role are appreciated by local and other stakeholders and they are duly integrated in the ecological, social and economic landscape.
- Clarify the benefits – especially the public good benefits – that **create important arguments for public policy support**, including due land use planning considerations and funding. Valuation is a valuable tool to help in spending decisions.
- Help estimate the benefits, especially relating to specific services serving private and public interest that can help in the **design of instruments** (e.g. PES schemes).

It will never be possible (nor, arguably, needed) to derive a precise, robust, static value of the Natura 2000. The value will always be dynamic, affected by population growth, demography, income, changing geographic conditions, interests and preferences, economic contexts and wider contexts (e.g. global carbon values and climate change). This, and the site specificity of function, services and values, also mean that that there are limits to what can be assessed for the EU level as a whole.

Fundamentally, robust, relatively precise estimates will only be possible for specific sites and specific time snapshots of value of marginal changes to inform decisions (and even here ranges are needed). This is the core role of valuation and its most important value added.

For national or EU totals, robust order-of-magnitude estimates with fairly wider ranges of values will be possible (and arguably only this will be needed) to help communicate the socio-economic (co-)values of the Natura 2000 network and contribute to the appreciation of the ecologic network of excellence by the wider public. There is considerable more to be done at the site level and at the aggregate level to reach a needed understanding of the different objectives. Robust and relatively precise snapshot values should be assessed for at site level, to assess marginal changes, while robust indicators and order-of-magnitude ranges will be needed for higher level assessments. Details of the steps required to improve the robustness of the values are given in Table 7.2 above.

There are strong merits in supporting the development of additional site-based benefits valuation for Natura 2000 in a manner that would allow a wider 'meta-analysis' to be carried out. The development of '**benefits production functions/value transfer functions'** would also be desirable for an EU wide assessment, in order to identify and characterise key factors driving the benefit values. In practice this would be done separately for terrestrial sites and for marine sites, given the quite different drivers of value. What is needed is a transparent framework to allow making comparable analyses and working with results from different methods in different contexts. The Millennium Ecosystem Assessment (MA) and TEEB frameworks offer a useful basis for this.

Terrestrial sites: The wide variation of per hectare values by site, while affected by different *methodological approaches* used (e.g. valuation framework (e.g. TEV) and valuation methods, such as stated preference and revealed preference) and the scope of the assessment (e.g. which component of TEV is focused on and/or which ecosystem services are assessed), can also be driven by the following potential key factors[64]:

- *Habitat type and species*, related to their impact on ecosystem functions.
- *Area*, due to its potential impact on services such as carbon capture and storage or flood control.
- *Conservation status*, as a reflection of ecosystem health and linked to resilience.
- *Uniqueness/rarity*, which can influence the scientific value, potential for bioprospecting, and tourism/recreation.
- *Spatial relation to other resources and their abundance*, determining the perceived scarcity/abundance of substitutes (e.g. water resources considering water provision/purification) as well as potential for benefits (e.g. location relative to crops).
- *Proximity to population and accessibility,* as the proximity of beneficiaries can impact the perceived benefits (e.g. recreation/tourism, benefits from air pollution control, health benefits, house prices); *population density* in the vicinity of the sites is also important.
- *Income*, linked to ability/willingness to pay.
- *Prices*, to calculate monetary benefits for services such as carbon sequestration.

To allow a statistically significant (i.e., robust) analysis, more data is needed. Ideally, data sources would at least encompass 200 quality comparable primary valuation studies on the benefits of Natura 2000 from across the EU Member States – i.e. around 20 studies per key factor driving benefits (standard rule of thumb to help get statistically significant answers). As temporal and spatial conditions are important and methods evolving, some past studies will not be useable in the future and new studies will be needed, based on a common methodology that builds on Member States' and TEEB approaches. Realistically, in the future it will be possible to update only a few of the figures/services currently estimated (e.g. change carbon values used) and new evidence and figures will have to be developed using state of the art tools (e.g. building on MA, TEEB framework and advances in methods).

Marine sites – fish and wider ecosystem services

As with terrestrial protected areas, it will be useful to carry out a range of site based studies within an overall strategy of developing an ecosystem services and valuation database for the wide variety of marine habitat types. Such a database would permit meta-analysis and the development of production functions for important marine ecosystem services. The same key features as for terrestrial environments hold here too, but with different emphases, relating to certain specificities of marine environments:

- many marine environments are remote and unfamiliar to people, which can influence the applicability of certain valuation methods. At the same time, non-use values may be particularly important, and many people have particularly strong values for marine protection;

[64] The above are a core set of drivers; there are also other issues – e.g. level of connectivity of the Natura 2000 sites with others sites and with wider green infrastructure. This will be important for certain services, but very difficult to characterise statistically and integrate into a production function.

- marine environments are generally less studied and less understood from bio-geo-physical perspectives, so there is a pressing need for research into the qualitative and quantitative relationships between habitat and service provision, as well as for valuation;
- marine environments are particularly strongly connected and flows (of organisms, nutrients, pollutants, sediments) across site boundaries need to be taken into account;
- policies can be harder to enforce in the marine environment, both in a practical sense and because of generally weaker governance outside territorial waters (12nm) and this can influence data (have the supposed control conditions actually been respected?) and values directly (e.g. the fisheries values of marine Natura will depend on the fisheries policy outside the sites, and the extent to which it is respected);
- because of the connectivity, and the difficulties of enforcing restrictions on a very local scale, site size can be an especially important determinant of value in the marine environment.

As regards number of studies required, the value of MPAs will be quite diverse, with value driven by particular site characteristics, locations and management practices. Different approaches would be possible: time-series studies of the evolution of MPA sites following designation, or cross-section studies comparing similar protected and non-protected areas (including allowing for different levels of protection, enforcement or other forms of management); ideally, panel data combining both approaches, offering better statistical control. As an indicative broad objective, assessments of 100 MPAs with 200 site studies could constitute a sufficient information base for proper analysis and development of production functions

In both terrestrial and marine cases, estimating values is rarely central to the routine management of a site, except in cases where value evidence is needed for setting payments for ecosystem services, entrance fees or similar. However value evidence is important in determining what the benefits of different sites and management options are, and forms a key input to policy and decision processes, notably regarding designation, allowable activities, and management methods. This does not mean, however, that primary valuation is required for all sites. Because there are many similarities across sites, the services provided and the human populations benefiting from them, value transfer methods can be used. Widespread application of standard valuation methods to a strategic selection of Natura sites – and for comparison purposes, unprotected areas - will provide the necessary value evidence database to enable robust estimation of the marginal benefits of the Natura network, filling the policy need for evidence to underpin decisions on funding the network and on site designation and allowable activities.

It would also be valuable to do an **analysis/survey of the level of ecosystem service provision from different sites to different stakeholders** (across geographic levels) to quantify the inter-connections and explore the quantitative scale of benefits, e.g.:

- Carbon storage and sequestration in specific sites, to complement the top down analysis.
- Water provisioning and purification in specific sites – how many cites and how many people benefit, what share of the population is affected.
- What number of sites offer flood control benefits in practice and where (develop a mapping).

- Where sites actually offer pollination benefits
- What is driving the services – e.g. link to population levels, visitors etc.

There is actually quite scarce information on site benefits at this stage and site-level analysis should deserve further attention in the future. This would both be a building block for developing meta-analyses and benefit production functions, as well as a useful bottom up analysis and a step towards an ecosystem services mapping, which in turn can support natural capital (physical) accounts. As noted above, it would also be valuable for cities and for companies to assess what benefits they get from Natura 2000 and wider green infrastructure, to help in the integration between ecological, economic and social systems.

GIS and spatial understanding and SEEA.

The potential for advancing valuation through improved use of Geographic Information Systems (GIS) and mapping is very significant. The progress of the work of the JRC and EEA in mapping and use of ecosystem service indicators underlines the scope here for important advances. This could help with site-based assessment as well as with wider regional assessments. It is expected that these tools will be of particular support to the future assessment of carbon storage and sequestration, and also for water supply, with potential even as regards pollination as well as flood control, which are currently very difficult to assess given site specificity.

The System of Integrated Economic and Environmental Accounts (SEEA), also offers to contribute to progress in benefit valuation, the underlying physical understanding of ecosystem services and the awareness of their importance. The SSEA is a statistical framework introduced by the Untied Nations that provides internationally agreed concepts, definitions, classifications, accounting rules and standard tables for producing internationally comparable statistics on the environment and its relationship with the economy. Data collection and elaboration in the context of the SEEA, or similar environmental/ecosystem accounting, can provide a useful evidence-base ecosystem benefits valuation, including in Natura 2000 areas. In turn, Natura 2000 related assessment can provide useful information for national/regional accounting, and therefore help driving policy and decision making.

7.3 Realising the road-map of valuation

As noted in the introduction to this chapter, a 'demand' for and commitment to valuation and the integration of the value of nature into decision making and national accounting is coming from each of global, EU and national levels.

Opportunities for EU level contributions

A number of policies and programmes exist which can help in the assessment of ecosystem services and their value, and that in turn cab be supported by such valuation. The 7th Framework Programme (7FP) offers a major potential (and already active) source of funding to help improve the scientific understanding, develop tools and use them in implementation. There remain a wide range of scientific gaps (e.g. on the relationships between components of biodiversity in protected areas, the functions and the service provision) as well as gaps in the valuation tools and understanding. At a policy level, the EU Cohesion Policy is already supporting some benefit assessments at site level, given the recognition that natural capital can be a driver for local economic development, competitiveness and wellbeing. There is significant potential, pending commitments to extend funding for wider green infrastructure, including for Natura 2000 sties. The Common Agriculture Policy (CAP) has also the potential to move towards greater public payments for public goods and can arguably be a source of support for certain land use types and services (e.g. water purification/provision, carbon storage, flood control, soil erosion, pollination, natural predation). There also seems to be some potential for the Water Framework Directive and Water Management Plans within river basins to take into account the ecosystem based provision of clean water, including specific focus on protected areas. In addition, the Common Fisheries Policy (CFP) and the European Fisheries Fund (EFF) could prove to be a valuable source of support for ecosystem assessments and valuation of marine areas. Finally, LIFE+ funding is also a potential mechanism to encourage assessments and valuation. There is therefore a wide range of opportunities for funding that need political and practical commitment to ensure they are realised.

Member State opportunities for progressing the road map

At Member State level there are national choices for the use of many of the above EU programmes and funds and a wide range of national (including down to local level) opportunities to encourage ecosystems assessment and valuation. National research support linked to university programmes are key (e.g. in the UK), as well as the use of assessments as part of impact assessments for policy valuation (e.g. the UK Marine Bill[65]). New policies and institutions can also help drive valuation – for example the recent UK *Natural Environment White Paper*, inspired by the *UK Ecosystem Assessment,* recommended the development of a new Natural Capital Committee and an annual statement of green accounts for the UK. At the city level, there is also major potential for progress given the range of critical benefits for cities (e.g. water purification and supply, flood control in certain areas, recreation, tourism and health). Similarly, companies can be encouraged to assess the value of (often currently unpriced) resource inputs and risks of loss of this (e.g. water companies and beverage companies). The recent and ongoing TEEB initiative is leading to some new momentum as regards ecosystem assessments and valuation of benefits – at country, city and business levels (e.g. TEEB-inspired assessments are already in progress in the Nordics, Netherlands, Belgium, Germany). It will be important that the Natura 2000 assessments become part of new national ecosystem assessments and feature as specific areas for assessment in national TEEBs.

Given the importance of having comparable studies, EU co-funding and, in places, coordination and facilitation of discussion and mutual learning between Member States will be invaluable, to ensure that the approaches taken are compatible and comparable and to allow improved cross EU value transfer and robust EU level aggregate values. Also, awareness raising at EU level will be valuable[66] to encourage wider sets of Member States' actions.

As regards the approach to take in the above road map and who can usefully support progress in what areas – there are merits in progressing with both the bottom up/scaling up approach (e.g. site or habitat based) and the ecosystem service approach – at both the aggregate and the local specific levels. These approaches are complementary and mutually informative. For a decision on a particular site, a site-based approach is naturally most useful. The focus can be either broad (e.g. multi-services), where the discussion is on the wider benefits of the site to the local community and beyond, or on a specific service, if it

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65 http://www.doeni.gov.uk/index/protect_the_environment/water/marine_bill_.htm

66 Kettunen et al, 2010

concerns a specific measure or instrument (e.g. PES for water provision) or investment (e.g. flood control measures). Deriving aggregate EU-wide values and indeed national values is instead of value in particular for policy discussions and funding and budget decisions. Hence, ultimately, the nature and timing of the specific decisions that need taking at local, national or EU level will be an important driver as to where progress in valuation is made.

There are therefore many ways forward to help realise the above road map, improve awareness and valuation of the values of Natura 2000 network and integrate them into reporting, accounts and decision making. While its prime objective is the conservation of the unique and endangered biodiversity in Europe, Natura 2000 offers critically important co-benefits to the economy and society. Understanding its value will be useful not only for the governance of policies that affect the network, but also for wider governance of nature and natural capital – at all levels, from local to national, EU and global, and from the public to the private sectors.

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ANNEXES

Separate electronic file