Assessment of the potential of ecosystem-based approaches to climate change adaptation and mitigation in Europe

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UNIVERSITY OF OXFORD
ENVIRONMENTAL CHANGE INSTITUTE
SCHOOL OF GEOGRAPHY AND THE ENVIRONMENT

Assessment of the potential of ecosystem-based approaches to climate change adaptation and mitigation in Europe

FINAL REPORT

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Glossary

CAP	Common Agricultural Policy
CBD	Convention on Biological Biodiversity
COP	Conference of the Parties
EbA	Ecosystem-based adaptation
EC	European Commission
EbM	Ecosystem-based mitigation
GHG	Greenhouse Gas
MS	Member State
NAS	National Adaptation Strategies
REDD	(United Nations Collaborative Programme on) Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
UNFCCC	United Nations Framework Convention on Climate Change

1 Executive Summary

Addressing the effects of climate change via adaptation measures and the implementation of mitigation measures is central to ensuring continued ecosystem functioning, human health and socio-economic security. Ecosystem-based approaches have emerged as a key instrument to confront these concerns across sectors of business and society, offering multiple benefits in a potentially cost-effective manner.

The concept of an 'ecosystem-based approach' builds on the Convention on Biological Diversity's (CBD) definition, stating that: "the ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way" and which aspires to maintain the natural structure and functioning of ecosystems. Ecosystem-based approaches address the crucial links between climate change, biodiversity, ecosystem services and sustainable resource management and thus have the potential to simultaneously contribute to the avoidance and reduction of greenhouse gas emissions and the enhancement of sinks - *inter alia* - through increased carbon sequestration. These approaches also maintain existing carbon stocks, regulate water flow and storage, maintain and increase resilience, reduce vulnerability of ecosystems and people, help to adapt to climate change impacts, improve biodiversity conservation and livelihood opportunities and provide health and recreational benefits.

Applying this definition, this study aimed to address current knowledge gaps regarding the uptake and implementation of ecosystem-based approaches and thereby gain a better understanding of their role and potential in climate change adaptation and mitigation in Europe. A database of 161 applicable projects, five in-depth case studies, targeted interviews with European Commission officials and a literature review served as the basis for this assessment. Using these sources, this study sought to illuminate the success factors leading to and obstacles hindering the implementation of ecosystem-based approaches in climate change programmes at local, regional, national and transnational levels and provide appropriate recommendations for overcoming existing obstacles. Furthermore, evidence on the costs and benefits of ecosystem-based approaches has been collected and compared to the costs and benefits of traditional engineered approaches for addressing climate change and its impacts.

The breadth of projects identified for the database, which employ ecosystem-based approaches, enabled several overarching observations to be drawn. The frequent cross-sectoral nature of such approaches, for example, place these projects in a position to potentially contribute to a range of EU, national and regional policies within the area of climate change adaptation and mitigation. However, little specific mention of ecosystem-based actions or evidence of ecosystem-based adaptation and mitigation actions was found in EU level documents, although there was recognition that ecosystem-based actions often provide multiple benefits including mitigation. The most frequently mentioned ecosystem-based actions within the country and sector documents were creating or maintaining protected areas and ecological connectivity and using ecosystems as carbon stores. At a national level, evidence of concrete adaptation actions was found in just less than half of the country level reports and evidence of mitigation action was given in the majority of cases in which measures were discussed. Ultimately, the review shows that many good examples of

ecosystem-based approaches to adaptation and mitigation exist and their implementation needs to be promoted, such that there is a move from theory to practice and potential synergies are exploited.

The research has also identified a number of factors leading to and obstacles hindering the successful implementation of ecosystem-based approaches in climate change programmes. Given the relatively small knowledge basis regarding these approaches, a host of challenges are created relating to the technical task of designing and implementing effective strategies, capacity issues regarding institutional, financial or technical resources, organizational challenges related to the need to bring together a wide variety of practitioners and stakeholders, behavioural issues arising from the power of habitual modes of practices and political and socio-economic barriers. In order to overcome these challenges, several factors were identified, including: project management experience amongst the staff, clear delineation of roles and transparent communication among project partners; stakeholder consultation and participation processes from the planning phase onwards; awareness raising about the current threats posed by climate change and biodiversity loss and the employed ecosystem-based approaches to address these threats. Highlighting the multiple benefits of the proposed project, which are linked to ecosystem-based approaches is key within this context.

Regarding costs and benefits, the lack of quantitative data made it difficult to fully assess these aspects in association with ecosystem-based approaches. While data on the financial costs related to the projects are generally available, the benefits are largely expressed in qualitative terms (e.g. habitat protection, recreational opportunities etc.). This indicates the need to commission detailed valuation studies at the project level. However, the available evidence indicates that the majority of projects using ecosystem-based approaches can be considered as beneficial from an economic point of view if one takes account of their long-term social and ecological benefits. In this respect, ecosystem-based approaches are likely to be more cost-effective than traditional engineered approaches, but further evidence is needed.

In addition to the above findings, this study has produced lessons and recommendations for implementing ecosystem-based approaches in Europe and for integrating such approaches in policies and strategies relevant for climate change at different spatial levels as well as for supporting the EU 2020 Biodiversity Policy and work on the planned EU Green Infrastructure Strategy.

Currently, there is a need to raise awareness about ecosystem-based approaches and the underlying concept, as well as the multiple functions and benefits offered towards climate change mitigation and adaptation. While quantitative evidence of how effective activities have been in terms of mitigation (e.g. how much carbon is sequestered) or adaptation (e.g. how much flooding damage has been avoided) is often still lacking, the multiple benefits aspect can be a powerful tool for advocating the use of such approaches. Providing examples of relevant ecosystem-based measures that can be undertaken in the different sectors (such as agriculture, forestry, water etc.) can also help to increase the understanding of these approaches.

Alongside the need for increased knowledge opportunities for potential financing are also to be made available to strengthen the integration of such approaches. The current financial crises provide real opportunities to promote and pursue ecosystem-based approaches as

they have the potential to be more cost-effective (particularly in the long-run), enable a sense of responsibility to be cultivated, allow for increased engagement of different stakeholders and can deliver multiple benefits as compared to traditional engineered solutions. Therefore, evidence on the cost-effectiveness of such approaches should be provided where available and further research (e.g. in the form of cost and benefits analyses for selected projects) should be undertaken where knowledge gaps exist. Further knowledge could also support financing by the private sector via, for example, public-private partnerships (PPPs), carbon markets, corporate social responsibility and regulative instruments.

In order to increase the uptake of ecosystem-based approaches and to make use of all potential benefits, increased cross-sectoral integration is needed. The analysis of the EU sector strategies revealed that the lack of integration is an obstacle for coherent and efficient implementation from the local to transnational levels. Furthermore, alongside coordinating knowledge transfer, promoting research and encouraging the uptake of best-practice practices, there is a need to i) clearly outline the ecosystem-based adaptation and ecosystem-based mitigation actions to be undertaken in the different policy sectors and pertinent programmes, strategies and action plans and ii) report on the implementation of these actions.

At a national and regional level, given the importance of technical capacity highlighted in the explored case studies, an increased knowledge and understanding of specific design characteristics for projects using ecosystem-based approaches and their implications should further be supported. Both positive experiences as well as barriers were encountered during implementation. These can serve as a useful knowledge basis for increasing the success and efficiency of emerging projects. Further, such information could help to create successful management frameworks and a more appropriate selection of measures. Systems of institutional learning can enhance these efforts, ensuring that knowledge can be transferred to a wider audience and that the utilization of lessons learned is maximized. Finally, increased stakeholder involvement and a higher level of awareness amongst policy makers and the general public are necessary. Governments can be seen as serving a central, guiding role here in acting as a motivating actor and providing impetus to action at the local level.

2 Introduction

2.1 Background

Adaptation measures for climate change and the enforcement of mitigation measures are urgently needed in many sectors of business and society, ranging from agriculture, forestry, urban planning and water management to nature conservation and human health. Ecosystem-based approaches are becoming increasingly important as they can provide multiple benefits and are often considered cost-effective solutions as compared to technological approaches to tackling climate change (see Box 1 definitions). Ecosystem-based approaches address the crucial links between climate change, biodiversity and sustainable resource management and, by preserving and enhancing ecosystems, enable society to better mitigate and adapt to climate change.

However, while the maintenance and restoration of natural habitats has already emerged globally as an effective strategy to increase the resilience of ecosystems and support sustainable livelihoods, quantitative evidence specifically on the cost-effectiveness and benefits of ecosystem-based approaches is limited and significant knowledge gaps remain. Existing case studies provide a useful foundation for beginning to explore what can be achieved by implementing these approaches, but the findings are restricted to specific contexts and are difficult to extrapolate to wider scales. Consequently, despite the concept of ecosystem-based approaches being increasingly recognized in policy and within the scientific community, progress is still lacking in the development and implementation of these approaches across different sectors throughout Europe. Moreover, lack of evidence is potentially compounded by the fact that some of the multiple benefits are more difficult to quantify.

Box 1: Definition of key terms

The **ecosystem approach** is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential processes, functions and interactions among organisms and their environment. The ecosystem approach aspires to maintain the natural structure and functioning of ecosystems and recognizes that humans and their action are an integral component of ecosystems.[1]

The term **ecosystem-based approaches to climate change adaptation and mitigation** is being used progressively in reports (CBD AHTEG[2]; Discussion Paper Towards a Strategy on Climate Change, Ecosystem Services and Biodiversity[3], Convenient Solutions for an Inconvenient Truth – Ecosystem-based approaches to climate change[4] and policy documents (Environment Council Conclusions on Biodiversity of 22/12/09[5]; on Biodiversity Post-2010 of 16/03/10[6] and follow-up to Cancun Environment Council Conclusions 14/03/2011[7] and CBD COP X 33[8] on Biodiversity and Climate Change, which highlights the multiple benefits that can be derived from ecosystem-based approaches. While ecosystem-based approaches can complement technological solutions to address climate change, they can also act independently.

Ecosystem-based adaptation (EbA)/ ecosystem-based mitigation (EbM) (short form for ecosystem-based approaches to climate change adaptation and mitigation) is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to/to mitigate the adverse effects of climate change.[9] As one of the possible elements of an overall adaptation strategy, EbA uses the sustainable management, conservation, and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. It aims to maintain and increase the resilience and reduce the vulnerability of ecosystems and people in the face of the adverse effects of climate change. EbA can generate significant social, economic and cultural co-benefits, contribute to the conservation of biodiversity and build on the traditional knowledge and practices of indigenous peoples and local communities, including the role of women as custodians of local knowledge. In addition, healthy, well-managed ecosystems have climate change mitigation potential (which can be enhanced through EbM), for example, through the sequestration and storage of carbon in healthy forests, wetlands, and coastal ecosystems (CBD 2009).

Another challenge within this field is to determine how best to integrate the principles of ecosystem-based approaches into existing policy domains and to achieve true buy in of the concerned sectors and departments. It is expected that through the development of green infrastructure[10], the use of ecosystem-based approaches can be integrated into a broader

[1] Adapted from: CBD COP5, Decision V/6 (see http://www.cbd.int/ecosystem/)

[2] http://www.cbd.int/doc/?meeting=AHTEG-BDCC-01

[3] http://ec.europa.eu/environment/nature/pdf/discussion_paper_climate_change.pdf

[4] http://siteresources.worldbank.org/ENVIRONMENT/Resources/ESW_EcosystemBasedApp.pdf (Worldbank 2009)

[5] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1997&language=EN

[6] http://register.consilium.europa.eu/pdf/en/10/st07/st07536.en10.pdf

[7] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/envir/119875.pdf

[8] http://www.cbd.int/climate/doc/cop-10-dec-33-en.pdf

[9] Connecting Biodiversity and Climate Change Mitigation and Adaptation - Report of the Second Ad Hoc Technical Expert Group (AHTEG) on Biodiversity and Climate Change under the Convention on Biological Diversity (CBD)

[10] This project adopts the definition of green infrastructure, which was developed by the research project "Design, implementation and cost elements of Green Infrastructure projects" (Ecologic and GHK, 2011). This definition is as follows: *"Green infrastructure is the network of natural and semi-natural areas, features and green spaces in*

strategy. This projection stems from the similar objectives of green infrastructure (to "enhance ecosystem health and resilience, contribute to biodiversity conservation and benefit human populations through the maintenance and enhancement of ecosystem services")[11] and those of the ecosystem-based approach ("to maintain the natural structure and functioning of ecosystems and recognize that humans and their action are an integral component of ecosystems"),[12] highlighting their close linkages with one another and shared aims.

Based on the limited existing evidence regarding the potential of ecosystem-based approaches to contribute to climate change adaptation and mitigation, the following aims are recommended to be integrated into and considered in designing such approaches to maximize benefits (TNC 2009):

- Maintain intact and interconnected ecosystems so they can adjust to changing environmental conditions and continue to provide services to people;
- Restore or rehabilitate fragmented or degraded ecosystems and re-establish critical environmental processes;
- Ensure that any use of renewable natural resources is sustainable under changed climate conditions; and
- Adjust resource management programs to deal with climate-induced impacts, such as the increased threat of fire or invasive species.

These approaches are ready for use and often considered to be cost-effective in tackling climate change as compared to technological solutions since they provide additional benefits from maintaining the natural structure and functioning of ecosystems. More specifically, ecosystem-based approaches have the potential to reduce greenhouse gas emissions and enhance sinks, increase carbon storage and maintain existing stocks, regulate water flow and storage, maintain and increase resilience and reduce vulnerability of ecosystems and people, improve biodiversity conservation and livelihood opportunities and provide health and recreational benefits. These benefits and others are outlined in Figure 1 below.

rural and urban, and terrestrial, freshwater, coastal and marine areas, which together enhance ecosystem health and resilience, contribute to biodiversity conservation and benefit human populations through the maintenance and enhancement of ecosystem services. Green infrastructure can be strengthened through strategic and co-ordinated initiatives that focus on maintaining, restoring, improving and connecting existing areas and features as well as creating new areas and features.

[11] Ibid.

[12] Adapted from: CBD COP5, Decision V/6 (see http://www.cbd.int/ecosystem/)

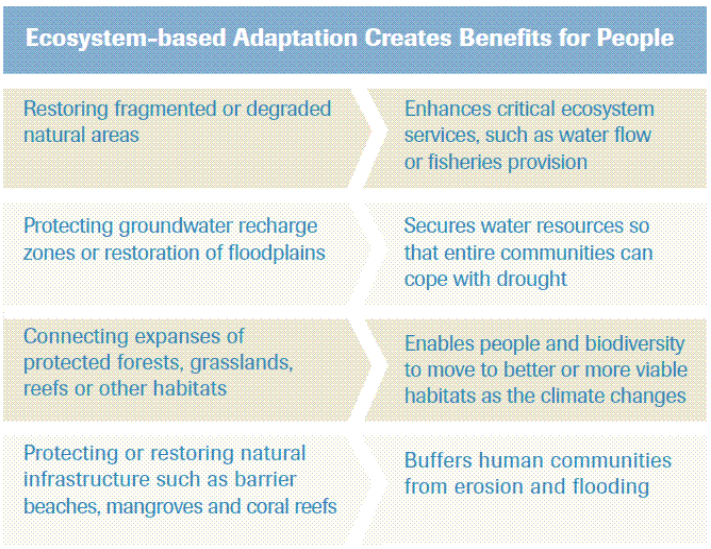


Figure 1: Benefits resulting from EbA (Source: TNC 2009)

The EU Commissioner for Climate Action Hedegaard in her speech during the closing session of GREEN WEEK 2010[13] said "we need both green technology and natural solutions in our climate change toolbox". This statement was picked up and also highlighted in a speech for climate change solutions in the Pacific region by Andris Piebalgs (European Commissioner for Development) in March 2011.[14] Therewith, while ecosystem-based approaches can complement technological solutions to address climate change, they can also act independently in certain contexts and serve as a substitute for the contributions of technological approaches. Unlike engineered solutions, the focus on ecosystem services and green infrastructure also serves to support people's fundamental needs, such as providing food, water, fuel and fibre in addition to overarching benefits, as outlined above.

2.2 Objectives

The limited knowledge and research completed to date in the area of ecosystem-based approaches to climate change adaptation and mitigation necessitates the targeted research envisioned in this study. Overall, this study aims to gain a better understanding of the role and potential of ecosystem-based approaches in climate change adaptation and mitigation in Europe. The following specific objectives have been defined helping to address the identified gaps and achieve the project aim:

- Take stock of current examples of working with nature - ecosystem-based approaches to climate change mitigation and adaptation in Europe;
- Screen adaptation strategies on local, regional, national and transnational levels in Europe and assess to what extent these adaptation strategies consider ecosystem-based approaches;

- Identify the obstacles that prevent integration and elaborate recommendations on how to overcome those obstacles;
- Identify success factors enhancing the integration of ecosystem-based approaches and good practice examples; and
- Conduct an assessment of costs and benefits associated with selected ecosystem-based approaches and compare the results to costs of traditional engineered approaches.

Further, these objectives will help to shed light on the success factors leading to and obstacles hindering the implementation of ecosystem-based approaches in climate change programmes on local, regional, national and transnational levels and provide appropriate recommendations to overcome the existing obstacles. In addition, evidence on the cost-effectiveness of such approaches will be provided. Results shall help to enhance the integration of ecosystem-based approaches in policies and strategies relevant for Climate Change at different spatial levels, to raise awareness to the multiple benefits provided by ecosystem-based approaches and to support the EU 2020 Biodiversity Policy and the work on the planned EU Green Infrastructure strategy (expected in fall 2012).

2.3 Sources of data

The project adopted a three-fold approach to gathering data for the analysis of ecosystem-based projects and pertinent policy, producing a database of ecosystem-based projects in Europe, five in-depth case studies and interviews with officials from different directorates of the European Commission. In addition, relevant literature was reviewed and taken into account in the subsequent data analysis. The different components of the project's evidence base are described in more detail below.

Project database

To start with, a project database (in MS Excel format) was developed to facilitate the collection of projects using ecosystem-based approaches in Europe. The database provides a framework for the classification of the projects and exposed the links of ecosystem-based approaches in the context of climate change adaptation and mitigation to biodiversity protection and nature conservation as well as to green infrastructure.

The projects incorporated in the database were classified based on three major categories: project identification, project scope and project operation. These parameters were expanded into further into sub-categories designed to describe specific characteristics of the reviewed literature in a direct and comparable manner (see Table 1). In total, details of 161 projects have been entered in the database.

Table 1: Parameters used to describe the projects in the database

Project identification			
	Project name and description	-	
	Sector	Agriculture, energy, fishery, forestry, health, nature protection, tourism, urban/regional planning, water	
	Strategy or policy involved	Specifies when the project is part of a broader strategy or policy programme and identifies it (LIFE+; Natura2000; INTERREG; National/Regional Strategies)	
	Member State involved	-	
	Project type	Research, restoration, scoping, strategy, monitoring, evaluation, dissemination etc.	
	Year of development/ state of implementation	Specifies the project's kick-off date and current status: proposed, planned, implemented, ongoing, evaluated	
Project scope			
	Ecosystems/ habitats covered	Arable land, coast, forest; grassland, river, wetland, urban ecosystems etc.	
	Geographical scale	Local, regional, national, transnational	
	Main objectives	E.g. adaptation, mitigation, biodiversity conservation; water quality; water supply; human health and well-being; soil protection; habitat/ecosystem restoration; increasing connectivity between habitats; coping with extreme weather events; development of integrated management plans at various scales; advisory on environmental issues; transfer of technology and best practices; etc.	
	Beneficiaries	Identifies the recipients of benefits (target group) resulting from implementation of the project (local/regional communities, landowners, farmers, small-scale businesses, conservation agencies, biodiversity, society in general).	
	Green Infrastructure elements addressed	Protected areas	Large areas of healthy and functioning ecosystems with minimal intervention required (e.g. national parks, forest reserves, IUCN categories I and II); smaller areas that require management intervention (e.g. Natura 2000, IUCN category IV)
		Restoration zones	Reforestation zones, increased foraging areas, new areas of habitat for ecosystem services (e.g. peat bogs); conversion of a habitat back into its original form via management actions
		Multifunctional zones	Balance between various uses such as access, recreation and biodiversity; promote enhanced public access to the landscape particularly adjacent to existing and planned settlements
		Green urban areas	E.g. parks, gardens, grassy verges, green walls, green roofs
		Natural connectivity features	Ecological corridors (hedgerows, wildlife strips) stepping stones, riparian river vegetation, etc.

		Artificial connectivity features	Features designed specifically to assist species movement (e.g. green bridges, eco-ducts, etc.)
Project operation			
	Actions/measures (adaptation-mitigation)	**Specific efforts aimed towards climate change adaptation**	
		Ecosystem conservation and restoration	Maintaining and restoring natural ecosystems and the goods and services they provide
		Ecosystem service maintenance and enhancement	Protecting and enhancing vital ecosystems services (e.g. water quantity and quality)
		Natural infrastructure conservation	Maintaining coastal barriers and natural mechanisms of flood control, pollution reduction, and water purification
		Reducing threats to biodiversity	Reducing pollution, reducing overexploitation, habitat fragmentation, degradation and loss
		Invasive species control	Reducing land and water degradation by actively preventing and controlling the spread of invasive alien species
		Key habitats management	Managing habitats that maintain nursery, feeding, and breeding grounds for fisheries, wildlife and other species on which human populations depend
		Reservoir endowment	Providing (creating) reservoirs for wild relatives of crops to increase genetic diversity and resilience
		Specific efforts aimed towards climate change mitigation	
		Carbon sequestration	Sequestration via expanded carbon pools (through e.g. afforestation, reforestation and restoration of natural habitats)
		Terrestrial carbon stores conservation	Maintenance of existing carbon stores (e.g. avoiding deforestation or protecting wetlands)
		Ocean carbon sink conservation	Maintenance of the ocean carbon sink
		Bioenergy	Substituting fossil fuel energy with cleaner technologies based on biomass
	Stakeholders involved	Government institutions, intergovernmental organisations, social actors and interest groups, research institutes etc.	
	Costs and Benefits	E.g. economic figures, budgets, employment, production, CO_2 emission rates before and after project measures (indicate evidence on adaptation, mitigation and biodiversity)	

In order to identify relevant projects and initiatives, projects which labelled themselves as using an ecosystem-based approach and which have a link to climate change action were selected and entered into the database. As the term ecosystem-based approaches is not being used consistently or recognized by all relevant initiatives, a further key criterion for entering projects into the database was to ensure that the objectives outlined by the project and the planned actions/measures focused on climate change adaptation and mitigation. By

employing these two search techniques, a wide variety of projects has been identified and included in the database.

Several approaches and sources were employed. A general web search efficiently provided an overview of existing projects and served as a starting point for further research, utilizing such terms as: *ecosystem-based adaptation, ecosystem-based mitigation, increasing ecosystem resilience, ecosystem goods and services, sustainable biodiversity use*, etc. In addition to the review of academic papers and grey literature, important sources included databases at international, EU and national levels such us the CBD Ecosystem Approach Sourcebook[15], the projects listed under the Rio Conventions' Ecosystem and Climate Change Pavilion[16]; databases form EU funds (CORDIS[17], LIFE+[18], INTERREG[19]) and national/regional programmes and initiatives (e.g. Defra project databases, Ourcoast database[20]). A further important source was research projects, such as RUBICODE[21], MACIS[22], Green and Blue Space Adaptation for Urban Areas and Eco Towns (GRaBS)[23] and Embedding Biodiversity Adaptation Principles (EMBEDS)[24] as well as reports from ENCA (Cowan and Schliep, 2010)[25], the World Bank (2009) and DEFRA.[26]

In addition, proceedings from expert meetings, conferences and related events were considered. Of particular relevance were here the findings of the Ad Hoc Technical Expert Group on Biodiversity and Climate Change established under the Convention on Biological Diversity (CBD AHTEG) and the work of the EU Ad Hoc Expert Working Group on Biodiversity and Climate Change.

The project search was also complemented where possible by the database being compiled as part of the parallel study on the “Design, implementation and cost elements of Green Infrastructure projects” as well as from the project UNEP-WCMC-project “Ecosystem-based Adaptation and Mitigation: good practice examples and lessons learnt in Europe” (Doswald and Osti, 2011).[27]

In-depth case studies

The main substance of this study was the analysis of five in-depth case studies, which were selected from the project database. These case studies allowed for a more detailed assessment of the initiation and implementation of the respective projects, their costs and benefits, and the barriers experienced in the implementation of the project. Given the wide

[15] https://www.cbd.int/ecosystem/sourcebook/

[16] http://ecosystemspavilion.org

[17] http://cordis.europa.eu/home_en.html

[18] http://ec.europa.eu/environment/life/project/Projects/index.cfm

[19] INTERREG IVB NWE project database: http://www.nweurope.eu/; INTERREG IVC project database: http://i4c.eu/approved_projects.html

[20] http://ec.europa.eu/ourcoast/index.cfm?menuID=8&keyApproacheID=4

[21] http://median-web.eu/research/Past-Projects/Rubicode/

[22] Minimisation of and adaptation to climate change: Impacts on biodiversity; http://www.macis-project.net/index.html

[23] http://www.grabs-eu.org

[24] http://www.defra.gov.uk/environment/natural/biodiversity/uk/biodiversity-climate-change/

[25] http://www.bfn.de/fileadmin/MDB/documents/service/Skript264.pdf

[26] England’s terrestrial ecosystem services and the rationale for an Ecosystem Approach; http://www.ecosystemservices.org.uk

[27] In total, 66 projects have been included from this database.

variety of ecosystem-based projects in Europe, a specific set of selection criteria was defined in order to select representative examples (see Table 2).

Table 2: Case study selection matrix showing the ten pre-selected projects and the final selection after evaluation and feedback from the European Commission

Selection criteria		In-depth case studies				
		Restoring Peatlands	De Doorbraak	SUDS, Augusten-borg, Malmö	Forest Rehabili-tation	Wallasea Island Wild Coast
MS	Country	BY[1]	NL	SE	CZ	UK
Scale	Local/regional					
	National					
	Transnational					
Sector	Agriculture					
	Built environment					
	Energy					
	Fishery					
	Forestry					
	Health (incl. recreation)					
	Tourism					
	Transport					
	Urban/regional planning					
	Water					
	Nature protection					
A/M	Adaptation					
	Mitigation					
Funding[1]	EU (e.g. LIFE+)					
	Public					
	Private					
Project Age	Finished			1997-2002	1992-2008	
	Ongoing	2008- 2011	2005-2015			2009-2019
€	Budget data					
	Cost-benefit data					

[1] The project is financed by the Federal Republic of Germany through KfW Entwicklungsbank in the framework of the International Climate Protection Initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

The following table provides a short description of the five case studies and the respective ecosystem-based measures to climate change adaptation and/or mitigation.

Table 3: Brief description of the five projects selected and the measures undertaken

	Case studies	Project Description	Measures taken for adaptation/mitigation
1	**Restoring Peatlands and Applying Concepts for Sustainable Management in Belarus (BY)**	The project builds on the peatland restoration experience of a UNDP-GEF project and aims at rewetting 15,000 ha of drained peatland, thereby avoiding the emission of an estimated 100,000 t CO_2 equivalents per year. By assuring that these emission reductions are verifiable and tradable in the voluntary carbon market, the initiative proposes a self-sustainable scheme, which integrates the provision of restored habitats for local/endangered species with the increase of carbon storage capacity in Belarus. The restoration of such habitats also promotes the re-establishment of basic ecosystem functions and the formation of ecological corridors and reservoirs, allowing for the migration of species and the enhancement of their populations.	Mitigation: Rewetting of peatland, which has been drained, thus avoiding GHG emissions).
2	**De Doorbraak (NL)**	After a damaging flood in 1998, improving water management in the river basin of the river Regge became a priority of the regional water board. In response, this project aimed to reconnect the Regge with its catchment basin by constructing a 13 km long stream called De Doorbraak ("the breakthrough"). This would address the seasonal flooding and the droughts experienced in the summer as well as improve the quality of the separation of rural and urban water. The stream also addressed nature protection aims by serving as an ecological corridor, improving functionality between previously isolated core natural areas.	Adaptation & Mitigation: Construction of a 13km long stream establishing a very important part of a resilient water system.
3	**Augustenborg, Malmö: Retrofitting SUDS in an urban regeneration area (SE)**	Augustenborg, a highly populated neighbourhood in Malmö, was the target of this project after having experienced socio-economic decline and floods from overflowing drainage. The key aim of the initiative was to create a more socially, economically, and environmentally sustainable neighbourhood by focusing on combating flooding, waste management and enhancing biodiversity. In order to minimise flood risk, a system was created to collect rainwater from rooftops and other impervious surfaces and channel it through canals, ditches, ponds and wetlands before finally draining into a traditional closed sub-surface storm water system (known as a "Sustainable Urban Drainage System" (SUDS)). Biodiversity was addressed through the creation of new wetland habitats.	Adaptation: Spatial planning, creating new green infrastructure components, increasing public awareness, ecosystem conservation, service enhancement (water flows), natural infrastructure conservation.
4	**Forest Rehabilitation in Krkonose and Sumava National Parks (CZ)**	Both the Šumava National Park (NP) and Krkonoše NP have suffered severe deterioration of the tree canopy due to industrial emissions/acid rain and inadequate forest management over the past century. Furthermore, while tourism is the main source of prosperity for local inhabitants of the Krkonoše Mountains, it has created sever problems as a result of the excessive number of visitors. The project aimed to find a balance in both NPs between the preservation of valuable forests and the promotion of economic prosperity in remote areas. Thus, reforestation and rehabilitation activities were undertaken to address areas affected by emissions, wind storms and bark-beetle population booms. Specifically, replanting aimed to diversify tree species and stabilise the degraded ecosystems. In doing this, CO_2 was sequestered and awareness in the region about the driving issues was increased.	Adaptation & Mitigation: Habitat restoration and biodiversity conservation; forest restoration; increase in water retention capability; stabilization of degraded ecosystems; sequestration of CO_2; knowledge generation and awareness raising.

	Case studies	Project Description	Measures taken for adaptation/mitigation
5	**Wallasea Island: Wild Coast Project (UK)**	Wallasea Island was re-claimed from the ocean over 400 years ago and converted to agricultural land. 'Grey' infrastructure flood defences were constructed, but have recently been found to no longer be economically viable. This makes continued public expenditures unlikely and puts the surrounding 12,100 ha floodplain at risk. The aim of the project is thus to combat the threats from climate change and coastal flooding by restoring the wetland landscape of mudflats and altmarsh, lagoons and pasture. It will also help to offset the historical losses of such coastal habitats elsewhere in England and address the ongoing regional flood risks.	Adaptation & Mitigation: Habitat creation/compensation (mudflats; lagoons; salt marshes; coastal grazing marshes; saline lagoons; rotational arable fields). Flood protection (2 Mio m^3 water to enter and leave on higher (i.e. 'spring') tides).

To ensure that the case studies are conducted in a comparative manner and to address all relevant research questions (see 2.3), a case study guidance document has been prepared. The following topics are covered in the document in the form of questions, which were addressed by case study interviewees:

1. **Project overview**
2. **Understanding of ecosystem-based approaches and barriers**
3. **Implementation**
4. **Funding and costs**
5. **Benefits**
6. **Awareness**
7. **Monitoring**
8. **Lessons learned and outlook to future action**

These topics shaped the questions posed to interviewees as well as the data sought through the document analysis. The framework enabled a more direct and robust comparison of case studies.

Interviews with EC officials

Significant resources, programmes and instruments exist at EU level which can contribute to driving the design and implementation of ecosystem-based approaches within Member States. A variety of factors, however, influence the extent to which momentum has built behind the embedding of ecosystem-based approaches in European policies, funding schemes, and international negotiating positions (such as those associated with the United Nations Framework Convention on Climate Change). These factors include the level of awareness of ecosystem-based approaches, organizational structure within the European Commission, multi-level interactions between local authorities, Member States and the EC, and a variety of other factors – each of which are explored in more detail in Section 4.5.

In order to assess the barriers and opportunities associated with ecosystem-based approaches at the European level, a small number of interviews were carried out with individuals holding key positions in relevant Directorates General. Ultimately, individuals were interviewed with DG Environment, DG Climate Action, DG Regional Policy, DG Development and Cooperation - EuropeAid, DG Health and Consumers, and the European Topic Centre on Biological Diversity. Interviews followed a semi-structured format and basic script, which

elicited information regarding awareness and understanding of ecosystem-based approaches, European-level policy and other tools that might facilitate uptake, and barriers by both Directorates General as well as Member States.

2.4 Analytical Framework

In order gain a better understanding of the role and potential of ecosystem-based approaches to climate change adaptation and mitigation in Europe, the project adopted a two-fold approach drawing on the analysis of i) EU policy documents (covering a wide range of sectors) and National Adaptation strategies and ii) in-depth case studies and a database of projects using ecosystem-based approaches. Following the objectives of the project[28], different research questions were defined which served as the foundation for the development of the project database, the case study guidance document, the screening of policies and strategies and the interviews with officials from the European Commission. The issues addressed by these guiding questions as well as their place within the overarching analytical framework of the project are outlined in Figure 2.

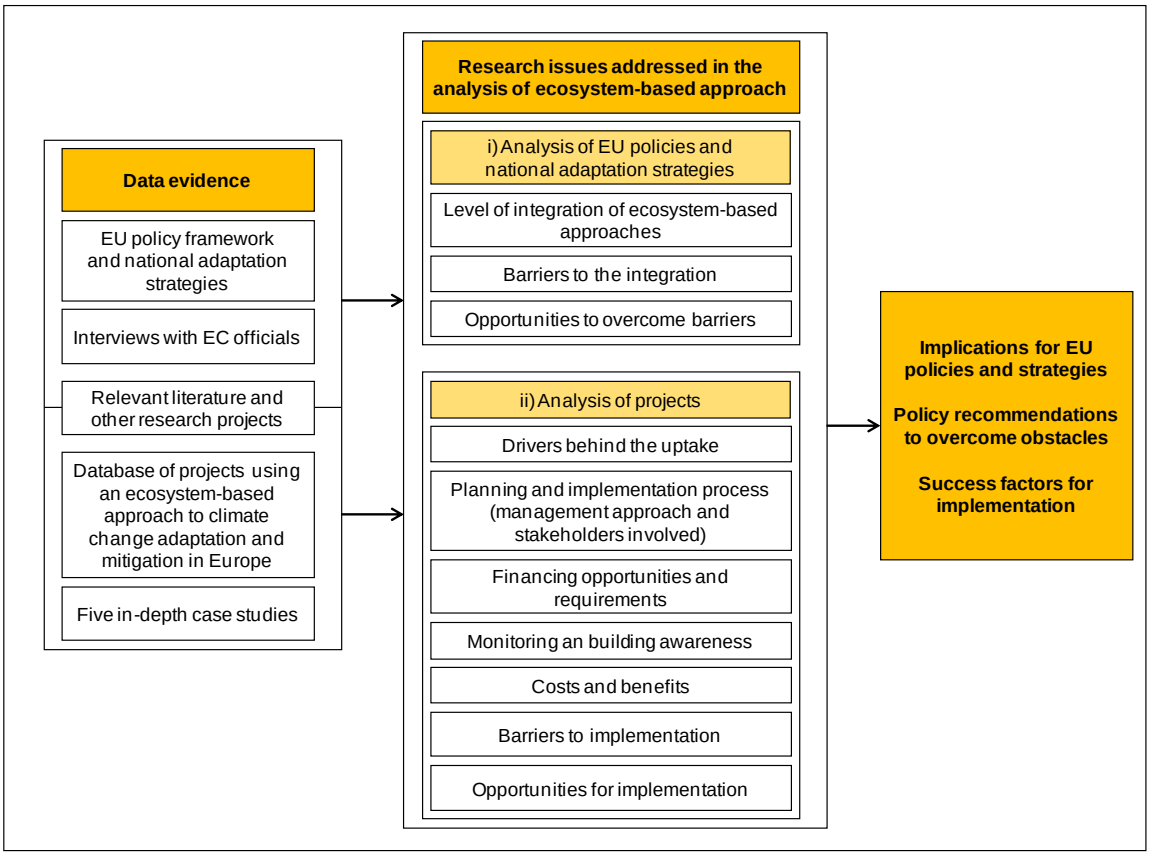


Figure 2: Analytical framework of the project

[28] i) To take stock of current examples of working with nature - ecosystem-based approaches to climate change mitigation and adaptation in Europe; ii) to screen adaptation strategies on local, regional, national and transnational levels in Europe and assess to what extent these adaptation strategies consider ecosystem-based approaches; iii) to identify the obstacles that prevent integration and elaborate recommendations on how to overcome those obstacles; iv) to Identify success factors enhancing the integration of ecosystem-based

The results of this analysis will shed light on the factors leading to and obstacles hindering the successful implementation of ecosystem-based approaches in climate change programmes on local, regional, national and transnational levels and provide appropriate recommendations to overcome existing obstacles. More specifically, the results will reveal the implications for policies and subsequently provide recommendations in order to strengthen and promote the integration of ecosystem-based approaches at different spatial levels and increase the uptake of ecosystem-based approaches to tackle climate change and other environmental challenges. Thus, the project will also contribute to the implementation of the EU 2020 Biodiversity Policy and in particular to the planned EU Green Infrastructure strategy.

In this context, it is crucial to raise awareness of the multiple benefits provided by ecosystem-based approaches among all relevant policy sectors and stakeholders, to outline the solutions to overcome existing barriers to the integration and implementation of such approaches and to highlight opportunities for future policy action.

approaches and good practice examples; and v) to conduct a cost-benefits analysis of selected case studies (to assess their costs/ cost-effectiveness) and compare results to costs of traditional engineered approaches

3 Spectrum of projects using ecosystem-based approaches

As mentioned in the previous section, a project database was constructed in order to collect and categorize an array of samples portraying the various ecosystem-based approaches. As shown in Table 1, the framework which serves as a basis for the project database consists of a wide range of parameters through which each of the 161 projects[29] were analysed in detail. This allowed for the identification of specific characteristics, which linked the reviewed projects to the concepts of ecosystem-based approaches and green infrastructure, as well as to climate change adaptation and mitigation issues (also see 2.2).

The sections below offer details about the objectives addressed, sectors targeted, ecosystems/habitats covered and actions/measures implemented as a result of the analysis of the project database.

Objectives addressed

In order to conduct a detailed classification of the projects analysed in this study, each objective mentioned in the project descriptions was noted. Main or primary objectives were differentiated from secondary ones to allow for further distinction and to refrain from a classification based exclusively on the projects' adaptation and mitigation goals. However, it must be noted that the various objectives are nevertheless related. In general, the primary objectives of the projects analysed in this study can be classified into three main categories: climate change adaptation, climate change mitigation and nature/biodiversity conservation (following the overall scope of this study). As expected from the nature of this study, almost all of the projects analysed relate their objectives to the first two categories (see Figure 3 below). The few which do not fall under this classification were still included since they serve as useful examples of the application of ecosystem-based approaches in other contexts, such as biodiversity conservation which was, also unsurprisingly, a common objective amongst the reviewed initiatives.

The initiative *Coastal Futures - Humber Community Project* (UK)[30], for example, applied measures like managed realignment, habitat restoration and creation of flood storage sites to adapt to coastal change. The project combined traditional and ecosystem-based approaches to protect the local community along the north bank of the Humber Estuary from flooding and sea level rise caused by climate change. The project's combination of engineered and ecosystem-based solutions allowed for a more viable and cost-effective scenario. In this context, another good example of an initiative combining climate change with biodiversity conservation and other secondary objectives is the project *De Doorbraak* (NL). This is an effort by the Water Board Regge and Dinkel whose objective is to increase the capacity of adaptation to climate change and to restore natural habitats that have been lost through

[29] The European Member States most active in the application of ecosystem-based approaches, according to the number of projects in place or planned in their territories were the UK and Germany, with 59 and 36 projects, respectively. Multi-national cooperation was also common, with a total of 22 projects in this category.

[30] http://www.coastalfutures.org.uk/humber.html

years of anthropomorphic pressures on nature. By reconnecting the river Regge to its original catchment basin, the project will reduce the vulnerability of the region to flood and drought and serve as a connectivity feature joining habitats that have long been detached. A detailed in-depth analysis of this project was conducted as part of this study.

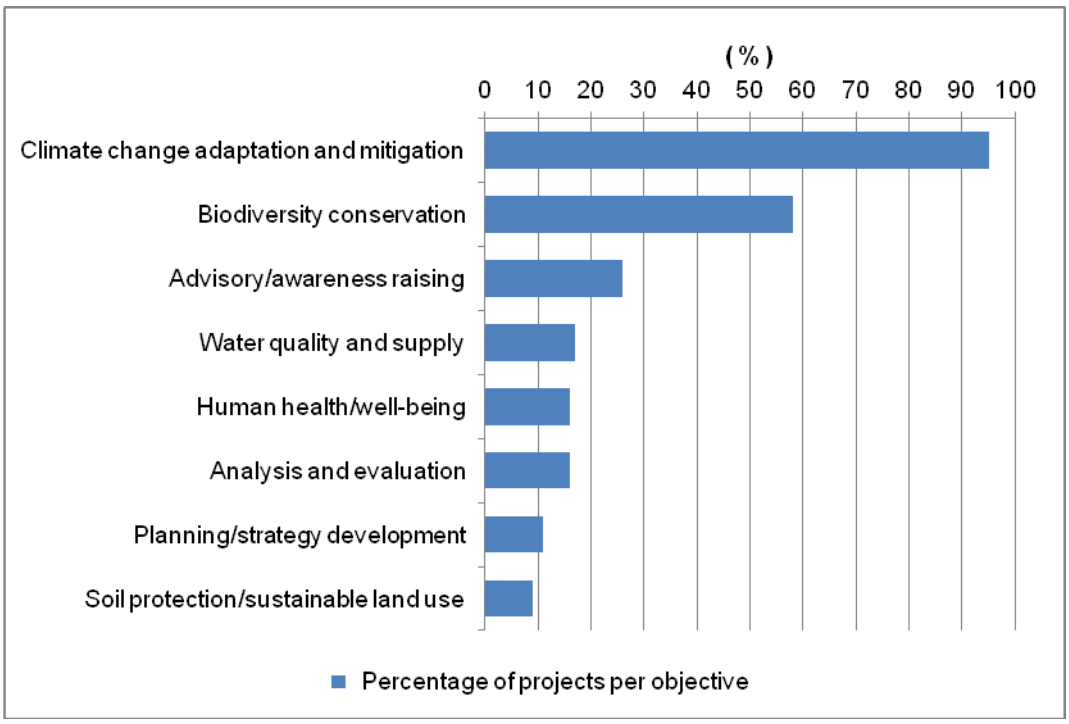


Figure 3: Project objectives

The following table shows the three main categories of project objectives; specific examples extracted from the five case studies conducted in this project serve as illustrations.

Table 4: Main objectives of the case study projects

Project	Climate change adaptation objective	Climate change mitigation objective	Biodiversity conservation objective
Restoring Peatlands (BY)	n/a	Increase carbon storage capacity and reduce CO_2 emissions	Increase the number and abundance of wetland species
Wallasea Island: Wild Coast (UK)	Addressing flood protection risks	Transforming the island into a net carbon sink rather than a source of carbon (secondary objective)	Offset historical losses of coastal habitats
De Doorbraak (NL)	Flood prevention / security / drought protection	n/a	Creation of an ecological corridor
Augustenborg, Malmö: Retrofitting SUDS (SE)	Flood management	n/a	Local species enhancement
Forest Rehabilitation in Krkonose and Sumava NP (CZ)	Sustainable forest management	CO_2-sequestration through reforestation of clear cuts	• Restoration of forest ecosystems • Reestablishment of natural species composition • Reestablishment of understory vegetation

Source: Own elaboration.

Ecosystems/habitats addressed

Among the wide range of habitats and ecosystems covered by the climate change and nature conservation projects analysed, the most frequently addressed were wetlands (including peatlands), forests, rivers and arable areas (see Figure 4). Considering that these habitats are commonly associated with primary sectors like agriculture, forestry, fishery and at times tourism, this could propose a line of action aiming to protect the economic activities under the aforementioned sectors from the harmful effects of climate change and biodiversity loss. A project in which this relation can be observed is *the Danube Islands* (BG)[31]. In this project, the values of the goods and services provided by the ecosystems present in the Danube Islands were assessed, leading to findings demonstrating that the conservation of these ecosystems will have a positive effect on the tourism and fishing sectors of the area while contributing to both adaptation and mitigation through flood protection, erosion prevention and carbon sequestration. Another illustrative project is the *West European Climate Corridor (NL)*[32] which was used as a strategy for climate change adaptation in the Rhine basin. Through the re-naturalisation of river systems (including the adaptation of forests to climate change), retention areas storing water for dry periods and new habitats for wildlife were created. These areas also help to reduce soil erosion on slopes and support the dispersal of species.

[31] http://ec.europa.eu/ourcoast/index.cfm?menuID=8&articleID=13
[32] http://www.gelderland.nl/smartsite.dws?id=3442

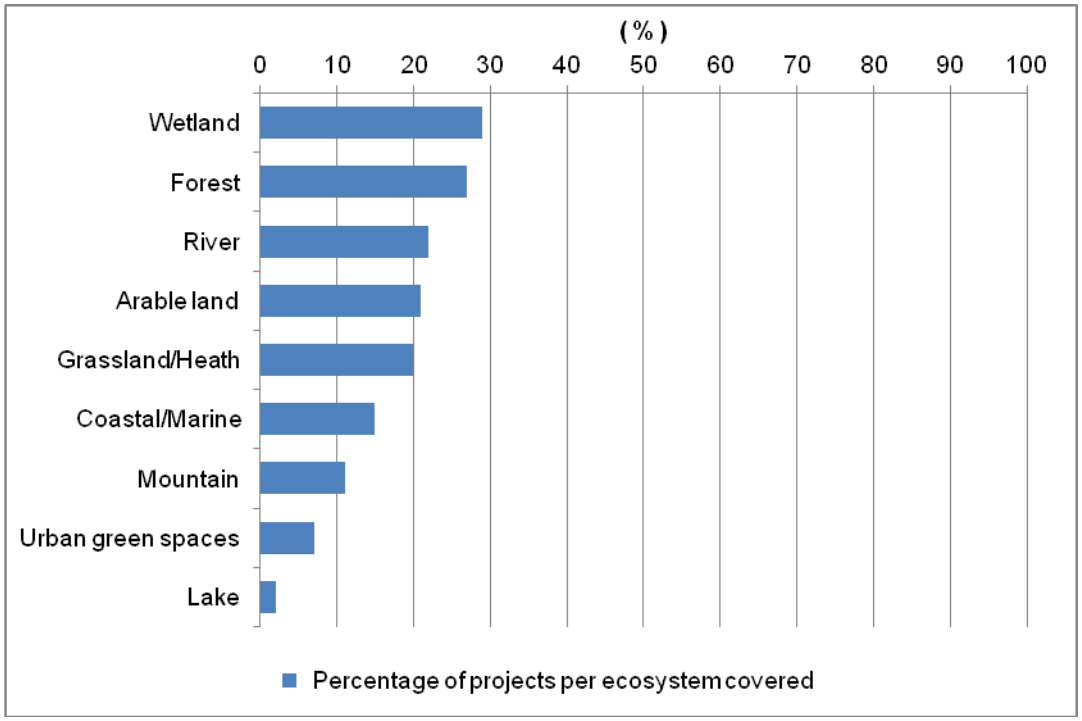


Figure 4: Ecosystem/habitat addressed by the projects

Sectors targeted

During the characterisation of the projects, it was found that these studies commonly target not only a single specific sector, but several at a time. There were frequently projects, which aimed to address issues that were common to more than one sector. This has given way to the advance of integrated strategies designed to engage climate change in specific ecosystems, e.g. coastal ecosystems, aquatic ecosystems. For instance, an initiative adopted in the agriculture or water sector could often be related to or have an effect on the forestry, nature protection or regional planning sectors. This can be illustrated for example by the *Parrett Catchment Project* (UK)[33] in its initiative to reverse arable land to woodland. This means that areas in or adjacent to the river catchment that are currently managed under an intensive arable crop regime will be converted to woodlands in order to inter alia protect them from flooding and decrease runoff.

In analysing the mix of sectors targeted by the reviewed projects (Figure 5), nature protection and the water sector were found to be the most commonly addressed areas by a substantial margin. This information sheds light on the areas in which ecosystem-based approaches have not yet been applied at a large scale; these less targeted areas include the transport and health sectors.

An important consideration is that although some sectors might not be explicitly addressed by the projects, i.e. they are not mentioned in the project description or in the reports, they may produce collateral and secondary effects, which affect these unlisted sectors. For example, urban green spaces contribute to the health of the people living and working in

[33] http://www.parrettcatchment.info/

these communities. Initiatives like the *Healthy Parks Healthy People* congress have engaged in exploring the links between green areas and a healthy society as well as the multiple benefits provided by parks and nature.[34] The creation of urban green spaces as well as other ongoing adaptation activities in numerous cities can be classified as ecosystem-based approaches.

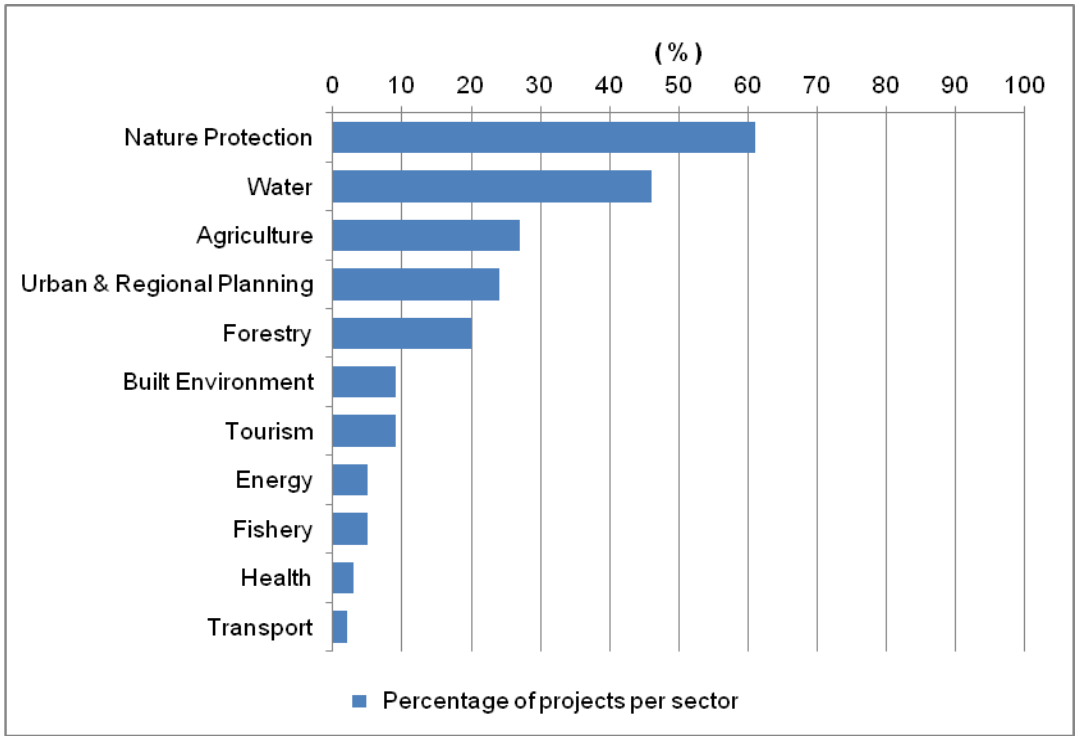


Figure 5: Sectors targeted by the projects

Ecosystem-based adaptation and ecosystem-based mitigation

Dividing the projects collected in the database according to the implementation or proposal of measures for adaptation and/or mitigation shows that the vast majority aim towards adaptation objectives. This is partly due to the inclusion of two regional climate change programmes (Bavaria and Brandenburg, Germany), which encompassed projects focusing on various sectors, but almost exclusively on adaptation measures (i.e. 18 out of 19 projects included adaptation measures). However, even when excluding these two programmes, the difference between the mitigation and adaptation is highly significant. In total, 153 of the 161 projects[35] in the database were linked to one or both of the approaches to climate change. Out of these 153 projects, 109 were found to implement measures exclusively for adaptation, while only 15 were doing so exclusively for mitigation. The remaining 29 projects applied measures simultaneously for both. It should be kept in mind, however, that any increase in vegetation cover makes a contribution to mitigation through CO_2 sequestration via photosynthesis. Although perceived as small or negligible on a case-by-case basis, the

[34] http://www.healthyparkshealthypeoplecongress.org/

[35] Eight projects in the database do not target climate change issues, however, as mentioned earlier, they were identified as appropriate examples of the application of ecosystem-based approaches in a different context

accumulated effect that could be achieved from the greening of urban areas – should it become a priority in all cities and megacities worldwide – would certainly constitute a significant contribution to the overall mitigation effort while providing multiple benefits including cooling, avoidance of the heat islands effect, provision of space for nature, jobs and business opportunities and contribution to health and energy efficiency.

Measures addressing climate change adaptation and mitigation whilst also adopting an ecosystem-based approach can be manifold and serve as a useful illustration of how the different sectors can contribute to promoting ecosystem-based approaches. The following table provides an overview of EbA/EbM measures, which can be assigned to the different sectors. As all measures listed contribute to tackling climate change; climate is not considered as a separate sector.

Table 5: Measures linked with EbA and EbM, categorized by sector

Sector	Relevant measures linked with ecosystem-based adaptation (EbA) and ecosystem-based mitigation (EbM)
Agriculture	• Land use zoning • Habitat protection for water regulation • Protection of key species (e.g. pollinators) • Conversion/reversion of arable land to grassland or forest • Maintaining genetic diversity • Consistency between crops produced and the local natural environment • Rain fed water harvesting techniques • Sustainable management techniques for crops and soil • Application of no/low-tillage cultivation, crop rotation, agro-forestry • Soil moisture conservation practices (e.g. incorporating green manure into the soil or provide some degree of surface cover for the soil by mulches or by tillage practices that leave plant residues on the soil surface in water-scarce ecosystems)
Built Environment	• Construction of more energy efficient buildings • Installation of hard defence structures (e.g. sea walls to buffer against coastal flooding) • Reduction of impermeable surfaces • Installation of green roofs and vertical gardens • Use of ecosystem-consistent materials (e.g. barriers for water retention in wetlands constructed with wood and peat from the site instead of concrete)
Urban and regional planning	• Land use zoning • Increase use of green infrastructure and spaces (e.g. green roofs, urban tree planting, parks/recreational areas, green belts) • Increase blue infrastructure and spaces (lakes and ponds) • Increase soil infiltration in parks, parking lots and green curbs
Energy	• Implementation of renewable energy policies to reduce GHG emissions • Encourage energy efficient behaviour to reduce public energy demand for fossil fuels • Enhance use of energy sources restoring biodiversity (e.g. coppicing/wood fuel) • Implement sustainable criteria for biofuels and bio-energy
Fishery	• Sustainable management of fisheries and avoidance of overfishing • Integrated river basin management

Sector	Relevant measures linked with ecosystem-based adaptation (EbA) and ecosystem-based mitigation (EbM)
Forestry	• Forest conservation, restoration, reforestation • Protection of watershed forests • Sustainable forest management (sequestration of carbon) • Evaluation of the protective characteristics of forests
Health	• Support creation of green spaces in cities to reduce the urban heat island effect • Plant urban trees to improve air quality • Support and marketing of organic food products
Tourism	• Enhance eco-tourism and sustainable nature tourism • Increased green area for recreation
Transport	• Maintain ecological connectivity in constructing grey infrastructure (via e.g. green bridges or tunnels)
Water	• River and floodplain renaturation/restoration • Restore canals to more natural meandering rivers • Dyke relocation • Habitat restoration, creation or protection • Watershed management • Dune restoration; sand nourishment (coastal zones) • Rain fed water harvesting techniques • Habitat protection for water regulation
Coastal defence	• Maintenance and restoration of mangrove forest (EU Outermost Regions and Overseas Countries and Territories include a number of small island states in the three oceans - Indian, Pacific and Caribbean) • Implementation and use of Integrated Coastal Zone Management (ICZM) principles and tools (e.g. managing impacts of climate change and safeguarding resilience of coasts/coastal systems; preparing for, preventing and managing natural hazards and technological (human-made) hazards; and integrating coherent strategies covering the risk-dimension (prevention to response) into planning and investment[36])
Biodiversity	• Land use zoning • Protection of key species (e.g. pollinators) • Conversion/reversion of arable land to grassland or forest • Maintaining genetic diversity • Consistency between crops produced and the local natural environment • Sustainable management techniques for crops and soil • Application of no/low-tillage cultivation, crop rotation, agro-forestry • Removal of alien/invasive species
General	• Installation of hard defence structures (e.g. sea walls to buffer against coastal flooding) • Reduction of impermeable surfaces • Use of ecosystem-consistent materials

Source: own elaboration and adapted in part from Doswald and Osti (2011)

[36] http://marine-team.eucc-d.de/iczm.html

Actions implemented

As can be seen in Figure 6, activities consisting of ecosystem conservation and restoration, maintenance of natural areas and enhancement of ecosystem services are the most commonly planned and implemented. The creation of new green infrastructure elements also emerged as a common measure employed by the projects in the database. Furthermore, although benchmarking and awareness-raising activities are not generally regarded as the principal actions in which the projects engage, they appear frequently as secondary or complementary measures. The project *Restoring Peatlands and Applying Concepts for Sustainable Management in Belarus* (BY)[37], for example, describes a useful approach to the restoration of degraded ecosystems. It considers not only biodiversity and habitat conservation through the re-wetting of peatlands, but also the mitigation of climate change by increasing the area's capacity for storing carbon and reducing CO_2 emissions from drained peatlands. One of the results of this project has been the adoption of a standard for Peatland Rewetting and Conservation (PRC). This makes it possible to sell carbon credits for the reduced CO_2 emissions on the voluntary carbon market. The profits gained are envisioned to be directly reinvested in further rewetting projects. This initiative demonstrates that the sustainability of such an approach is viable and replication is already being considered in countries like the Ukraine, Poland and Ireland.

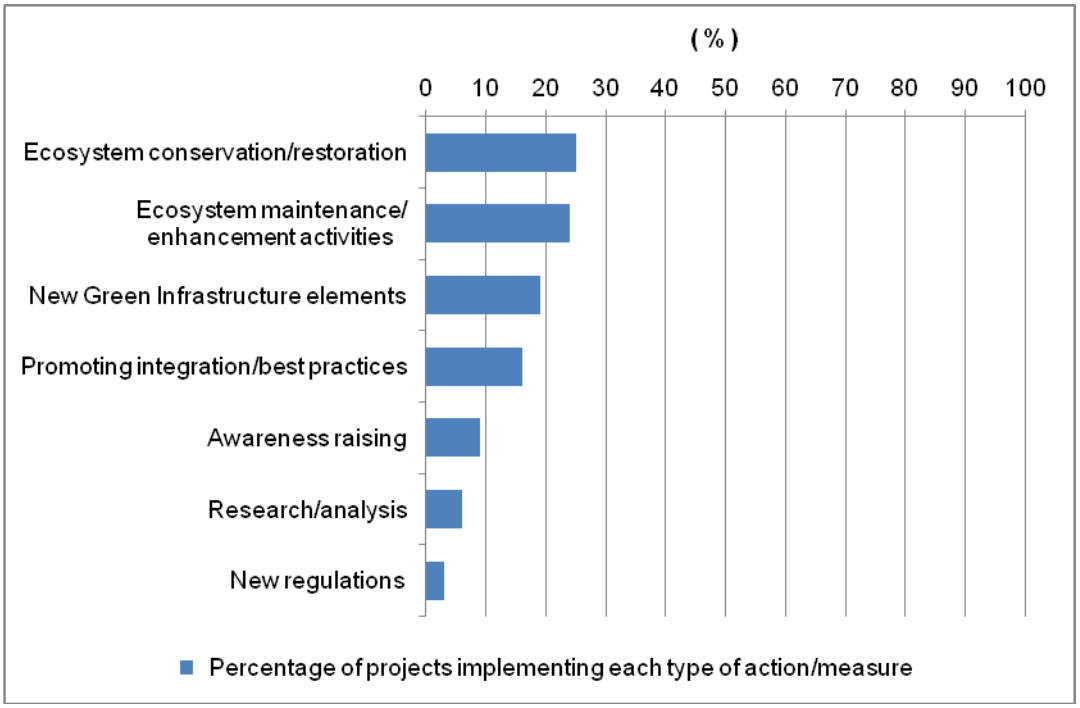


Figure 6: Actions/measures adopted

[37] http://restoringpeatlands.org/index.php?option=com_content&view=article&id=47&Itemid=28&lang=en

4 Integration of ecosystem-based approaches into EU policies and national adaptation strategies

The potential of ecosystem-based approaches for addressing the mitigation of and adaption to climate change has been regularly cited in the last decade within the literature and reflected in numerous policies and decisions of the European Union.

In the first phase of the project, examples of the development and use of ecosystem-based approaches to climate change mitigation and adaptation in Europe were collated into a database. In a next step, the extent to which ecosystem-based approaches to adaptation and mitigation have been incorporated into local, regional, national and transnational levels in Europe has been assessed. This was done by examining EU[38] and sectoral policies[39] and selected National Adaptation Strategies (NAS)[40] for mention and evidence of mitigation and adaptation actions. The full list of documents reviewed under this task is given in Annex A.

The adaptation actions and mitigation were assessed according to their aims. The categories used are listed in Table 6 below. Annex B gives an overview of the detailed actions that can be taken within the adaptation categories. These were developed as biodiversity adaptation principles for the UK, but can also be more generally applied to ecosystem-based adaptation actions.

Table 6: Adaptation and mitigation actions/measures[41]

Adaptation actions*	Mitigation actions
• Maintaining and increasing ecological resilience; • Accommodating change; • Developing knowledge and planning strategically; • Integrating across all sectors; • Taking practical action now	• Maintaining existing stock; • Decreasing greenhouse gas emissions through demand reduction; • Decreasing greenhouse gas emissions through supply reduction or increase carbon storage • Increase carbon storage

**Source: Adaptation actions were classified based on those of Smithers et al. (2008)*

The following sections highlight ecosystem-based actions in the documents analysed and provides some interpretation of the reasons for actions or the lack of them.

[38] White paper: Adapting to Climate Change – Towards a European Framework for Action (COM(2009) 147 final); Adapting to climate change: Towards a European framework for action: Impact assessment (SEC(2009)387)

[39] Including the following sectors: agriculture, built environment, energy, fishery, forestry, health, tourism, transport, urban and regional planning, water, biodiversity

[40] Belgium, France, Finland, UK, Germany, Portugal and evaluation reports

[41] Specific examples of ecosystem-based measures/actions can be found in Table 5.

4.1 EU Strategies

The EU, as exemplified by the White Paper on "Adapting to Climate Change - Towards a European Framework for Action (COM(2009) 147 final)", has a strong commitment to climate change adaptation and mitigation - “Firstly, and importantly, we must reduce our greenhouse gas (GHG) emissions (i.e. take mitigation action) and secondly we must take adaptation action to deal with the unavoidable impacts.” (EU White Paper, 2009:33). It recognizes that “strategies focused on managing and conserving water, land and biological resources to maintain and restore healthy, effectively functioning and climate change-resilient ecosystems are one way to deal with the (climate) impact” … and that “working with nature’s capacity to absorb or control impact in urban and rural areas can be a more efficient way of adapting than simply focusing on physical infrastructure” (EU White Paper, 2009:5). Thus it provides leverage for the development and implementation of ecosystem-based approaches to climate change adaptation and mitigation, but it contains little specific mention of ecosystem-based actions or evidence of ecosystem-based adaptation and mitigation actions. There is, however an action point which encourages “strategies which increase the resilience to climate change of health, property and the productive functions of land, inter alia by improving the management of water resources and ecosystems” (EU White Paper, 2009: 5). In other documents, including Environment Council Conclusions and CBD COPX 33 on biodiversity and climate change, it is recognised that ecosystem-based approaches and green infrastructure often provide multiple benefits, including both adaptation and mitigation. The EU Biodiversity Strategy up to 2020 (COM(2011)244) states that "ecosystem-based approaches to climate change mitigation and adaptation can offer cost-effective alternatives to technological solutions, while delivering multiple benefits beyond biodiversity conservation".

More detail on adaptation approaches and options is provided in the Impact Assessment (SEC(2009) 387), which accompanies the White Paper. It suggests that “in terms of adaptation approaches, choices have to be made about how to pursue adaptation policy further, and what should be the adaptation measures that should be either promoted or prevented.” (EU White Paper, Impact Assessment, 2009:29). Three broad categories of adaptation are identified: “grey” infrastructure, “green” structure and “soft” on-structural approaches. The “Green” infrastructure approach, it suggests, helps increase ecosystem resilience and reduce biodiversity loss, while using ecosystem functions and services to achieve more cost-effective and sometimes more feasible adaptation solutions than those based on “grey” infrastructure. It also includes examples which are ecosystem-based approaches, e.g., using trees to cool urban areas, managing wetlands to allow them to adapt, but also providing flood management, and improving soil infiltration and water retention to aid groundwater recharge and surface water resources to allow greater development of vegetation for tackling climate risks, such as floods, droughts and heat waves.

Of the five adaptation principles, maintain and increase ecological resilience, accommodate change and develop knowledge and plan strategically were evident in both the White Paper and Impact Assessment, while the other two (integrating across all sectors and take practical action now) were only explicitly evident in the Impact Assessment. Examples of acknowledgement of specific actions are given in Box 2.

Box 2: Examples of adaptation actions from the White Paper (WP) and Impact Assessment (IA)

Maintain and increase ecological resilience

- Conserve range and ecological variability of species - measures to maintain diversity in and increase connectivity between nature conservation sites are necessary (IA)
- Maintain existing ecological networks - the impact of climate change must also be factored into the management of Natura 2000 to ensure the diversity of and connectivity between natural areas and to allow for species migration and survival when climate conditions change (WP).

Accommodate change

- Make space for the natural development of rivers - enabling plants and animals to survive and helping wetland-dependent communities to adapt to climate change, while at the same time providing through wetlands and salt marshes for natural barriers that allow managing increasing water flow, floods and storms over large areas (IA).
- Develop the capacity of institutions to cope with change – WP mentions Guidelines, governance and co-ordination an EU action option (p36) also capacity building (p40).

Develop knowledge and plan strategically

- Undertake vulnerability assessments of biodiversity: Work is already ongoing at DG Environment to assess the feasibility and provide options for the design of a (set of) vulnerability indicator(s) (WP and IA).
- Identify potential (cross-sectoral) win-win solutions - use the functions and services provided by ecosystems to achieve a more costs effective and sometimes more feasible adaptation solutions (IA).
- Monitor actual impacts of climate change - The proposed system for monitoring and reporting on climate change impacts will help in gathering further knowledge irrespective of the impacts of climate change (WP and IA).

Integrate across all sectors

- Integrate adaptation & mitigation measures - need to exploit the synergies between mitigation and adaptation efforts (IA).
- Build and strengthen partnerships - …many regions would benefit from assistance for capacity building and best practice sharing (IA).
- Raise awareness of benefits of the natural environment to society - Communication / Awareness raising/ Capacity building - an EU action option (IA).

Take practical action now

- Conserve existing biodiversity - The maintenance of biodiversity and ecosystems is essential for both ensuring their resilience to climate change impact and allowing the provision of ecosystem-based services (IA).

Despite the focus on adaptation in the White Paper and Impact Assessment, there is a good linkage through to mitigation, with the latter stating that "priority should be given to measures that are beneficial for both mitigation and adaptation". There is acknowledgment of the need to protect existing carbon stores in soils and forest and the potential of reforestation and afforestation to contribute to emissions reduction. Renewables are also identified in the Impact Assessment as a means of emissions reductions, but no indication is given of whether this would involve biomass.

The term ecosystem-based approaches to climate change is not used in the White Paper and Impact Assessment, although there is mention of both the ecosystem approach/ecosystem-based adaptation in relation to the Common Fisheries Policy and actions to be implemented under the new integrated Maritime Policy (IP/07/1463). Also the

Impact Assessment does talk about ecosystem-based services (EU White Paper, Impact Assessment, 2009: 27[42]) and there is an implicit understanding of their importance.

4.2 National Strategies

As announced in the White Paper the European Commission has set up an Impact and Adaptation Steering Group (now called Adaptation Steering Group composed of representatives of Member States (MS) to assist MS in adaptation, to support cooperation on adaptation and to take the adaptation framework forward. This implies encouraging "the further development of National and Regional Adaptation Strategies with a view to considering mandatory adaptation strategies from 2012" (EU White Paper, 2009:15) and establishing a number of sectoral technical groups.

The Impact Assessment identified that "the impacts of climate change vary regionally and every country has its own national priorities, the national adaptation strategies focus upon sectors of particular relevance and different countries consider different sectors." (EU Impact Assessment: p20). At the same time there are some sectors, which hold importance in all reviewed strategies. **Water management** (in particular flood prevention), **land use/agriculture and ecosystems** are clearly considered to be a priority in the majority of strategies. Two diverging features are that biodiversity/ecosystems seems to be significantly more tackled in Northern Europe; whereas for Central Europe food production and security is the most targeted area. In all strategies, cross cutting themes are addressed, such as the need for awareness rising, the need for coordinated action at different levels and between MS and coordinated research.

Member States are in different stages of preparing, adopting and implementing their NAS.[43] The PEER report[44] (Swart et al., 2009) also identified that the NAS vary in their emphasis: for example water availability is stressed in southern European countries, whereas flood risk is a regularly discussed in central and northern Europe (Swart et al., 2009). The analysis in that report of countries, which had adopted NAS (namely Denmark, France, Finland, Germany, The Netherlands Spain and UK), therefore, reflected the national and socio-economic conditions of the specific countries to which they related, placing emphasis on dealing with the most relevant challenges. Other countries, including Austria, Belgium, Latvia, Portugal and Sweden were in different stages of preparing their NAS. All countries, however, have submitted information on their adaptation plans in their 4th National Communication to the UNFCCC (2005). These differences are likely to reflect their perceived importance of climate change adaptation.

The analysis has shown that the application of ecosystem-based approaches to tackle the effects of climate change and loss of biodiversity has been significantly more frequent in EU 15 (79%) than in EU 12 (21%). Of the countries included in the review, the UK and Germany

[42] "Conservation and Management of Natural resources: The maintenance of biodiversity and ecosystems is essential for both ensuring their resilience to climate change impact and allowing the provision of ecosystem-based services ("green infrastructure") as adaptation options alternative to "grey infrastructure". **Ecosystem-based services** provide often multiple benefits including mitigation."

[43] http://www.eea.europa.eu/themes/climate/national-adaptation-strategies

[44] Reviewing NAS from Denmark, Finland, Latvia, Germany, France, Spain, Portugal, The Netherlands, United Kingdom and Sweden

seemed to be the most active in the field of adaptation, although this may just be a factor of how the NAS for those specific countries were written. One of the factors affecting this balance could be the more advanced, specialized and demanding national strategies of the EU 15. When performing a broad overview of the National Adaptation Strategies (NAS) of EU 15, generally they stand out because of the high number of initiatives they encompass, not only at the national, but also at a regional level.[45] For instance, Germany and the UK have published approaches for their different regions (although for the former this may be due to federal structure of the country). When the same exercise was done with the new MS, their strategies appear to be much less elaborated and some have not been published yet (e.g. Cyprus and Slovenia[46]). From the literature review conducted during the study it is clear that recently efforts are being taken to promote best-practices and share knowledge with the new EU 12 MS. These actions may result in a tendency towards a more balanced share of projects in the future.

The review of NAS showed that a number of countries included examples of actions that could be considered as ecosystem-based (see later) but there was little mention of 'ecosystem-based approaches' being applied or built into planning processes and it was therefore not possible to assess the level of understanding about the importance of applying ecosystem-based approaches. It was often difficult to distinguish whether particular actions were undertaken because they make good sense from a conservation perspective, or because they were part of a larger plan to apply an ecosystem-based approach. Overall there is currently hardly any discussion on ecosystem-based approaches in policy documents in Europe, whereas at the international level the number of reports on natural solutions and ecosystem based approaches and their multiple benefits is steadily growing.[47]

4.2.1 Ecosystem-based approaches to adaptation

All countries analysed except for Portugal included statements that show their acknowledgment of the inevitability of climate change. For example, the Finnish NAS includes an entire section on what changes are likely to occur as a result of climate change, and the strategy lists the research that is planned for climate change adaptation in the short, medium and long term. The strategy discusses the impacts and adaptation measures that are being/should be addressed in regard to each sector (e.g. water resources, forestry, agriculture, reindeer husbandry). The Belgian NAS outlines some of the research that has been done on the effects of climate change on biodiversity and states that changes have already been observed in certain ecosystems, with species attempting to adapt to them and/or to migrate north or to higher altitudes. Finally, the UK NAS outlined the MONARCH (Modelling Natural Resource Responses to Climate Change) programme[48], which was designed to assess the impact of projected climate change on wildlife in Britain and Ireland, and a Natural England project undertaken in 2009 to consider how well the existing network of sites of specific scientific interest (SSSIs) will be able to respond to natural processes and

[45] http://www.eea.europa.eu/themes/climate/national-adaptation-strategies

[46] The status of MS NAS can be found at http://www.eea.europa.eu/themes/climate/national-adaptation-strategies

[47] Including Report of the Environment Department of the World Bank: Convenient Solutions Ecosystem based approaches to climate change; UNEP: the Natural Fix; WWF et al: Natural Solutions, report by the CBD AHTEG on Biodiversity and Climate Change; several other CBD Technical Series reports and upcoming UNFCCC report

[48] http://www.eci.ox.ac.uk/research/biodiversity/monarch.php

climate change, stating that the project was to be developed into a full regional review in 2011/2012. The NAS also states that in the UK, the Department for Environment, Food and Rural Affairs (Defra) is encouraging other departments, public bodies and businesses to adapt to the effects of a changing climate through the Adapting to Climate Change Programme (ACC)[49], which is run by Defra.

Overall there was relatively little specific discussion of ecosystem-based approaches being applied. While half of countries advocated the use of ecosystem-based approaches (UK, Finland and Belgium), it was often difficult to see whether such approaches had either been applied or been the underlying driver in decisions made regarding which actions should be undertaken. However, the development and use of these approaches is ultimately what matters. In the UK the only mention of ecosystem-based approaches is that they will be applied – no justification of why was given. The Finnish NAS states that "The maintenance of the ability of ecosystems to function and recover and the management and restoration of habitats valuable to biodiversity, in addition to a sufficient network of protected areas, lay the foundation for the conservation of Finland's natural species and for the adaptation to climate change" (page 204). The Belgian NAS advocates managing water and land to protect natural systems and preserve vital ecosystems goods and functions. There was no dedicated discussion of ecosystem-based approaches in these NAS. What was clearer was the overlying aspiration to protect the natural world, for example, in the UK Defra states that it is essential to understand and capitalize on the crucial role played by the natural environment in planning a response to the economic and social challenges posed by climate change, and as such it commits to securing a diverse, healthy and resilient natural environment. But the link between ecosystem-based approaches and action actually undertaken on the ground was weaker.

Some adaptation measures, 'maintaining and increasing ecological resilience' and 'taking practical action now', actually involve biodiversity or ecosystem services and as such are inherently ecosystem-based. All countries included some discussion about measures being taken to 'maintain and increase ecological resilience' and half included discussions around what practical actions were being undertaken (Figure 7). Some examples of the aspirations towards maintaining and increasing ecological resilience seen in the NAS include the Belgian NAS, which states what should be done in order to improve the resilience of forest ecosystems, the priority set for the UK to enhance the resilience of ecosystems, and the German NAS, which outlines that in order to reduce fragmentation of natural systems and land take, a suitably prudent approach must be taken to settlement, infrastructure and transport planning, and appropriate measures must be taken alongside rivers and existing transport routes. Specific examples of actions undertaken in the UK include the active consideration by Natural England of how well the existing Sites of Special Scientific Interest (SSSI) network will be able to respond dynamically to natural processes and the predicted effects of climate change, and Forestry Commission's key objective to increase the resilience of trees, woods and forests to climate change. Only the NAS from the UK and Germany included any evidence that actions had been undertaken. The other NAS all included aspirational statements (we will, we should etc.) rather than specific evidence of action undertaken.

[49] http://www.ukcip.org.uk/government/central-government/acc/, http://www.defra.gov.uk/environment/climate/adapting/

While all countries could be seen to be applying ecosystem-based approaches to adaptation because they are either actively maintaining and increasing ecological resilience and taking practical action now or are at least planning to undertake actions falling into these categories, only the UK actually used the term 'ecosystem-based' and even in that case, the term was used only in an aspirational sense ("we will apply ecosystem based approaches") rather than in a practical sense. So while there is widespread use of ecosystems or biodiversity as a means of adapting to climate change, what is not yet coming through is that the action being taken is specifically part of a plan to adapt to climate change. For example, reducing fertilizer and pesticide use in agriculture is classified as 'taking practical action now', but this is being done because of the polluting and contaminating nature of fertilizers and pesticides, not because reducing this use will ultimately help us to adapt to climate change. Recognition of the multiple benefits that can be derived from ecosystem-based approaches may help to secure sustainable funding, in particular in times of economic crisis when environment budgets are often cut or reduced.

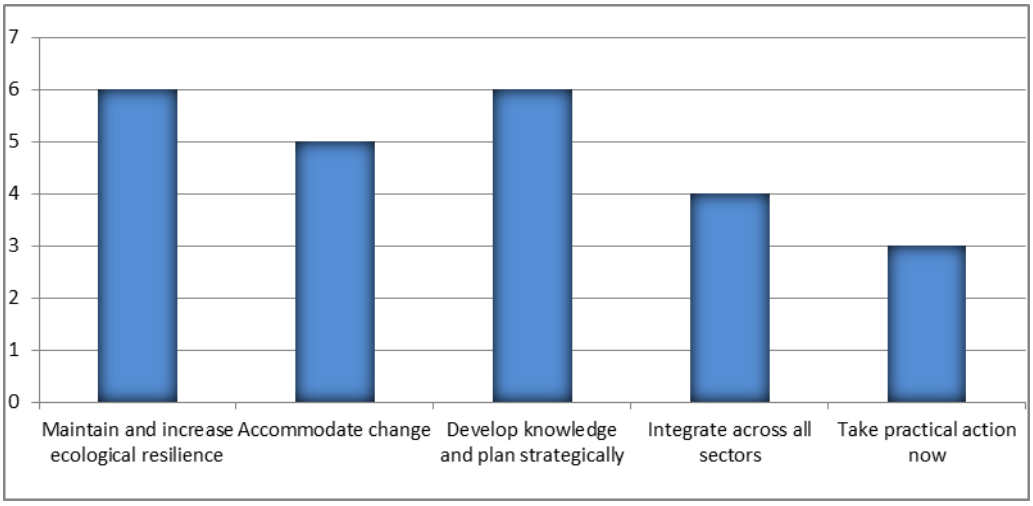


Figure 7: Number of countries mentioning the different types of adaptation actions/measures in reports (their NAS) (total number of reports analysed: six).

The most commonly mentioned adaptation measures in the NAS were 'developing knowledge and planning strategically' and 'maintain and increase ecological resilience'. It was noted that 'taking practical action now' was the measure discussed by the least number of countries. These results are as expected as the country NAS are meant to be more concerned with strategic issues rather than on the ground actions undertaken. However, there is also a possibility that the lack of mention of action being undertaken could be due to shortfalls in commitment levels and also to a lack of understanding and awareness of the urgency of the situation.

4.2.2 Ecosystem-based approaches to mitigation

At the country level, only half of the reports (UK, Belgium and Germany) mentioned mitigation actions. Of the NAS that did discuss or mention mitigation, there was no clear

picture of popularity with regard to the specific actions discussed as each action appeared in only two reports, and there were no two reports that covered the same actions.[50] The least discussed mitigation measure at the NAS level was 'increasing carbon storage'. The relative focus on mitigation activities that reduce emissions (through either demand-side or supply-side strategies) compared to carbon storage may be related to the dominant purpose (and authors) of the document. Policy and research documents that focus on mitigation often grow out of the dominant discourse in this field, which has been led by specialists in energy, engineering, and economics. As such, proposed mitigation solutions most often pertain to reducing emissions (i.e. through demand reduction or supply side shifts). Carbon storage as a key mitigation strategy may be more prevalent in documents focused on ecosystems or biodiversity as this is the most obvious mitigation co-benefit of ecosystem approaches.

On a national level there were considerably more discussions about adaptation measures than there were about mitigation. Perhaps this was because the focus of the NAS naturally is specifically on adaptation and often tackles technological approaches, which only contribute to adaptation, whereas the natural solutions often may address both adaptation and mitigation simultaneously.

As with adaptation measures, some mitigation measures are inherently ecosystem-based because of their use of ecosystems and biodiversity, including 'maintaining existing stock' and 'increasing carbon storage'. Half of the countries included in the review included one or both of these measures in their reports. Germany, Portugal and the UK have all increased woodlands, while in Belgium the agricultural strategy is to maintain carbon content of agricultural land. The German NAS also mentions the role played by protected areas in maintaining existing carbon stock.

Both the UK and Belgium included discussion about the reductions that they had made in their GHG emissions over time and the Belgian NAS stated that some of these reductions had been achieved by reducing livestock populations, changing some agricultural practices, restricting deforestation, encouraging reforestation and preserving the ecological stability of forests. These measures could be taken to be ecosystem based as changes of this sort are likely to be of benefit to natural ecosystems, but once again the lack of 'ecosystem-based' terminology makes it more difficult to make the connection between mitigation measures and ecosystem-based approaches. In all likelihood, some or all of these practices are occurring in other countries as well but they not have been mentioned in the NAS.

As for adaptation, it was often not possible to tell from the NAS whether ecosystem-based approaches were being used to drive practical actions undertaken by individual countries. One example where the aspiration of applying ecosystem-based approaches is outlined and then specific examples of actions taken to protect and restore biodiversity are given can be found in the Belgian NAS. Here, it is stated that "Ecosystem-based approaches represent potential triple-win measures: they contribute to preserving and restoring natural ecosystems, mitigating climate change by conserving or enhancing carbon stocks or by reducing emissions caused by ecosystem degradation and loss, and providing cost-effective protection against some of the threats that result from climate change. Protection and restoration of biodiversity are "low cost co-benefit" measures to reduce emissions." The NAS

[50] i.e. Country 1 covered issues A and B, Country 2 covered issues B and C and Country 3 covered issues A and C – none of these reports covered the same actions. In total four different actions were mentioned

goes on to outline the actions that have been undertaken to reduce GHG emissions, some of which should protect and restore biodiversity, such as reforestation and preservation of ecological sustainability of forests.

In the UK, a number of initiatives are discussed that will consider the importance of 'whole ecosystem' approaches to climate change adaptation and mitigation. These included the discussion document which was due from Defra in March 2010 that will build on work with stakeholders and partners to consider the importance of 'whole systems' approaches, the Lawton review "Making Space for Nature" (Lawton et al., 2010), which examined the extent to which the collection of UK sites represents a coherent and resilient ecological network capable of adapting to the challenge of climate change and other pressures and Natural England's Character and Quality of England's Landscapes (CQuEL) Project, which will measure changes in landscape character[51] and assess the quality of these places, as understood by the ecosystem service approach.

4.3 Sector Strategies

The White Paper also recognizes that a "strategic approach is needed to ensure that timely and effective adaptation measures are taken, ensuring coherency across different sectors and levels of governance." (EU White Paper, 2009: 3). It identifies sectors with strong EU policy involvement for which adaptation strategies are needed. Those mentioned in the paper, which are most relevant to ecosystem-based approaches are agriculture, urban development and physical infrastructure, forestry, biodiversity, water and coastal and marine areas, but little detail is provided here or in the Impact Assessment as to particular approaches and how they might be employed. To gain further insight, documents from the key sectors: agriculture, energy, forestry, water, urban and regional planning were examined. These sectors were chosen because of their potential/actual interaction with biodiversity and ecosystem services, as well as ones identified through the analysis of the project databases (see Section 3) with fewer examples for using ecosystem-based approaches, such as transport and health. A full list of sectors and documents analysed is given in Annex A.

Specific projects that were assessed as part of this study often targeted not only a single sector, but several at a time. Thus, integrated strategies have often been designed to engage climate change in specific ecosystems, such as coastal or aquatic ecosystems. For instance, an initiative adopted in the agriculture or water sector could often be related or have an effect on forestry, nature protection or regional planning.

4.3.1 Ecosystem-based approaches to adaptation

On the whole, all sector documents that were reviewed discussed some kind of adaptation measures that were being/to be applied, although not all of these discussions were ecosystem-based (see 4.6). Table 7 shows the main types of adaptation measures discussed in these documents. Agriculture, water, biodiversity and urban/regional planning sectors included some mention of all of the adaptation actions. Where adaptation actions

[51] Landscape character is related to landscape attributes that people or stakeholders feel are central to defining the landscape character. These may include perceptual qualities, such as tranquility, and not just to specific physical features.

were discussed or mentioned, there was often little or no evidence that they had actually been implemented. In a recent study commissioned by Defra, a lack of a firm high-level directive to embed the adaptation principles was cited as the reason why few actions for climate change adaptation had been undertaken (Berry et al. 2011). This may also be true for work at the EU-level. The most commonly covered measure in sector documents was 'taking practical action now' (Table 7), with all sectors including some mention of what they were doing/intended to do in this regard. Many of the actions included within this measure are, however, also examples of good conservation practice, the importance of which has been highlighted through many arenas in recent years.

The least discussed adaptation measure at the sector level was 'integrating across all partners and sectors', with only four of the sectors reviewed mentioning this in some way (biodiversity, agriculture, urban/regional planning and water). This could be because the sector documents are specifically concerned with outlining measures to be undertaken in their own sectors. One can't help but wonder, however, whether there would be higher success if the sectors did outline how they do/could work together to achieve objectives. Examples where integration was discussed can be found in Germany, where the site selection strategy for energy crops takes into account sensitive biotopes and protected areas. In addition the Water Framework Directive specifically recognises the need for integration of its objectives across different sectors and policy areas, e.g. agriculture, energy, fisheries, regional policy, tourism, transport. The lack of integration has been identified as an obstacle for coherent and efficient implementation on different levels from local, national, EU to international levels, with the EU documents. Where there are legislative or practical requirements action has been taken to integrate the various sectors, but as where this is not specifically required, scare resources may force prioritization of actions specific to that individual sector, rather than building relationships across sectors or jurisdictions. Again, the conscious recognition of the multiple benefits from integrated approaches such as ecosystem-based approaches could foster integration.

Table 7: Sectors mentioning the different types of adaptation actions/measures in reports

Sectors	Types of adaptation actions/measures				
	Maintain and increase ecological resilience	Accommodating change	Developing knowledge and planning strategically	Integrating across all sectors	Taking practical action now
Biodiversity	✓	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓	✓
Built Environment					✓
Energy					✓
Fishery	✓	✓	✓		✓
Forestry					✓
Health					✓
Tourism					✓
Transport			✓		✓
Urban and Regional planning	✓	✓	✓	✓	✓
Water	✓	✓	✓	✓	✓
Total	**5**	**5**	**6**	**4**	**11**

The sector specific documents were more likely to discuss the ecosystem-based nature of items proposed than the country documents (regarding adaptation). Of the 15 sector documents reviewed, six of them contained an element of discussion about the ecosystem-based nature of the actions discussed. Although only six countries were included in this review, there were 14 documents reviewed under the country analysis because each country published both an NAS and an NC5 (Climate Change National Communication) and the Defra in the UK published two additional documents that were also reviewed. Of all these documents, only one included any mention of ecosystem-based approaches. As stated earlier, some adaptation measures actually involve biodiversity or ecosystem services and as such are inherently ecosystem-based. These include 'maintaining and increasing ecological resilience' and 'taking practical action now'. All of the sectors included discussion of one or both of these measures and therefore may all be regarded as using ecosystem-based approaches to adaptation. However, significantly fewer actually mention the term 'ecosystem-based' with regard to adaptation measures, with only five sectors (agriculture, fisheries, forestry, urban and regional planning, and water) outlining the ecosystem basis for their initiatives. Again, while there is widespread use of ecosystem services or biodiversity, it is unlikely that the actions to conserve biodiversity are actually being taken for the explicit purpose of climate change adaptation. However, this may change in the future. It is hoped that the recognition of the multiple benefits of ecosystem-based approaches will steadily increase. A number of sectoral documents included initiatives being undertaken that can be considered as ecosystem-based approaches (see Table 23 in Section 7.2). Examples include *inter alia* the agri-environment measures under the Rural Development Regulation (CAP), measures undertaken in the context of the Natura 2000 network and policies promoting sustainable land use practices in tourism.

There are also instances where ecosystem-based approaches are advocated, but little evidence of how it is implemented is given. For example, the Common Fisheries Policy and

the EU's new Integrated Maritime Policy both state that they are committed to ecosystem-based approaches, but there are not many examples in the policy documents on what ecosystem-based actions will be taken, except perhaps for the conservation of fish species and habitat. In addition, the EU Communication on tourism outlines that the sustainability of tourism covers a number of environmental aspects, including the responsible use of natural resources, taking account of the environmental impact of activities (production of waste, pressure on water, land and biodiversity, etc.), the use of 'clean' energy and protection of heritage and preservation of the natural and cultural integrity of destinations, but although these principles are largely reflected in tourism strategies introduced at national and regional level, there is little evidence of concrete actions being undertaken.

Where action is being taken, it is not always being consistently applied across Member States. For example, documentation reviewed for the UK suggested that work being done to reduce demand for greenhouse gas emissions included policies applied in agriculture, supply chain, environmental behavior, water supply and use, buildings (both domestic and business), transport and estates management while the same action in Belgium mentioned only agriculture, waste disposal and buildings. Again, these differences might be due to actual differences in performance on the ground or they might be due to differences in the levels of detail included in reports.

4.3.2 Ecosystem-based approaches to mitigation

Mitigation measures were mentioned or discussed in most but not all of the sectors, and not all of these discussions were specifically on ecosystem-based approaches (see 4.6). Not surprisingly, the energy sector documents contained the most information about mitigation measures, but did not specifically mention ecosystem-based approaches any more than the other sectors. The term 'ecosystem based' was not frequently used in the sector documents, though some sectors did include discussion on inherently ecosystem based approaches, which include seeking to maintain existing stock and increasing carbon storage. Although there was no mention of including ecosystem-based mitigation measures in the reports reviewed for fisheries, health or tourism, all the other sectors included at least one reference to mitigation measures. Table 8 shows the main mitigation measures discussed within the documents. The most commonly discussed mitigation measure was 'decreasing GHG emissions through demand reduction' (Table 8), which is perhaps not surprising since this is the measure that all sectors can actively participate in. More than half of the sectors mentioned this measure (agriculture, built environment, energy, forestry, transport, and urban and regional planning), and all of them used examples that were relevant to that specific sector. For example, the transport sector discussed reducing emissions from transport and the built environment discussed energy efficiency in buildings. The documents focusing on biodiversity specifically[52] only included maintaining existing carbon stock.

[52] See Annex A for more details

Table 8: Sectors mentioning the different types of adaptation actions/measures in reports

Sectors	Types of mitigation actions/measures			
	Maintaining existing carbon stock	Decreasing green house gas (GHG) emissions through demand reduction	Decreasing GHG emissions through supply reduction or increase carbon storage	Increase carbon storage
Biodiversity	✓			
Agriculture	✓	✓	✓	✓
Built Environment		✓		
Energy	✓	✓	✓	
Fishery				
Forestry	✓	✓		✓
Health				
Tourism				
Transport		✓		
Urban and Regional planning		✓	✓	✓
Water		✓	✓	✓
Total	**4**	**7**	**4**	**4**

Some mitigation measures are inherently ecosystem-based because of their use of ecosystems and biodiversity, including 'maintaining existing carbon stock' and 'increasing carbon storage'. Half of the sectors in the review, including agriculture, energy, forestry, urban and regional planning and water, included one or both of these measures in their reports. Sector specific actions included halting deforestation, preventing extensive grazing, injecting carbon dioxide into saline aquifers, promoting of green infrastructure and applying sustainable agricultural practices. The only sector to bring an "indirect" ecosystem-based slant to 'reducing GHG emissions by supply reduction' was energy, where the need to consider the impacts on biodiversity when promoting the growth of biofuels as an industry was discussed.

The Common Agricultural Policy (CAP) integrates renewable energy production as well as the reduction of GHG emissions by the adoption of resource efficiency measures. The legislative proposals for CAP post-2013 that were published in October 2011 indicate climate change mitigation and adaptation as key cross-cutting priorities for the agricultural sector and land management. The future CAP is foreseen to include a number of measures that will promote the exploitation of the sector's capacity to enhance carbon stocks through the application of sustainable management practices and other innovative measures (CAP Legislative Proposals, October 2011). Only few of the documents reviewed made any attempts to link discussions of these initiatives and measures to ecosystem based approaches. On the international level the progress is being made through the work towards a REDD+ mechanism and the green infrastructure initiative on EU level is a good opportunity to boost the development and use of ecosystem-based approaches to climate change adaptation and mitigation.

Although the role of the forest sector in climate mitigation was confirmed by the rules of the Kyoto Protocol agreed since the adoption of the Strategy, development of dedicated

measures for carbon sequestration, including afforestation and reforestation, has been slower than expected (Forest Strategy Communication[53]). So while some ecosystem-based approaches have been advocated, there is no evidence that they have been applied. The Forest Strategy Communication outlines that certification is a tool that encourages the sustainability of forest management and allows consumers to discriminate positively in favour of wood products originating from sustainably managed forests, and so far, certification has developed as a private sector, market-based tool, with limited regulatory intervention by public authorities. The requirement for certification could benefit the conservation and sustainable use of biodiversity and ecosystem services, but the documents do not make an explicit link between this and climate change adaptation/mitigation.

Mainstreaming adaptation

The White Paper recognizes that "Adaptation needs to be mainstreamed into EU policies" (EU White Paper, 2009, p8). It suggests that priority should be given "to adaptation measures that would generate net social and/or economic benefits irrespective of uncertainty in future forecasts (no-regret or win-win measures)….. and "to measures that are beneficial for both mitigation and adaptation" (EU White Paper, 2009: 8). Ecosystem-based approaches can often meet both these criteria, as can been seen by the examples from the database and from Table 9, and thus they represent key adaptation measures contributing to the achievement of EU policy objectives. The Impact Assessment does not specifically mention any ecosystem-based no-regrets measures, but under win-win, it includes creating or re-establishing flood plains or salt marshes for flood management and supporting conservation objectives.

Table 9: Examples of how ecosystem-based actions relate to adaptation principles (synergies between adaptation and mitigation are highlighted)

Ecosystem-based action	Adaptation principle	Mitigation principle
	Maintaining and increasing ecological resilience	
Restoration of forests, floodplains wetlands & peatlands	Conserve range and ecological variability of habitats/Establish ecological networks through habitat creation	Increased carbon storage
Alien species management	Take prompt action to control spread of invasive species	
Improve coastal protection infrastructure	Conserve range and ecological variability of habitats	Possible short-term maintenance of carbon stocks
	Accommodating change	
Soft coastal defences	Make space for the natural development of coasts	Could increase carbon storage
Wetland corridor creation to enhance resilience to climate change	Establish ecological networks through habitat creation	Could increase carbon storage
Manage transition from freshwater to brackish lagoon	Make space for the natural development of rivers	Could help maintain carbon stocks

[53] http://eur-lex.europa.eu/LexUriServ/site/en/com/2005/com2005_0084en01.pdf

Ecosystem-based action	Adaptation principle	Mitigation principle
	Taking practical action now	
Maintain or increase crop yield in drought incidences; reduce soil erosion from excessive water runoff	Reduce sources of harm not (directly) linked to climate	Could increase carbon storage
Raise spring lake water levels to reduce the risk of summer drought impacts	Conserve existing biodiversity	

4.4 Cross-sectoral issues

The Impact Assessment identifies a number of synergies and trade-offs with mitigation, including measures which are beneficial for both and could be considered as part of ecosystem-based approaches to adaptation, such as afforestation and reforestation and the conservation and sustainable use of biodiversity and ecosystems (EU White Paper, Impact Assessment, 2009: 32). The trade-offs mentioned, however, do not particularly relate to ecosystem-based adaptation measures per se, but rather how responses to climate change impacts may affect ecosystems and their services. It does, however, imply that poor design of water storage for dams could adversely affect river ecosystem functioning, and thus its ability to adapt to climate change. Similarly it identifies that autonomous adaptation actions by farmers may modify agri-environmental processes and lead to adverse impacts e.g. application of more pesticides or fertilizers, so there is a need to ensure sustainability and avoid mal-adaptation.

4.5 Barriers to integration at the EU and national level

In Section 4.5, we explicitly apply the same typology used above in the context of five case studies of ecosystem-based approaches throughout Europe. We also explore strategies that have been employed to overcome these barriers, and opportunities that exist to build momentum behind ecosystem-based approaches in Section 6.

Barriers may exist which inhibit the ease with which uncertain and complex phenomena, such as climate change, are addressed and novel solutions are employed. These barriers are often institutional or behavioural in nature, and represent powerful sources of inertia behind habitual modes of practice (Burch 2010a, b; Pierson, 2000). In other contexts, examples of barriers have included organisational silos,[54] organisational cultures of combativeness, outdated or limited policy and regulatory tools, inappropriate jurisdictional powers, and a host of others (Burch 2010a, b; Swart and Raes, 2007).

Human and organisational behaviour are complex phenomena that require a specific mix of attitudes in support of pro-environmental behaviour, beliefs about the consequences of one's actions, the tools and capacity (such as technical information and financial resources), and an enabling organisational or political context. Thus, changing behaviour is rarely as simple

[54] Organizational silos are created when various units or individuals within an organization are incapable of, or disinclined toward, reciprocal interaction and collaboration. This may be reinforced by organizational structure (for instance the absence of opportunities for inter-unit collaboration through steering committees, working groups etc), organizational culture, job descriptions, and standard operating procedures.

as providing additional or better information, but is rather a process of activating values, counteracting inertia providing compelling incentives and enabling instruments.

Recent research has shown that affective (or emotional) responses may act as either barriers or enablers of action, but will invariably influence decisions that might be presumed to be based solely on a rational analysis of available information. At the individual level, values, beliefs and social context are also critical antecedents or determinants of behaviour (see for example: Kaiser and Wolfing, 1999, Kollmuss and Agyeman, 2002, Stern, 2000, Stern, 1992), and thus may either facilitate or inhibit climate change responses. Cultural/behavioural barriers include the organisational ethos, habitual modes of practice, personalities and values present within organisations, which may deeply influence the success of efforts to embed climate change adaptation principles in biodiversity plans and vice versa (Burch, 2010a).

The study of climate change policy design and organisational responses to global environmental change illustrate two additional categories: structural/operational and regulatory/legislative barriers to action. These fields teach us that constraints on, or facilitation of, effective adaptation and mitigation may be influenced by:

- Institutional funding structures and incentive programs (Schipper and Pelling, 2006);
- The fit between the institutional arrangement and the problem it is intended to solve (Cash *et al.*, 2006, Young, 2002);
- Various levels of government claiming jurisdiction over a problem (Lee and Perl, 2003);
- The codified rules and practices (Immergut, 1992); and
- The antecedent development regulatory decisions (Adger and Vincent, 2005, Kok *et al.*, 2000).

Finally, we must consider the reality of delivering projects that employ ecosystem-based approaches to adaptation and mitigation: project designers and implementers do not operate in isolation, but rather are part of a complex web of human/environment interactions, political and economic trajectories, and public values that deeply shape the suite of available policy responses to climate change and their likely success. Awareness of climate change (Kempton, 1997, Lorenzoni and Pidgeon, 2006) and perception of the risk (Leiserowitz, 2006, Lorenzoni *et al.*, 2005) influence the willingness of the individuals to take and/or support leadership on the issue, while the social context at any given time may alter both the importance individuals attach to risk responses (Kasperson and Kasperson, 2005, Pidgeon *et al.*, 2003) and their ability to act (Corraliza and Berrenguer, 2000, Gatersleben *et al.*, 2002). Broader economic and political structures, furthermore, tightly constrain the set of available collective and individual behaviours (Baber, 2004, Hall and Taylor, 1996, Krasner, 1984). In other words, contextual issues shape the environment within which organisations function and influence our values and priorities. Even so, individuals are not without opportunities to act. As later sections in the report discuss, opportunities can be created for building momentum behind ecosystem-based approaches to adaptation and mitigation in light of new information about climate change.

The typology explored above is summarized below (Table 10), and serves to highlight the variety of barriers that may be encountered when attempting to design and implement climate change response strategies. Nascent ecosystem approaches to adaptation and

mitigation may be particularly susceptible to these barriers, as costs and benefits are evaluated, and strategies are designed. All of these barriers are typically characterized by inertia (or path dependency), making dramatic shifts in policy direction development path challenging to implement (Burch 2010a, b).

This typology has been used to explore the barriers to the integration of ecosystem-based approaches to climate change adaptation and mitigation in EU policies by conducting interviews with EC officials (also see 2.2). Moreover, this typology has been applied in the case study analysis to identify barriers experienced in the project development and implementation (see 5.3).

Table 10: Barrier typology applied in the project

Type of barrier	Description
Structural or operational barriers	Features of an organization's architecture or function that influence day-to-day activities and help to define long-term policy direction (Burch, 2010a). Examples are the institutional funding structures and incentive programs (Schipper and Pelling, 2006), the fit between the institutional arrangement and the problem it is intended to solve (Cash et al., 2006; Young, 2002), various levels of government claiming jurisdiction over a problem (Lee and Perl, 2003), the codified rules and practices (Immergut, 1992) and the antecedent development regulatory decisions (Adger and Vincent, 2005; Kok et al., 2000), which may all serve to either constrain or facilitate ecosystem approaches to climate change.
Regulatory and legislative barriers	The nature of the policy tools that the organization has at its disposal and the interactions between multiple levels of government. The use of ecosystem-based approaches to respond to climate change may require simultaneous recognition of regulations pertaining to greenhouse gas emissions, biodiversity and conservation, urban planning, and a host of others, the goals of which may conflict with one another.
Cultural and behavioural barriers	The relationships between individuals in various critical positions within the implementing organization or level of government, their personalities, and the collective ethos and customs at play. Particularly important in this regard are the habitual modes of practice that have shaped past policy priorities and may inhibit fundamental shifts towards integrated sets of priorities.
Contextual barriers	Contextual barriers may arise from the environment within which the government or organization functions and the values and priorities of the public (Burch, 2010a). For instance, ecosystem-based approaches to climate change adaptation and mitigation may require the use of land for flood management and biodiversity conservation over residential or commercial developments, thereby stimulating debate over public priorities.
Capacity barriers	Include the technical, human, and financial resources that are required to estimate climate change impacts and devise effective response strategies. Capacity barriers may be particularly prevalent in the case of ecosystem-based approaches to climate change, when compared with more traditional grey infrastructure, as relatively few examples exist of large-scale, implemented, and evaluated projects using ecosystem-based approaches.

Multiple barriers to action are at play at any given time in a particular organization or governmental context, and thus are deeply interwoven. Well-established or habitual methods

for evaluating costs and benefits (a behavioural barrier), for instance, may more effectively address existing climate change or biodiversity legislation (a regulatory or legislative barrier), leading to challenges in securing the financial resources required (a capacity barrier) to implement an ecosystem-based project. As such, in identifying strategies for overcoming barriers, it is important to consider the policy design and implementation process in an holistic manner.

The first barrier noted by EC interviewees was a general lack of awareness and understanding of ecosystem-based approaches at all levels: from the European to the local scale, including Ministers and heads of state. This lack of awareness may become manifest in a number of forms such as confusion about concepts and terminology (for example the conflation of ecosystem services, ecosystem approach, ecosystem-based approach etc), and a lack of understanding about the multiple functions and services that a particular ecosystem might provide and thus the multiple benefits of ecosystem-based approaches to adaptation and mitigation. These might be considered both capacity and behavioural/cultural barriers, insofar as technical information (or capacity) is lacking or not taken on board, but habits or particular perceptions of the climate change problem may prevent individuals from building this capacity. Interestingly, a lack of financial capacity was only mentioned as a barrier that was *not* impeding the uptake of ecosystem-based approaches: one interviewee suggested that plenty of funds are available, but Members States simply don't know how to use it.

Interviewees noted that significant human capacity is needed to pursue ecosystem-based approaches, since a wider variety of partners or stakeholders must participate in their design and implementation. This may dissuade stakeholders initially, but prove to be a fruitful avenue for collaboration and mutual learning. Similarly, EC interviewees suggested that ecosystem-based approaches may be more costly in the short term, because the cost-effectiveness may require the lifetime of the project to become evident. These are largely barriers of awareness, financial capacity, and technical capacity, each of which may be gradually remedied as ecosystem-based approaches gain momentum.

Regulatory or legislative barriers, those linked to antecedent and emerging policy decisions, were frequently raised by EC interviewees. For instance, one interviewee indicated that there are no strong policy drivers behind ecosystem-based approaches at the national or regional level, leading to a lack of incentives for municipalities to make decisions with other scales in mind. Furthermore, it was noted that there is a significant lack of consistency, in both intention and implementation, amongst various areas of European policy (ie agriculture, biodiversity, fisheries, transport etc.). Added to this is a very heavy burden of reporting and administration associated with abiding by European rules, which inhibits the local application of the European policy that *does* exist.

A recent review of National Adaptation Strategies[55] provides useful insights on the factors that have either contributed to or hampered the achievement of adaptation strategies. The Impact Assessment draws on the PEER review (Swart et al., 2009) (Table 11) and picked up that "political institutional problems may be a greater challenge then finding the appropriate technical solutions" and that cross-level or cross-sectoral conflicts are important issues to take into account for future developments (Impact Assessment, 2009: 20).

[55] "Europe adapts to climate change: status of developing National Adaptation Strategies", Partnership for European Environmental Research, to be published in 2009 (PEER, 2009).

Table 11: SWOT analysis of National Adaptation Strategies (NAS)

	Contributing significantly to achieving the NAS objectives	Hindering the achievement of the NAS objectives
Related to historical conditions and institutional development of the NAS	**(STRENGTHS)** • Targeted research programmes • Planning for the implementation, monitoring and funding of adaptation • Planned coordination between sectors and administrative levels	**(WEAKNESSES)** • Lack of coordination between levels and sectors • Lack of adequate stakeholder involvement • Unclear responsibilities between administrative levels • Lack of context-specific adaptation knowledge
Related to current and future conditions and developments external to the NAS	**(OPPORTUNITIES)** • Development and export of knowledge • Spill-over of policy integration and multilevel governance for non-climate policies	**(THREATS)** • Cross-level conflicts • Cross-sectoral conflicts • Insufficient resources • Lack of public support • Impacts of global impacts (trade, migration, security)

Source: Swart et al. (2009)

International negotiations provide another interesting context within which the conversation discussion about ecosystem-based approaches is playing out. The nature of the negotiations on the United Nations Framework Convention on Climate Change, for instance, is such that any issue that is divisive or complex will be pushed away in the interests of obtaining consensus. Negotiators are explicitly told not to 'overload the boat' and so the possible synergies between climate change and biodiversity, for instance, are given short shrift. Similarly, biodiversity (and thus, ecosystem-based approaches to adaptation and mitigation) adds complexity to REDD+ negotiations: biodiversity is notoriously difficult to measure, and accuracy of measurement is a fundamental component of market-based funding mechanisms for REDD+.

Structural barriers are particularly challenging at the EC level. Interviewees noted that biodiversity continues to be separate from climate change because of the organizational divisions within the EC. Biodiversity remains the domain of DG ENV, while climate change is the focus of DG CLIMA. To some extent this facet of organizational structure contributes to a cultural/behavioural barrier, that is, rivalry and competition between EC units, and isolationist or deeply disciplinary thinking. One interviewee noted that many individuals within the EC have difficulty extending their view (and indeed may not be permitted to do so) to apply ecosystem-based approaches to their own work unless it directly answers one of their problems. At the level of international negotiations, the three Rio Conventions (on climate change, biodiversity, and desertification) have created organizational silos, and compete for funding. Ecosystem-based approaches may provide a way to simultaneously achieve the objectives of all three conventions (see Section 7 for further discussion) but there are few mechanisms for such cross-pollination. The Rio Conventions Pavilion, a joint outreach activity of the secretariats of the three Rio Conventions (UNFCCC, UNCCD and CBD)

together with an impressive list of partners, aims to harness synergies and promote collaboration and may constitute an important first step towards enhancing the development and use of integrated approaches such as ecosystem-based approaches to climate adaptation and mitigation.

4.6 Discussion and conclusions

Glick et al. (2011) found that interest in and acceptance of adaptation has increased in both the conservation community and more broadly over the last ten years. They found a five-fold increase in climate change adaptation literature from 2007 to 2020 and from this they infer that the conservation and research communities have realized that mitigation alone is no longer sufficient to address the challenges of climate change. However, they did find that papers focused on human systems were most prevalent, with those orientated towards biodiversity and ecosystem conservation being least well represented. They also found that from 2007 to 2010 "the term 'ecosystem-based adaptation' has gained currency (e.g. Vignola et al. 2009; Colls et al. 2009; Watts et al. 2011), although it is still very poorly represented in the published literature".

"While scientists can offer specific information to guide conservation actions, the choice of restoration or management goals is ultimately a process driven as much by societal values, economic constraints, and political feasibility as scientific knowledge (Lackey 2004, Tear et al. 2005, Stein 2009, Lindenmayer and Hunter 2010)" (Glick et al. 2011).

The review has found that in the majority of cases, for EU, country and sector documents, it was difficult to tell whether action had been taken. At the EU level, given the broad nature of the documents, there was little specific mention of ecosystem-based actions or evidence of ecosystem-based adaptation and mitigation actions, although there was recognition that ecosystem-based actions often provide multiple benefits including mitigation. The most frequently mentioned ecosystem-based action categories within the country and sector documents were protected areas, ecological connectivity and using ecosystems as carbon stores. A specific example is creating or re-establishing flood plains or salt marshes for flood management and support biodiversity and habitat conservation objectives. In the EU White Paper and Impact Assessment, actions relating to "Develop knowledge and plan strategically" and "Integrate across sectors" were, not surprisingly, very evident especially in the Impact Assessment. This also noted that with regards to adaptation that "it was clear that stakeholders found it easier to identify problem areas than to propose concrete action" (EU Impact Assessment: 6).

Also, the recently adopted EU communication "Roadmap to a Resource Efficient Europe"[56] states that the Commission *will* "significantly strengthen its efforts to integrate biodiversity protection and ecosystem actions in other Community policies with a particular focus on agriculture and fisheries (continuous)" (EU Roadmap to a Resource Efficient Europe: 14). In addition, it advocates a drive to a low-carbon economy; maintaining natural carbon stores is thus one way of enabling this to be achieved.

[56] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0571:FIN:EN:PDF

The actual emphasis in NAS might differ from that specified in the White Paper and Impact Assessment for two reasons. Firstly, many of the NAS were published before the White Paper and Impact Assessment. This could have prevented the key messages from the EU documents being effectively covered in the NAS. Another reason could be due to the different focus applied by the various NAS. For example, the PEER report (Swart et al., 2009) identified that the NAS vary in their emphasis: for example water availability is stressed in southern European countries, whereas flood risk is a regularly discussed in central and northern Europe. The NAS analysed in that report, therefore, reflected the national and socio-economic conditions of the specific countries to which they related, placing emphasis on dealing with the most relevant challenges.

Both the NAS and the sector policy/communication documents, which are predominantly guiding documents for what needs to be implemented at the MS level, were generally written such that they included aspirations or intentions. In most cases there was little evidence of actual concrete action that had taken place. There was much use of terminology such as 'should' or 'will', and while this makes the intent clear, it does not provide any information on what is actually being done. For example:

- The Thematic Strategy on the sustainable use of natural resources[57] will highlight the importance of using natural resources in an efficient way which reduces environmental impacts. Better urban management can reduce the impacts of day to day use of resources such as energy and water.
- Other structural challenges must be fully integrated into tourism policy. Thus the supply of tourism services must in future take into account constraints linked to climate change, the scarcity of water resources, pressure on biodiversity and the risks to the cultural heritage posed by mass tourism. Tourism businesses need to reduce their use of drinking water where there is a risk of drought, and reduce their greenhouse gas emissions and environmental footprint (EU Communication on Tourism 2010).[58]
- Each Member State shall adopt a national renewable energy action plan with national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020 (Renewable Energy Directive, 2009/28/EC).

Biesbroek et al. (2010), in their paper based on the PEER report (Swart et al., 2009), also comment that "Most of the NAS mark the beginning of a process rather than the end, putting the issue on the national policy agenda but often without elaborating concrete proposals or processes for implementation and measuring effectiveness of the NAS".

On average, it was only possible to identify that concrete actions had been undertaken in around one third of instances where sector reports included discussion on adaptation and mitigation (10/26 and 5/16, respectively). Where examples of concrete actions were given, they most typically fell under the adaptation principle of 'taking practical action now'. The

[57] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52005DC0670:EN:NOT

[58] COM(2010) 352 final: Europe, the world's No 1 tourist destination a new political framework for tourism in Europe, 2010

most common mitigation measure for which there was evidence of concrete action was 'decreasing emissions through supply reduction'.

Evidence of concrete adaptation actions was found in just less than half of the country level reports (10/24). The adaptation principles most commonly discussed, along with evident action taken, were 'taking practical action now' and 'developing knowledge and planning strategically'. For mitigation at the country level, evidence of action was given in five out of eight instances where measures were discussed. This apparently high level of action is likely because mitigation has been on the political agenda for longer through international climate change negotiations. Many countries are also seeking to achieve mitigation targets. Climate change adaptation does not yet have such concrete targets as the climate agenda for the last decades has focused on mitigation. It is only comparatively recently that, at least rhetorically, adaptation and mitigation have been on the same footing.

The supposed lack of stated evidence in official documents regarding action undertaken does not necessarily mean that sectors or countries are not undertaking actions. The documents reviewed here have specific aims, such as to outline what needs to be done and how it can be done. What is actually being done might well be included in documents that were not reviewed in this study. For example, the UK NAS says very little about practical action that is being undertaken now, but there are a number of documents produced by Defra, the England Biodiversity Group and Natural England that go into much more detail about what is being done, and from those documents it is clear that action is being undertaken.

Also, the wording used in documents may not lend itself to accurate determination of whether or not an action has been undertaken. For example, a country or sector may be taking action that could be seen as 'responding to changing conservation priorities', but if the reports reviewed do not specifically use those words or give clear examples of why conservation priorities have changed and what has been done about it, then that sector or country may have a low score on 'accommodating change', even though something is being done about it. Similar issues were identified in a recent study on embedding climate change adaptation principles into the England Biodiversity Strategy (Berry et al. 2011).

Certain concrete actions could, however, be identified in some of the documents. For example, the UK NAS explained how Natural England is actively considering how well the existing network of Sites of Special Scientific Interest (SSSIs) will be able to respond dynamically to natural processes and the predicted effects of climate change, and how it has committed £6m over three years, concluding in 2011, to undertake work at a landscape scale that is designed to support biodiversity to adapt to a changing climate, focusing on wetlands, such as the Great Fens. Given that the documents reviewed were concerned with adaptation, a number of adaptation actions were mentioned, although mitigation was also covered. This was because the documents clearly recognised the link between the two and need to exploit the synergies between mitigation and adaptation efforts. This synergy is pertinent when dealing with ecosystem-based approaches, as any type of vegetation contributes to carbon sequestration. Even if considered "minor" on a local scale the cumulative effect is likely to be significant. Links with sustainable development were also acknowledged. Action from all the adaptation and mitigation categories were recorded, although there was less mention of actions under taking practical action now and most under integrating across sectors, thus reflecting the broad remit of the documents. There was a special emphasis on integration of adaptation (not necessarily ecosystem-based adaptation)

into all relevant sectoral policies. This integration was also noted by Biesbroek et al. (2010) as a common feature of all the NAS that they reviewed.

Other researchers have also explored policy documents and analysed adaptation actions. Mawdsley et al. (2009), for example, identified 16 possible adaptation strategies for wildlife management and biodiversity conservation from the scientific literature and public policy documents. They grouped them into four broad categories: 1) land and water protection and management; 2) direct species management; 3) monitoring and planning; and 4) law and policy. Eleven of the strategies fall into the first two categories and this emphasis is similar to those of Smithers et al (2008). While many of the individual principles are identical or similar to those used in this project. While many of the individual strategies are identical or similar to those used in this present study, for example increasing the size of protected areas, reducing pressure from sources other than climate change and the translocation of species, others have broader descriptions and hence the difference in the number of principles considered. For example, Mawdsley et al. (2009) have only one strategy related to law and policy: "Review and Modify Existing Laws, Regulations, and Policies Regarding Wildlife and Natural Resource Management", which covers several of the principles assessed in this project. They conclude that many of the strategies seem like "business as usual" for wildlife management and biodiversity conservation managers. Even some new activities (e.g. reviewing monitoring programs or laws and regulations) only require development of existing approaches rather than new ones. This concurs with a review of the implementation of the Smithers et al. (2008) strategies in the England Biodiversity Strategy, which also concluded that many of the strategies were part of current good conservation practice (Berry et al., 2011), although both emphasise that it is important that climate change is taken into account in all conservation strategies.

This desk study has discussed a number of findings and limitations. The documentation alone does not allow a clear picture to be formed on what actions have been undertaken and by whom, though it does show clear intent in the EU to adapt to and mitigate climate change and in most sectors and countries. Ecosystem-based approaches to adaptation and mitigation are being undertaken by all sectors and all countries, but very few sectors or countries have measures in place for all adaptation principles. There is some variability in which measures have been undertaken but all sectors are 'taking practical action now'. And all countries are either 'maintaining and increasing ecological resilience' or 'taking practical action now'. As a result, all sectors and countries are applying ecosystem-based approaches, though it is not clear whether there is a specific intent to use these approaches to adapt to climate change or whether the adaptation merely falls out of good conservation practice. Mitigation is less commonly referred to, possibly due to the nature of the documents selected for review. Significantly fewer sectors and countries are applying ecosystem-based approaches to mitigation, and again, the intent of applying ecosystem-based approaches is not clear. This could be changed by a Payment for Ecosystem Services approach, which has certainly been recommended for various sectors in Europe (e.g. water; UNECE, 2007) and has been discussed in several countries (e.g. UK, Defra, 2010).

The review has shown that many good examples of ecosystem-based approaches to adaptation and mitigation exist and their implementation needs to be promoted, such that there is a move from theory to practice and potential synergies are exploited. The integration of ecosystem-based adaptation and mitigation actions should provide a more efficient and cost-effective approach to tackling both the causes and impacts climate change and would

contribute to the achievement of both climate change and biodiversity policy objectives. Biodiversity and ecosystem services have a dual role in relation to the adaptation discussion. While there is a need for adaptation for biodiversity through measures to allow species to cope with the changing climatic conditions, the maintenance and restoration of healthy ecosystems and their services - adaptation with biodiversity inter alia through the development and use of ecosystem-based approaches - constitutes a necessary pillar for the overall adaptation effort.

5 Process of design and implementation of ecosystem-based approaches at project level

This section will analyse inter alia how ecosystem-based projects have been designed and implemented, what the barriers and opportunities related to their design and implementation are and how they have been addressed by projects. These aspects will be elucidated by drawing on evidence from the project database, the five in-depth case studies and a literature review.

5.1 Drivers behind the application of ecosystem-based approaches

Different drivers for the implementation of ecosystem-based approaches at the project level can be identified, ranging from policy and strategic objectives at the EU level to specific national and/or local policies as well as local needs and stakeholder motivations. Ecosystem-based approaches appear to be applied primarily to meet biodiversity and other environmental objectives, while their contribution to overarching adaptation and mitigation efforts often remains overlooked. The database of projects using ecosystem-based approaches and the in-depth case studies confirm this observation; in most cases, the projects do not explicitly state adaptation and mitigation as their primary objectives, but such effects rather emerge as positive side-effects[59]. As mitigation and adaptation become further integrated within different sectoral policies, they are also expected to become more visible as explicit project objectives.

Policies and strategies

The United Nations Framework Convention on Climate Change (UNFCCC) was the driving force behind one of the case study projects, namely the Forest Rehabilitation project in the Czech Republic. Specifically, the project was part of the joint implementation mechanism as outlined in Article 6 of the Kyoto Protocol, which enables Annex 1 Parties to implement carbon sequestration projects in another Annex 1 country. This enables a cost-efficient and flexible means for emission reductions for the investing country and allows for an influx of foreign investment and technology transfer for the host country. Providing the global framework for mitigation activities including for Land Use, Land-Use Change and Forestry, the Kyoto Protocol could have the potential to be an important driver for implementing ecosystem-based approaches. More recently, decisions adopted during the CBD COP 10 in Nagoya, and in particular CBD COPX33 on Biodiversity and Climate Change, fully recognise the importance and potential of ecosystem-based approaches to climate change adaptation and mitigation.

At the EU level, the Water Framework Directive (WFD) constitutes an important driver for ecosystem-based approaches to climate change adaptation and mitigation. The WFD establishes a framework for the protection of inland surface waters, transitional waters,

[59] While two of the five in-depth case studies focus on sequestration together with biodiversity, the database suggests few additional cases where sequestration is an explicit objective.

coastal waters and groundwater. The central objective is to achieve 'good ecological status' of water bodies by 2015. Article 1 of the WFD states that Member States must "prevent further deterioration and protect and enhance the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems." The measures required to achieve WFD objectives are often complementary or overlapping with measures needed to achieve nature protection and climate objectives. In addition, the Flood Risk Management Directive is closely linked to WFD. Ecosystem-based approaches are particularly suitable in this context, including, for example, the restoration or establishment of habitats to support water quality and reduce flooding risk and damage. In two of the case study projects, De Doorbrak and the Augustenborg project, the implementation of the WFD was a principal motivation for public authorities to initiate the project.

The Habitats Directive requires the maintenance and restoration at a favourable conservation status of natural habitats and species of wild fauna and flora. Together with the Birds Directive it provides the basis for the EU Natura 2000 Network of protected sites. While not explicitly stated by project managers as the principal driving force, they appear nonetheless relevant as two of the case studies involve project work in either existing or planned nature protection areas where the objective of the project is to contribute to improved protection or restoration of habitats. In the area of "soft law", the White Paper on Adaptation[60] and the EU Biodiversity Strategy up to 2020 (COM(2011)244) are very relevant for the promotion of ecosystem-based approaches.

At the national level, commitments to implementing the EU legislation are obviously an important factor. As mentioned above, the implementation of the WFD and the Birds and Habitats Directives is especially relevant. In addition, specific national plans and strategies such as those for sustainable development, nature protection and biodiversity[61] or for improving ecological connectivity are relevant drivers. The UK Wallasea Island wild coast project, for example, presents a follow-up to a previous national scheme, which aimed to protect the agricultural activities for additional ten years. It is also linked to UK commitments to biodiversity preservation and the provision of compensatory habitat due to habitat degradation elsewhere, contributing to the UK Biodiversity Action plan and climate protection. The Dutch De Doorbraak project, for example, ties in with the Dutch ecologic network, national spatial plan, and nature protection planning. The International Climate Protection Initiative funded by the German Ministry of Environment, Nature Conservation and Nuclear Safety is a further example of a national scheme that can be a facilitating factor for ecosystem-based approaches.

Local/regional needs

Given the scope and scale of projects using ecosystem-based approaches, the involvement of national agencies and their respective policy priorities appears essential in securing both momentum and financial resources for project implementation. While the international, EU and national policies provide the framework for implementation, the projects are initiated and

[60] European Commission (2009): White paper - Adapting to climate change: towards a European framework for action. COM(2009)147 final. See. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF

[61] For example, the National Biodiversity Strategies and Action Plans (NBSAPs)

carried out at the regional and/or local level, coordinated either by regional or urban public bodies or private non-profit organizations. The local needs and motivation of local stakeholders including public authorities are thus important for the project initiation. The most important of these local drivers as evidenced in the case study projects are outlined below.

The perception and evidence of risk at a local level is a strong impetus for action. The risk of flooding, in particular, was a driving motivator in three of the in-depth case studies. The Augustenborg project is part of a broader City of Malmo stormwater management policy which aims to avoid the effects of urbanization on natural water balance, prevent pollutants from entering urban runoff, improve the drainage system to avoid harmful backing up of the system, and use stormwater as a positive resource in an urban landscape. In the case of the Wallasea Island: Wild Coast Project this flooding affects primarily agricultural land, whereas in the Malmo regeneration project and the De Doorbraak project the flooding also presented immediate risk to properties. For addressing flooding risks, ecosystem based approaches are particularly effective.

Moreover, a strong motivating factor at the local level are the multiple benefits that the projects can deliver compared to grey infrastructure solutions. The De Doorbraak project, for example, also improves access to green space and recreational areas for the local residents in an otherwise urban area. In the case of the Wallasea Island project, an important benefit of using ecosystem-based approaches was that the project could draw on waste material produced in urban transport excavations that would otherwise have to be transported and disposed of in another way, possibly incurring greater costs. Moreover, the Augustenborg project also fits within a City of Malmo regeneration initiative for the local neighbourhood and, more broadly, the ambitious city sustainability plans. Thus, in addition to well-articulated local needs, a pioneer mentality by city authorities has also been a key driver.

5.2 Project set-up and implementation

5.2.1 Management structure

Different management approaches applied in ecosystem-based projects can be identified in-depth case studies. Depending on the type of the project, the funding source, and the geographic and socio-economic context, the actual management structure can vary widely. The different types of management structures that have been identified are described in Table 12.

Table 12: Management structures applied in the case study projects

Project	Approach to management
Restoring Peatlands and Applying Concepts for Sustainable Management in Belarus (BY)	International project managed by a consortium of organisations from the UK, Germany and Belarus. Funding is provided by the German Ministry of Environment within the framework of International Climate Protection Initiative. A *steering committee* formed by key stakeholders in the project provides strategic and planning guidance for the project manager. The project has seven specialized modes, which are each lead by one expert and with clearly defined responsibilities. Consultants provide specific services to support the modules. The modules include: Carbon/Climate, Rewetting, Biomass, Administration, Biodiversity, Communication, and Capacity Building.
De Doorbraak (NL)	Regional project managed by *a partnership* of two public authorities – a regional water board and the provincial government. The province provides co-funding together with the Dutch Ministry of Economic Affairs, Agriculture and Innovation. A steering committee and an *external project group* give strategic guidance to the core management team, which coordinates the operational activities of the various parties involved. In addition to contractors, the main contributions are made by two national ministries, the municipalities, a non-governmental organization and a local district. Local landowners and public were key stakeholders in making the project publically accepted.
Augustenborg, Malmö: Retrofitting SUDS in an urban regeneration area (SE)	City-level project is jointly run by *a partnership* between the Malmo Housing Company and the City Government. The day-to-day management is carried out by the Housing Company, whereas the City oversees the seasonal maintenance. The water company carries out specific maintenance tasks. The Housing Company and the City government own the land on which the project is operated.
Forest Rehabilitation in Krkonose and Sumava National Parks (CZ)	International project initiated and coordinated by the Dutch Face Foundation as a 'Joint Implementation' project under the UNFCCC. Face Foundation, an independent non-profit foundation founded by the Dutch electricity generating board, provides funding for research and restoration. Other partners include the Czech Ministry of Environment, University of Amsterdam, and two National Park Administrations, local municipalities and contractors. A local project manager coordinates the project implementation.
Wallasea Island: Wild Coast Project (UK)	Regional project initiated and managed by the Royal Society for the Protection of Birds (RSPB) in cooperation with public authorities, contractors and landowners. The main government partners include the Environment Agency, which is responsible for creating compensatory habitat to meet the UK Biodiversity Action Plan requirements, and the UK Department of Environment, Food and Rural Affairs. The RSPB bears the majority of costs with additional funding coming from Crossrail, a joint venture between Transport for London and the Department for Transport, which will deliver the waste material and carry out the majority of the construction work. A technical advisory panel is a critical source of expertise during the project implementation.

Keeping the management structures as simple as possible maximizes the efficiency of management and minimizes costs. Clear and transparent internal management procedures can facilitate effective management. A well-developed management structure from the start of the project with clear description of roles of individual entities is an important factor for success. For example, a core management group that is guided by a steering committee or a technical advisory group and which then sub-contracts specific tasks appears to be an effective set-up. Clear and well-organised management is especially important for projects that span borders, with funders and primary managers coming from a country other than the location of the project. In the peatland restoration project in Belarus, for example, the management structure evolved in response to barriers encountered during the initial phase. Specifically, the project was divided into specialized modules with expert leaders and a local manager was hired in order to coordinate activities within the country.

The delivery of the project can further be enhanced by ensuring that the management structure contains appropriate mechanisms and processes for information sharing, awareness raising and stakeholder participation from the beginning of the project. Early stakeholder involvement is, for example, very important where the project requires access to privately owned land or includes significant changes to the landscape. In the case of the Dutch De Doorbraak project which involved the creation of a new watercourse and ecological corridor, private owners and the general public were not initially involved in the planning phase. Once open meetings and other face-to-face contact were introduced, the communication and acceptance of the project improved as well.

Given the scope and complexity of projects using ecosystem-based approaches, it is clear that the participation of a number of different public and private stakeholders is required for their implementation. Table 13 illustrates the different roles that stakeholders can assume in the implementation of ecosystem-based approaches.

Table 13: Possible role of different stakeholders in the implementation of ecosystem-based approaches

Stakeholder	Role in implementing ecosystem-based approaches
EU authorities	• Setting of the legislative requirements (Directives) • Provision of funds through Common Agricultural Policy, LIFE+, Cohesion Policy • Setting of strategic objectives and planning (for example, Rural Development Programmes, Biodiversity Strategy, upcoming Green Infrastructure Strategy and Adaptation Strategy) • Provision of enabling environment • Awareness raising • Development of Instruments and Tool Kits
National authorities	• Provision of funds • Strategic objectives and legal framework • Submission of funding application (e.g. LIFE) • Administration of the budget and submitting applications • Supervisory, coordination or management role in implementation
Regional/local authorities	• Project initiation and management • Planning and approval of works • Provision of funds

Stakeholder	Role in implementing ecosystem-based approaches
NGOs	• Provision of funds • Identification of funding possibilities • Conduct information/background surveys to identify project need • Communication campaigns and PR-activities • Development of educational materials, • Capacity building for stakeholders • Supervisory, management or coordination role in implementation • Maintenance of project, post-implementation • Monitoring activities
Private companies [62]	• Provision of funds (potentially as 'Corporate Social Responsibility' or as part of mandatory compensation/mitigation measures) • Technical implementation via sub-contracting jobs (e.g. construction and engineering jobs)
Planning authorities	• Support project design, based on ecological data and existing regional plans • Integration of projects into regional spatial plans
Land users/owners; local community	• Carrying out project measures and activities (e.g. through agreements) • Act as consultants during project development and implementation (e.g. sharing of best practices, knowledge and experiences) • Maintenance of project, post-implementation • Abiding by land use restrictions or physically relocating, when necessary • Act as multipliers, passing on and sharing knowledge with other land users, inhabitants etc.
Scientific/technical experts or expert groups	• Advisory/consultative role during planning and implementation stages • Serve as specialist for specific theme or area of the project, supporting decision-making processes
Research institutes (e.g. universities, think tanks, scientific foundations etc.)	• Evaluation of project (including costs and benefit analysis) • Monitoring activities/outcomes • Scoping studies

In all the case studies, the management structure involves a partnership in day-to-day management between at least two stakeholders. These stakeholders include EU, national and regional public authorities, non-governmental organisations, as well as private contractors, landowners and the general public. The case studies show that projects can be initiated by different stakeholders depending on the context and their capacities. It is interesting to observe that in three of the five case studies, a key facilitating and management role is played by a non-governmental organisation. In two cases, public authorities (at city and regional level) were the initiators and managers. In all cases, government agencies and/or local and regional public authorities are involved, underlining the importance of their political commitment, the strategic and legal framework and co-funding that they provide for projects using ecosystem-based approaches.

[62] E.g. construction, engineering, water or architecture companies

5.2.2 Financing of projects

A central factor in the implementation of environmental protection initiatives is the access to funding for the design and application of projected measures. As securing funds for the implementation of projects using ecosystem-based approaches is often not a straightforward procedure, developing innovative funding schemes may provide additional impetus.

The present study has identified cases in which project managers integrate the ecosystem-based approaches with other perspectives (e.g. traditional engineered approaches) to increase the projects' feasibility and gain acceptance among funders. Additionally, by establishing projects within the domains most relevant to European and national policy and by aligning project objectives with those of specific financing sources, the opportunities for gaining financial support for the application of project measures are increased.

A number of international initiatives and mechanisms already exist to achieve the objectives of climate change and biodiversity policies. In the case of the European projects which have been identified in the database, the sources of funding can be divided into three categories - EU funding, public funding and private funding; this section looks at these genres in more depth, drawing on the database and in-depth case studies for additional clarification. Recommendations regarding financial considerations of projects using ecosystem-based approaches are given in Section 7.

EU financing

The two most common EU funding sources used to finance the ecosystem-based approach projects in the database are the LIFE+ and ERDF (INTERREG) programmes. However, additional EU financing sources also have the potential to support such projects in the future, such as the European Agricultural Fund for Rural Development (Common Agricultural Policy, Pillar 2). EU financing is third in line as a funding source after national and private funders. The following table provides a brief description of these financing instruments and their relevance for ecosystem-based approaches.

Table 14: EU financing programs and relation to ecosystem-based adaptation and mitigation

EU Financing Programme	Relation to ecosystem-based adaptation and mitigation
LIFE+, the Financial Instrument for the Environment[1]	LIFE+ (2007-2013) supports projects directly or indirectly contributing to climate change mitigation and adaptation via ecosystem-based approaches under the strand of "nature and biodiversity" and "environment policy and governance". Under 'environment policy and governance', for example, climate change is listed as the first theme. Projects are to be supported which contribute to the adaptation and increased resilience of the EU economy and society, nature and biodiversity, water resources and human health to the predicted impacts of climate change and mitigate its impact. This could include, for example, developing schemes for market based instruments to promote adaption to climate change. Additionally, the areas of water, air, soil, urban environment, forests, environment and health and strategic approaches are also supported. Here, projects under water management are supported which "develop an ecosystems based approach to the sustainable management of the seas, the management of coastal zones and the reaping of the benefits of the sea".[63] More specifically, the 'energy and climate' theme sponsored by LIFE+ offers funds for projects focusing on e.g. energy production and distribution, renewable energy technologies, energy-efficiency in areas such as industry, services, buildings, transportation, lighting and equipment, as well as the reduction of greenhouse gases.
EU Cohesion Funds (INTERREG/ ERDF) **The Interregional Co-operation Programme**[2]	The aim of the EU Cohesion Fund (INTERREG and the European Regional Development Fund, ERDF) is to "strengthen economic and social cohesion in the European Union with a view to promoting sustainable development"[64]. More specifically, ERDF aims are to reach convergence, enhance competitiveness and increase cooperation between the European regions (which is addressed through the INTERREG Programme). A growing number of ERDF projects are financing ecosystem-based approaches which, despite not necessarily being labelled as such, aim to mitigate climate change and prepare communities and ecosystems for e.g. predicted intense rainfall and extended drought periods. Some of the projects incorporate complementary green infrastructure elements allowing for microclimate regulation and biodiversity protection or focus on the restoration of ecosystem services. Co-financing is also provided for managing Natura 2000 and promoting the development of sustainable renewable energies in the context of regional development, maintaining and in some cases increasing the carbon storage capacity and of European regions and decreasing GHG emissions. These measures are often funded under the budget line for the promotion of biodiversity and nature protection.

[63] See www.tameside.gov.uk/business/europeanfunding/environment.pdf
[64] See http://europa.eu/legislation_summaries/agriculture/general_framework/g24233_en.htm

EU Financing Programme	Relation to ecosystem-based adaptation and mitigation
European Agricultural Fund for Rural Development (EAFRD - Common Agricultural Policy, Pillar 2)[3]	This scheme provides a framework for voluntary contracts with farmers to ensure management options that help maintain, enhance and restore habitats, soil and water. EAFRD priorities acknowledge the need to provide additional support in the areas of climate change, renewable energies, water management and biodiversity. Under the climate change and renewable energies objective, operations are to be supported which, for example, improve efficiency of nitrogen fertilizer use and energy efficiency and increase sustainable soil management, the conversion of arable land to pastures, afforestation and agro-forestry systems, flood prevention and management measures and the processing of agricultural/forest biomass for renewable energy. Water management aims also to support wetland restoration, conversion of agricultural land into swamps and forest/agro-forestry systems and the creation of meandering rivers and natural banks through river renaturalisation. The biodiversity objective strives to conserve genetic diversity, promote extensive grassland management, avoid the application of fertilizer and pesticides and increase integrated and organic food production. All these actions have the potential to reduce GHG emissions, adapt to the effects of climate change on soil and forests, sequester carbon, substitute fossil fuels, protect and improve water quality, conserve high-value water bodies, conserve genetic diversity and improve the biotope network.

Source: Adapted from [1]European Commission (2011); [2]IEEP et al (2011) and INTERREG IVB NWE (http://www.nweurope.eu/pop_page.php?id=61); [3]European Council (2009)

It should be noted that in addition to the aforementioned EU financing instruments, database projects also received financing from the EU Research Framework Programmes and the Joint Research Centre (JRC), European Agricultural Guidance and Guarantee Fund (EAGGF), JAF EU (Joint Approach for Managing Flooding) and EU URBAN Programme. The sectors and objectives addressed by the 51 projects in the database, which are totally or partially funded by the EU, are shown below in Figure 8 and Figure 9. Here, it becomes evident that projects within the nature protection, water, agriculture and forestry sectors are the most frequently EU funded projects, respectively. Additionally, projects aiming to address climate change adaptation and mitigation and biodiversity conservation in an integrated manner are the most commonly financed.

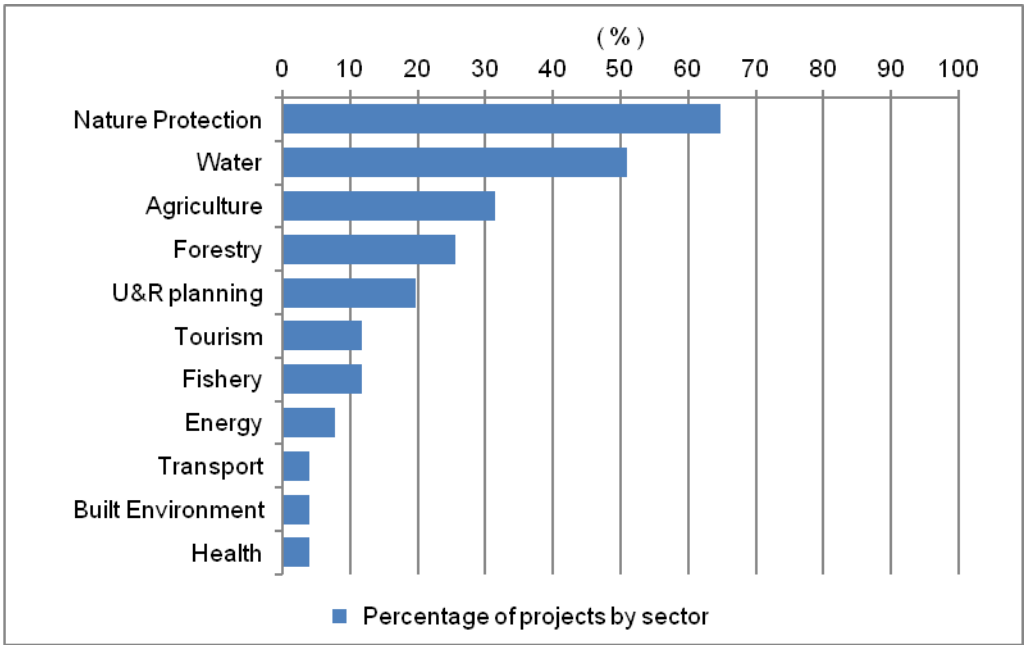


Figure 8: Sectors addressed by projects with EU financing

Addressing the most commonly represented sector, the nature protection project "*Management of Posidonia, vernal pools and halophytic wetlands in Natura 2000 sites*"[65] in Cyprus was partially funded by LIFE+. Posidonia beds contribute to mitigation in that they act as long-term carbon sinks and protect shorelines from erosion via the production of seagrass material, which accumulates on beaches.[66] The total budget for the four year project was €2,551,277, of which LIFE+ contributed €1,530,766 (60%). The project aimed to implement immediate actions in order to secure a favourable conservation status for the natural habitats and wild species in five posidonia oceanic beds. In parallel, these actions would create a base of important experience and set standards for the management of Natura 2000 sites in Cyprus.

Looking at the forestry sector, the *"Transnational Forestry Management Strategies in Response to Regional Climate Change Impacts"* project (ForeStClim)[67] is another interesting EU funded example. This ongoing project (taking place in Germany, France, the Netherlands, UK and Luxembourg) aims to show regionalized climate change impacts on forest site characteristics, protection functions, yield, biodiversity, water resources and carbon sequestration across North-West Europe. These factors will all be linked to a diverse set of multi-level risk assessments associated with preserving the multitude of forest goods and services. The development of transnational coordinated forestry management and forest protection and adaptation strategies will be the principal outcome of the project. Of the total €11.6 million budget, €5.7 million are being provided by the European Regional Development Fund (ERDF).

[65] See http://ec.europa.eu/ourcoast/index.cfm?menuID=8&articleID=236 for more information.

[66] Dante, G (2007). Development of sustainable strategies for conservation and management of Posidonia oceanica, (Linneo) Delilie 1813, meadow: a case study with a Site of Community Importance. Universita Degli Studi Della Tuscia di Viterbo - PhD Thesis.

[67] See http://forestclim.eu/ for further information.

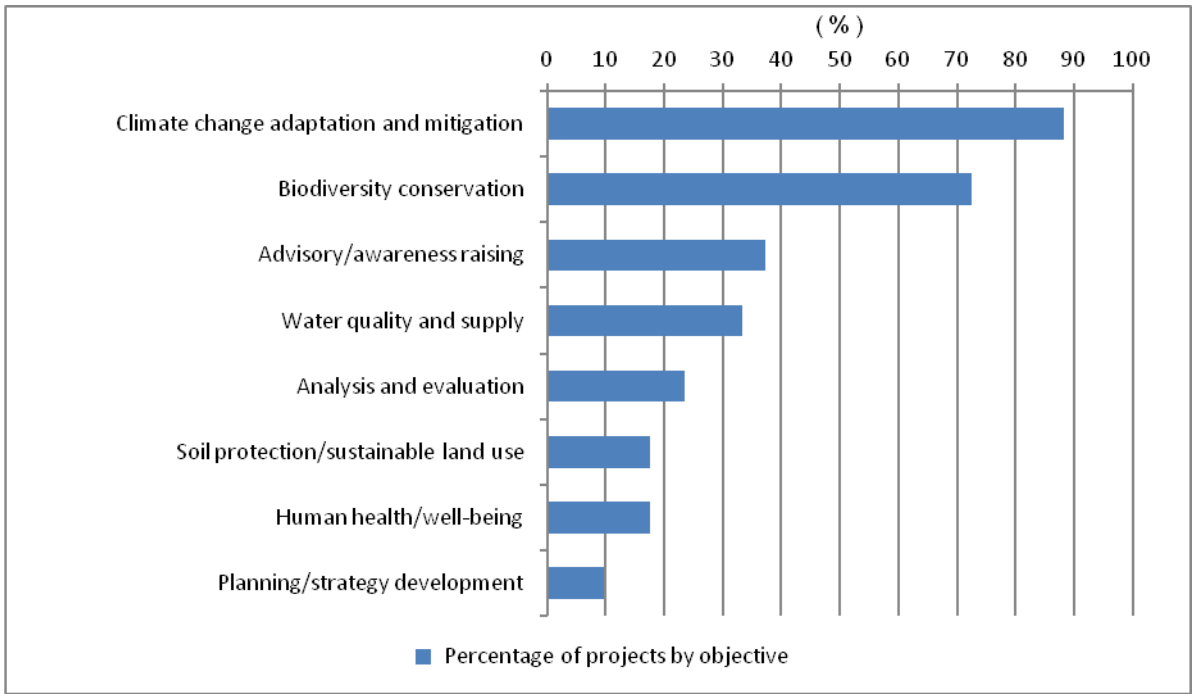


Figure 9: Objectives addressed by projects with EU financing

Almost 90% of the database projects addressed climate change adaptation and mitigation as an objective. The EU FP7 research project RESPONSE ("Responding to the risks from climate change - developing sustainable strategies for management of natural hazards in coastal areas taking account of the impacts of climate change")[68], for example, aimed to develop sustainable strategies, soft measures for the management of natural hazards in coastal zones in the UK. It intended to demonstrate an innovative regional-scale methodology for studying coastal evolution, leading to risk mapping for coastal natural hazards taking account of the impacts of climate change. This risk mapping served to guide local authorities and stakeholders in land-use development and planning by ensuring that decisions are compatible with specific local coastal conditions and likely future challenges and allowed for an assessment of the current and predicted costs of climate change in the face of inaction. The project thus sought to promote cost-effective preventative action in the field of coastal protection using ecosystem-based approaches, in line with LIFE-Environment objectives on Integrated Coastal Zone Management. The total budget was €1,682,954, of which €841,477 were contributed by LIFE.

Projects aiming to improve human health and well-being characterized just below 20% of the EU funded projects listed in the database of this study. "Development of harmonized indicators and estimation procedures for forests with protective functions against natural hazards in the alpine space" (ProAlp)[69], for example, developed harmonized indicators and a methodology for estimation of forests with protective functions against natural hazards, which are likely exacerbated by climate change. This methodology included identifying the protective functions of the forests and selecting useful indicators and/or surrogates of these

[68] See http://www.coastalwight.gov.uk/response.html for more information.

[69] See http://www.proalp.ifn.fr/index.html or http://forest.jrc.ec.europa.eu/docs/studies/forest-protection/ForestFocus.ForestProtection.EUReport24127.pdf for more information.

as well as the mapping of hazards, focusing on avalanche and rockfall and damage potentials for infrastructure like buildings, roads or railroads. The project was financed by the European Commission, DG Joint Research Centre and the Institute for Environment and Sustainability, lasting from 2006-2008.

Public regional/national financing

Public funding from the various government levels was the most common source of financing for the identified projects. In total, 116 projects fell into this category, obtaining funds exclusively from public sources or in combination with other sources. National and regional adaptation strategies and programmes provided financing for at least 15% of the initiatives reviewed in this study. The Bavarian Climate Protection Programme 2020[70] presents one good practical example of a regional programme (taking place at federal state level) and is outlined in the box below.

Box 3: The Bavarian Climate Protection Programme 2020

The Bavarian Climate Protection Programme 2020 has been taken as an example as it encompasses several ecosystem-based initiatives; all having received public financing as part of a regional adaptation programme, and embraces a cross-sectoral approach to addressing climate change. Along with reducing greenhouse gas emissions, the programme aims to enable areas that are particularly sensitive to the effects of climate change to best adapt to these impacts by 2020. To implement the adaptation strategy (2008-2011), €84.7 million were made available from German national funds. An additional €350 million have been provided for the next four years to specifically address the conditions in Bavaria via tailored measures, addressing the fields of, for example, water, forests and forestry, agriculture and health. Here, projects utilising an ecosystem-based approach include, e.g.:

- **Dynamically adapting Flood Control Action Programme 2020 to climate change** by: increased wide-scale flood-water retention, reducing residual risks in flood control systems exposed to a risk of overflow, and keeping emergency overflow facilities clear for storage capacities above the scope of regular flood management; €50 Mio are reserved for this measure.
- **Take precautions against drought and dry spells** by: increasing security of drinking water supplies on the local and regional levels by networking production facilities through alternative water options, sustainable production of usable groundwater resources and updating thermal load plans.
- **Mountain forests protection program** by: stabilising mountain forests' vital protective functions through intensive care and redevelopment, combined with effective regulation of hoofed game. A state-wide information system will facilitate targeted responses in regional risk areas; €7.5 Mio is reserved for this program.
- **Program to stabilise biodiversity and ecosystems** by networking habitats to create opportunities for animals and plants to migrate and reducing the fragmenting and barrier effect of transport routes, river constructions and land used intensively for agriculture or forestry.
- **Improving the local climate** by preserving and renaturing floodplains, promoting climate-friendly agricultural use of moorlands and maintaining and improving green spaces in towns and cities as well as fresh-air corridors. These measures are all examples of ecosystem-based approaches.

[70] See http://www.stmug.bayern.de/umwelt/klimaschutz/klimaprogramm/index.htm for more information.

The sectors and objectives addressed by the publically funded projects in the database are illustrated in Figure 10 and Figure 11, below. As was the case with EU funding, public funds on a national and regional level primarily support projects using ecosystem-based approaches in the areas of nature protection and water. Here, however, urban and regional planning is the third most supported sector, which demonstrates the potential and high motivation within this sector.

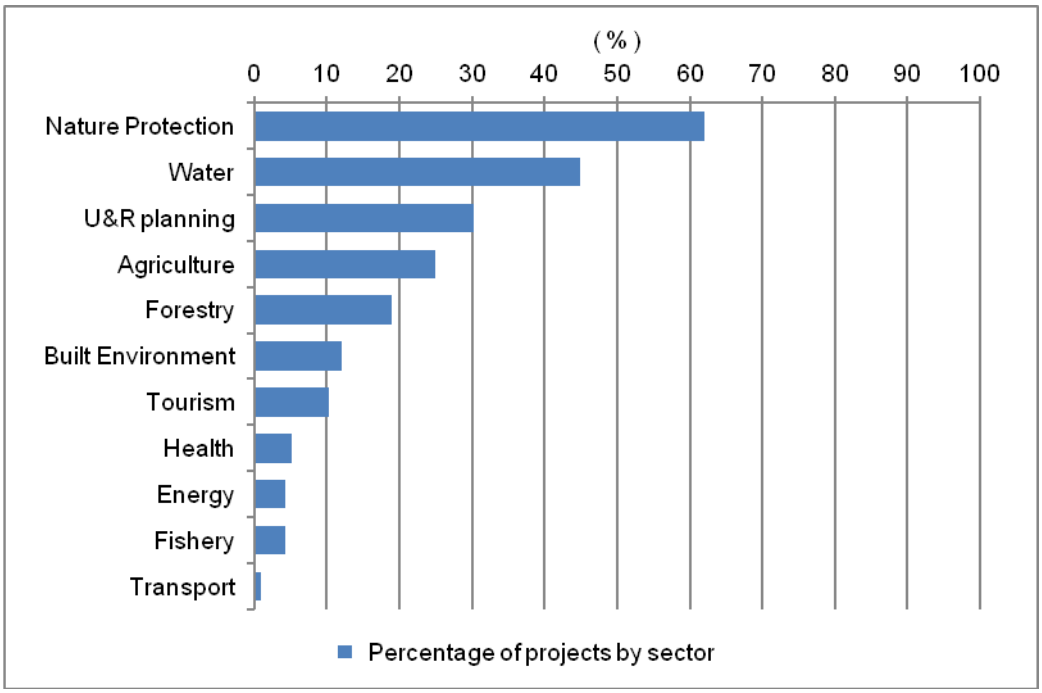


Figure 10: Sectors addressed by projects with public financing

The project *"New forests adapted to future climate"*[71], for example, addresses the sectors of water and, to a lesser degree, forestry, agriculture and nature protection. The Danish project is a joint initiative by the Danish Forest and Nature Agency, Copenhagen Energy (KE) and Hillerød Municipality, which addresses climate change in two afforestation projects and aims to protect and optimise groundwater resources. As of 2010, 140ha of land has been purchased for the project. KE is financing these purchases through a user levy of approximately DKK 0.50 per m^3 of drinking water. The Hillerød Municipality is also donating some sites and is committed to establishing connecting paths and outdoor facilities. In parallel, the North Zealand office of the Danish Forest and Nature Agency is managing the acquisition of land as it becomes available. Overall, the land is being acquired through an open market, therefore perhaps requiring several years before a single cohesive forest can be established.

[71] See http://klimatilpasning.dk/en-us/service/cases/sider/newforestsadaptedtofutureclimate.aspx for further information.

The three most commonly financed objectives are consistent with those financed with EU funds, but the remaining prioritization differs. With national and regional public funds, human health/well-being is the fourth most frequently funded priority objective.

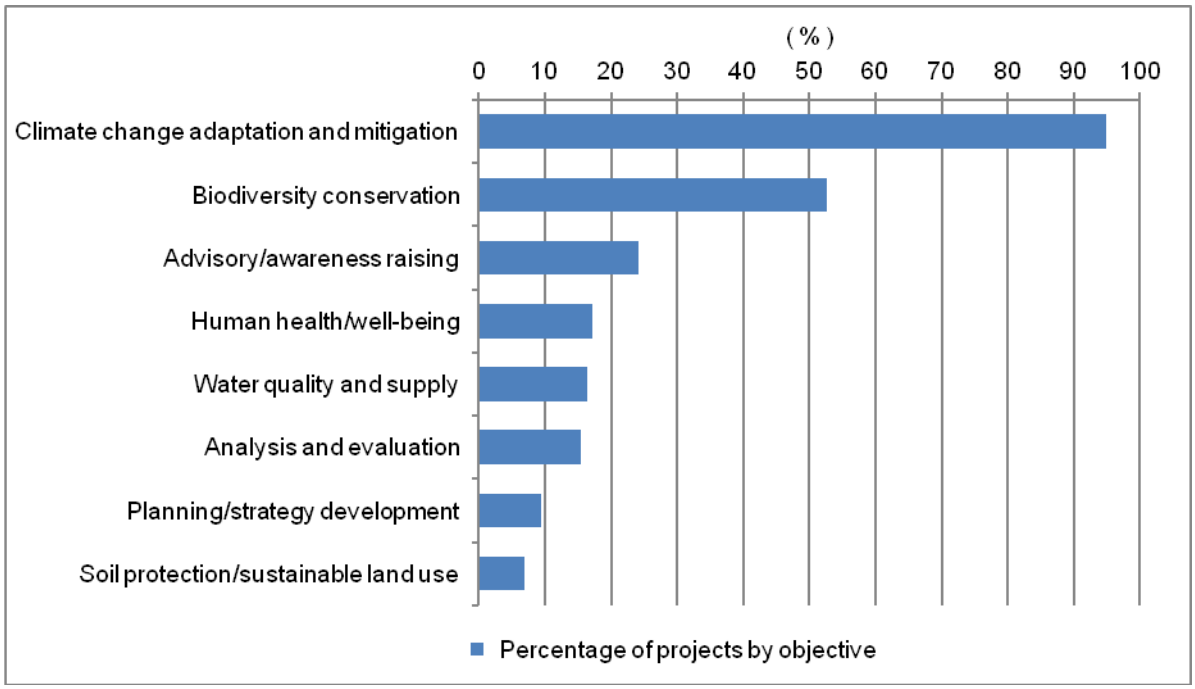


Figure 11: Objectives addressed by projects with public financing

The Wachau project "*Living space in the rivers of Mostviertel*"[72], for example, primarily addressed the objectives of biodiversity conservation and soil protection, while also contributing to climate change mitigation and adaptation. The project aimed to improve the status of river habitats in the Danube and its tributaries and to halt the loss of threatened fish species by implementing extensive river restoration measures to re-establish the spawning, reproduction and wintering habitats that have been degraded over the past decades by strong anthropomorphic pressures. The initiative is co-financed by Austrian authorities and EU funding (50%), with a total budget of €6,685,000. Half of the costs are shared between the following public bodies: Northeast Federal Water Engineering Administration, 'via the Danube', Lower Austrian Landscape Fund, Lower Austrian State Fishing Association, Public Utility Company of Amstetten, community of Amstetten, Ministry of Agriculture, Forestry, Environment and Water Management and the Lanius Association.

Private and other financing schemes

Private sources of financing comprise the second major category of funders (54 projects) and include contributions from, for example, NGOs, foundations, businesses and landowners. While projects using ecosystem-based approaches benefited from this financing source with relative frequency, few projects identified in the database were financed entirely through

[72] See http://www.life-mostviertel-wachau.at/ for additional information.

private financing. This stems from the tendency to combine various sources of funding through, for example, the more commonly employed and promoted public-private partnerships (PPPs) or via other innovative types of cooperation. These and other forms of private funding that have been employed in such projects to date are outlined in more detail in this section.

More generally, the breakdown of sectors and objectives addressed by privately financed projects within the database are illustrated in Figures 12 and 13. As is consistent with the publicly funded projects explored, nature protection, agriculture and water fall within the top four most frequently financed sectors. Similarly, the main objectives addressed are biodiversity conservation and climate change adaptation and mitigation (as with the other financing types), followed by advisory and awareness raising goals.

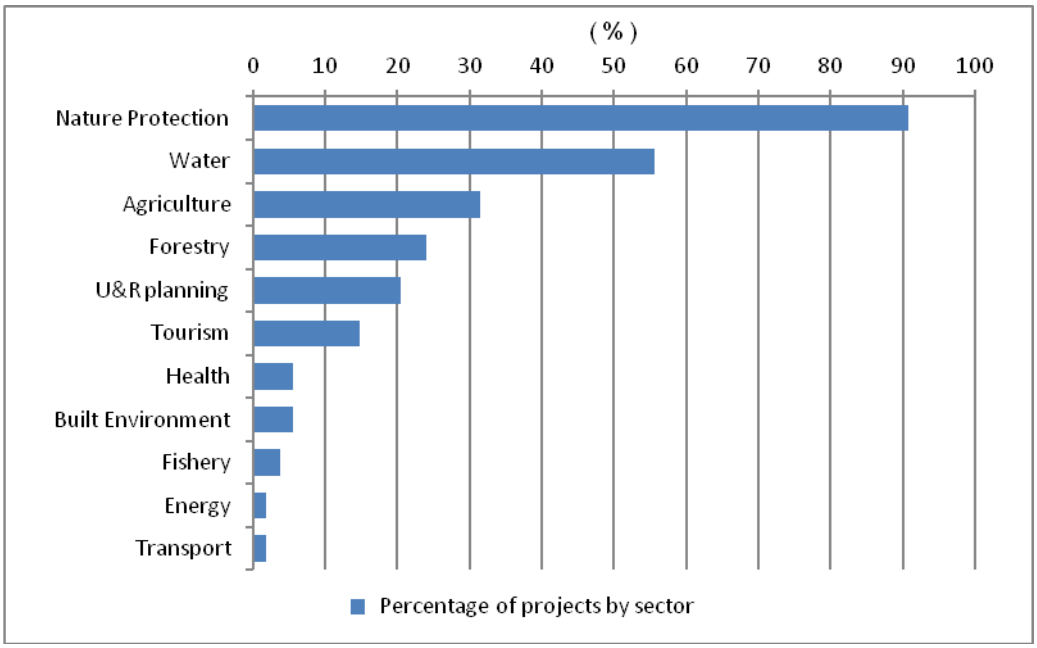


Figure 12: Sectors addressed by projects with private financing

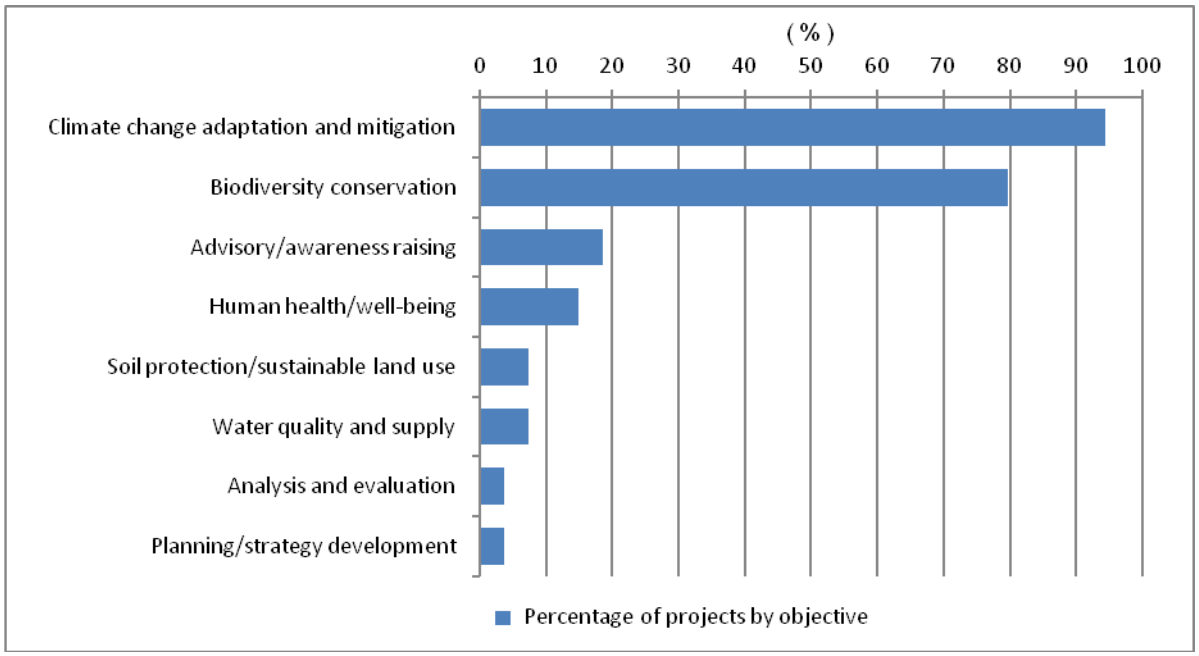


Figure 13: Objectives addressed by projects with private financing

Over 15% of the total number of projects in the database was financed via public-private partnerships. In some cases, these also integrated EU funding sources. Various sources of motivation can move private organizations or actors to finance projects using ecosystem-based approaches. For example, funders could aspire to pursue altruistic motivations or wish to demonstrate corporate social responsibility (CSR). This venue of participation from the private sector is particularly promising given that it has the potential to address environmental as well as social aspects of climate change. In addition to supporting ecosystem-based approaches, companies are also investing more in mitigation activities cutting GHG emissions. The 10th annual Carbon Disclosure Project found that 68% of the 500 largest companies in the world are now prioritizing climate change in their business strategies[73], also extending beyond company activities into the public sphere.

Alternatively, regulative instruments could require the restoration or renaturalisation of damaged sites (e.g. those used for extraction purposes, following the 'polluter pays principle') or compensation actions to offset environmental damages resulting from the construction of new infrastructure (e.g. highways, energy lines, housing complexes etc). The in-depth case study 'Wallasea Island Wild Coast Project' provides an example of such a PPP below (see Box 4).

[73] https://www.cdproject.net/en-US/Pages/global500.aspx

Box 4: Example of public-private partnership financing model (Wallasea Island)

Wallasea Island Wild Coast Project (UK)

The aim of the project is to combat the threats from climate change and coastal flooding by recreating the ancient wetland landscape of mudflats and saltmarsh, lagoons and pasture. It will also help to compensate for the loss of such tidal habitats elsewhere in England. Once completed, this will provide a haven for a wonderful array of nationally and internationally important wildlife and a recreational space for the local community.

After the initial feasibility study, a precondition of the project was obtaining sufficient funds to (1) purchase the necessary land (over £5 million) and (2) obtain the required materials for and carry out the desired construction projects (approximately £17.5 million for the physical implementation works). Sufficient buy-in was obtained to buy the land, but funds had not yet been collected to carry out the project itself. Crossrail (a 50/50 joint venture between Transport for London and the Department for Transport) stepped in to address this second cost category, thereby improving their CSR image while also addressing economic and logistical factors involved with their planned infrastructure project.

As Crossrail is currently constructing a major rail tunnel under London, they would have had to pay to transport and then dispose of the material they are removing during their construction project. Instead, they decided to pay the required costs to deliver the waste material to the island by ship and are carrying out the majority of work on the ground (placing at the correct heights to build the desired habitat), under the supervision of the Royal Society for the Protection of Birds (RSPB). Crossrail is also covering the cost of purchasing the land and some of the staff costs associated with the project. As such, the majority of costs are covered by this partner. The remaining costs are covered by the Environment Agency, who are paying a fee per hectare of re-created habitat (which is ultimately to be transferred to Crossrail to help partially offset their costs).

In addition to public private partnerships, there are several other financing models, which have been employed in the explored case studies and for which the private sector plays a crucial role. For example, 'revolving funds' such as the sale of carbon credits from emissions reductions is such a financing possibility. While the trading mechanism has not yet been finalized, the Belarus in-depth case study provides an interesting example of how to create a framework for such a self-financing mechanism.

During the first project phase of 'Restoring peatlands in Belarus', the Federal Republic of Germany financed the project through KfW Development Bank in the framework of the International Climate Protection Initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) with an overall budget of €2.5 million. The BMU acts as the funding organisation, while KfW functions as an organ through which the finances reach the chief project partner of the consortium, namely RSPB.

For the next project phase, however, the rewetting and sustainable management of the areas are envisaged to be financed by the commercial sale of credits from avoided carbon emission and restored carbon sequestration. Since March 2011, the Verified Carbon Standard (VCS) Programme[74]recognizes Peatland Rewetting Conservation (PRC) activities

[74] "The VCS Program is among the most widely used quality assurance system for accounting for greenhouse gas (GHG) emission reductions in the voluntary carbon market. Used by more than 600 projects worldwide, the VCS Program is recognized and trusted to ensure GHG emission reductions and removals are real, measurable,

as a means for the avoidance of carbon emissions by rewetting or avoiding the drainage of peatlands. This sets the necessary framework for the sale of carbon credits originating from PRC activities. In addition, the project developed a proxy to measure avoided CO_2 emissions through a combined indicator using water level and vegetation cover, which are a lot easier and less expensive to measure and monitor. Once the monitoring of emission reductions in the different sites is entirely adapted and fully functional, the revolving fund will provide the financing for future rewetting initiatives. To date, no funding for the project has come from the sale of credits; this is intended to be used in the post-project phase to cover maintenance costs of rewetted sites and to finance the restoration of new sites.

Alternatively, the in-depth case study "Retrofitting SUDS (Sustainable Urban Drainage Systems) in an urban regeneration area" in Augustenborg, Malmö utilised a different method of generating funds from the private sector. Of the total sum invested in the project area (approximately €22 million at 2011 exchange rates), around half came from the municipal housing company, MKB. A further €2.6 million can from the government's local investment programme as well €648,000 from EU LIFE and URBAN funds. The remaining funding came from a variety of other private and public sources. While this PPP between both EU and national public funds already represents a novel approach to securing financing, the MKB took the project a step further and incorporated some of the costs they incurred into the rents paid by residents. This illustrates a partial cost recovery by requiring that those benefiting from ecosystem services also contribute financially to their maintenance.

Finally, foundations have the potential to be a larger player in financing projects using ecosystem-based approaches as they often have a more general funding focus. The 'Forest rehabilitation in Krkonose and Sumava National Parks' project, for example, cost a total of approximately €22,137,500 (1992 - 2007). The project received 80% of its funding from the Face Foundation and 20% from the contract partners. The Face Foundation, set up by the Dutch Electricity Generating Board in 1990, worked with partners interested in sustainably managing forests, aiming to increase forest cover and reduce CO_2 emissions through forest rehabilitation, planting and conservation activities.

Ultimately, while public sector funds are limited and support a move towards increased private sector financing of ecosystem-based approaches, it should be noted that the extent to which this sector will become involved is uncertain. Strategic support through the public sector can have a catalytic effect to attract private funding sources; Cooperation through public private partnerships for improved CSR and the involvement of industry in compensation and off-setting actions serve as likely areas for increased involvement. However, a general lack of awareness regarding the benefits provided by ecosystem services and the value of ecosystem-based approaches as compared to traditional engineered approaches warrants more outreach and greater research and more uniform measuring techniques in order to increase general support for and thereby private financing of such projects.

additional, permanent, independently verified, conservatively estimated, uniquely numbered and transparently listed in a central database." From: http://www.v-c-s.org/how-it-works/vcs-program

5.2.3 Monitoring and evaluation

All of the projects, which were examined in the in-depth case studies analysis, have undertaken either evaluation or monitoring activities, or both. In most cases, the projects conducted an evaluation study to measure the extent to which the objectives were achieved and the project's impacts, thus providing a basis for assessing the project's success. In the case of Augustenborg, Malmö, for instance, the evaluation showed that stormwater is now successfully led through a complex arrangement of green roofs, swales, channels, ponds and small wetlands. Evaluations also often aim to gather information on costs, but only rarely conduct an analysis of benefits or a full cost-benefit analysis. Wallasea Island, Wild Coast Project was the only project for which an economic benefits study was carried out by an external institute (eftec 2008). In the case of the De Doorbraak, a 'No Action' evaluation was conducted to explore possible costs that would have been incurred in the event that De Doorbraak would not have been built. The result showed that in the future, a part of Almelo could have been under water and that it would have resulted in €30 million in incurred costs. With such studies, evidence can be provided as to why such projects are needed and the range of benefits that can be achieved.

Several case studies[75] also revealed that in terms of measuring the impacts of climate change related actions, the challenge is, for example, to assess the amount of CO_2 captured (in ecosystems such as forests and peatlands) by the actions carried out. The basis for such procedures is to outline the initial state (establishing a baseline) as well as the desired post-implementation state. For the restoring peatlands projects, mapping has been identified as an effective primary tool of prediction used in this stage, which helps to characterize the site and its biological community. In this case, the obtained information was used to identify the target biotope desired for the site in the future. Moreover, the project adapted the GHG emission site type (GEST) model developed by the University of Greifswald in Germany to meet the specific conditions in Belarus. This model uses vegetation type and water level as a proxy for the levels of avoided CO_2 emissions, which are estimated for the Belarus project sites at an average of 2.5 tons of CO_2/ha/year.

In some projects, monitoring activities were also carried out, albeit with different frequencies. De Doorbraak, for example, started monitoring activities from the beginning of the project to produce consistent observations of the development of flora and fauna, regardless of whether responsibility for or within the project changed. Monitoring is carried out once a year and will be also continued after the project has ended. The emphasis is on the development of 'target-species' set for this project, not only to assess the impacts on biodiversity, but also on the water quality of the ponds built. In the Wallasea Island project, monitoring activities are planned to track the flow rates at the breaches and sedimentation rates in the wider estuary. This will include assessing vegetation, the impacts of development on the ecology of the system and impacts on the oyster fisheries.

Assessing a project's success and informing relevant stakeholders and the interested public about the outcomes, thereby increases the acceptance of and support for such projects. In order to conduct such evaluation studies, setting clear targets (in qualitative and quantitative terms) as well as establishing a baseline is very helpful, but is still rarely done in projects.

[75] Including the projects: Forest rehabilitation Krknose and Sumava NP and restoring peatlands in Belarus.

While the focus of evaluation and monitoring activities is often on environment impacts, analyses of wider benefits can provide additional information, including the different types of ecosystem services delivered as well as wider socio-economic benefits, providing evidence of the effectiveness of ecosystem-based approaches (also see Section 6).

5.2.4 Building public awareness and stakeholder involvement

When discussing the level of public awareness about the current threats posed by climate change and biodiversity loss, different groups should be taken into consideration, including the general public, authorities and policy makers, private companies/business, social actors civil society (NGOs) and researchers.

Throughout the world, the understanding of the aforementioned topics and the extent of their influence on humans is an issue that varies widely. While some countries are highly conscious, informed and/or engaged, others appear to be absent from the discussion (these disparities are also often true at the regional and local levels). Within a European context, although efforts are being taken by the EU regarding the harmonization and establishment of appropriate legislation and mechanisms to combat environmental degradation, the level of awareness across the regions varies considerably.

Regarding the main topic within this study, the ecosystem-based approaches to climate change adaptation and mitigation, the concept has emerged relatively recently, implying the need for outreach, awareness raising and further scientific underpinning. Therefore, it was surprising that the roughly 161 projects reviewed in this study assigned varying levels of importance to awareness raising measures. In general, the projects, which gave substantial weight to their awareness raising activities, have also identified this as a key factor within the project design, which can be credited for the success of the proposed initiatives.

Activities promoting awareness building and stakeholder engagement might be not relevant for all projects, but can be considered useful tools and as success factors in projects in certain scenarios. Projects in which such activities were found to be especially important were those in which different interests and point of views converged, projects led to land use restrictions and/or required the purchasing of land and projects in which behaviours and attitudes towards more sustainable management needed to be changed.

Approaches employed for awareness raising, communications and consultation

Table 15 shows a categorization of the approaches used by project managers to build awareness both in the sites in which the projects are being implemented and abroad. The items highlighted in bold were found to be particularly relevant to project success and are discussed in more detail below.

Table 15: Public awareness approaches employed by the projects analyzed

Public addressing events	Seminars	Print media	Electronic media	Others
Conferences/ presentations	**Field seminars**	Technical and non-technical publications	Website	Photo exhibitions
Workshops	**Community consultation seminars**	**Newsletters/ hand-outs**	Media stories	Posters
Open meetings	Seminars in education institutions	Periodical flyers/leaflets	Online databases	Museum expositions
Press releases***	Technical knowledge sharing seminars	Training material	E-newsletter	Best practice advice
-	-	**Newspaper articles**	TV appearances	-

Source: Own elaboration.

According to the information gathered in the detailed case studies, engaging the public has been found to be a key factor for the success and durability of initiatives beyond the lifetime of the initiating project. This conclusion holds true whether the public is integrated by including the inhabitants of a small community, the representatives of a private enterprise or the government authorities of a municipality. According to several interviewees, the most effective instruments to get stakeholders and beneficiaries informed and involved are workshops, field seminars, consultation seminars and periodical print media, such as newspaper articles and booklets. While electronic media was utilised by several projects in the form of websites, the field of social media was not addressed within this context. However, given the potential of this medium as powerful multipliers, social media use should be more thoroughly explored and considered in future projects.

Workshops, field seminars and community consultation seminars: These three methods of addressing the public have similar structural characteristics, although the distinct advantages of each were clearly identified by interviewees. In the case of workshops, the face-to-face interaction and the ability to react to inquiries immediately were considered as the main advantages. Regarding field seminars, using the project site as a setting for the event enhanced the audience's understanding of the project and created a sense of belonging. Lastly, community consultation seminars created a direct communication channel between stakeholders, beneficiaries and project members and enabled a 'hands-on' environment, which was highly influential to the sharing of ideas and experiences.

Newspaper articles and booklets: These forms of communication media provided an opportunity for the public to access brief descriptive overviews outlining the problem(s) addressed and proposed solution(s).

Some of the projects are exploring more innovative methods of communication, such as photographic exhibitions (both live and online) as well as museum displays. These tools offer new ways to raise the public interest in environmental issues and also gain access to detailed information.

Stakeholder involvement

Stakeholder involvement and participation processes play a special role in the successful implementation of many projects at the local/regional level. Such involvement might be necessary if conflicting priorities exist (e.g. agricultural land use vs. flood prevention through wetland restoration), if a wide variety of stakeholders are involved and if projects are embedded in wider spatial planning processes requiring consultation and agreements with different authorities and stakeholders. Moreover, stakeholder participation might be necessary to obtain public perspectives on the proposed project design to validate its feasibility, include the local and regional needs of the affected stakeholders and thus create support for and increase the acceptability and ownership of the idea. Such processes are also key to ensuring the maintenance of the project and a long-term collaboration with the involved land users and/or the local community. On the other hand, a need for stakeholder participation might be minor in cases in which the relevant land is owned by the public or already designated to sustainable land use and/or nature protection.

All of the conducted in-depth case studies targeted stakeholder involvement processes, which for the most part, were initiated at the beginning of the projects. In the De Doorbraak project, for example, one of the major barriers experienced was a lack of support on behalf of the local community and, in particular, from the farmers as their own land would have been part of the project area. Frequent stakeholder involvement activities, starting in the planning phase, contributed to the fact that approximately 90% of the people that work with the project or live close to the project area have changed their opinion about the project to being positive (also see 5.3.3).

Similar experiences were encountered in the Wallasea Island project; here, extensive public engagement and consultation processes were carried out during the design phases. This was particularly important because the project aim was to create new habitats at the expense of productive agricultural land and because the public had voiced strong objections to the sea walls being breached (also see 5.3.3). The sense was that past generations had worked very hard to reclaim these areas from the sea. Other objections from the community came from the oyster fishermen and recreational yachtsmen who were concerned that the project might disrupt yachting routes and diminish oyster productivity. As a consequence, public consultation processes were carried out with local landowners (farmers), residents, oyster fishermen, and recreational yachtsmen as well as the project partners (Defra, the Environment Agency and private companies). Additional activities included education campaigns, conducting studies and designing solutions so that oyster productivity could ultimately improve and the impacts on yachting could be minimized. The barriers associated with public awareness have not yet been fully overcome, but have helped to create a more supportive public opinion.

The Forest Rehabilitation Krkonose and Sumava National Parks outlined the advantages of adopting an integrated project approach and pertinent stakeholder participation, as follows:

- creates the possibility to explore all the expert knowledge of specialists of specific departments to resolve relevant issues,
- creates good conditions for cooperation between specialists (foresters with nature conservationists; practitioners and researchers; professionals and stakeholders),
- induces a sphere of involvement, common interest and participation,

- develops a sphere of responsibility (both individual and common),
- enhances the idea of a need for change in the matter concerned,
- brings innovation into the planning and field of practice, and
- creates the need for strong coordination and the exchange of information.

In order to successfully implement projects, the need for stakeholder participation should be considered in the early stages of and perhaps throughout the entire project in order to adequately design, plan and implement the consultation process. Experience reveals that such activities often take a long time before showing success.

The effects of building awareness on project development and delivery

To illustrate the actual effects of awareness levels specifically on ecosystem-based approaches, some examples can be extracted from the case studies and are provided in the following box.

Box 5: Examples on building awareness effects from case studies

Wallasea Island (UK): In this project, public awareness of the impacts of climate change and the response options that are available was quite low prior to the consultation process. This yielded some public objections and negative press in response to the project. In particular, the public needed to be educated about the ecological reality that certain ecosystems are always in a state of flux and thus cannot/should not indefinitely be preserved in a static state.

Augustenborg, Malmö (SE): It is probable that due to a lack of understanding of the ultimate benefits of ecosystem-based approaches, future projects of this nature throughout Malmö and Sweden have slowed somewhat over recent years. Increased awareness could lead to additional funding being devoted to projects of this type and enhanced the level of public acceptance regarding their implementation.

Forest Rehabilitation in Krkonoše and Sumava National Parks (CZ): In this case, the design of a new protection plan for the Krkonoše National Park turned out to be a lengthy procedure which, in the opinion of the project members, would have benefited from a higher level of awareness about the benefits of the approach. As all Czech forests are regulated by Czech Forestry Law, increased awareness could help to change the political approach to forestry away from commercial forestry, thereby having implications for the success of and level of financial support for implementation of close-to-nature forestry on the ground.

In summary, building awareness activities and stakeholder involvement is often vital in terms of:

- Increasing acceptance for projects and its implementation and for developing ownership of the idea;
- Highlighting the benefits of the proposed project (implementing an ecosystem-based approach);
- Exploring potential financing sources;
- Ensuring maintenance of the project; and
- Changing a political approach/strategy towards more sustainable management.

5.3 Barriers and Opportunities

Ecosystem-based approaches to adaptation and mitigation represent significant potential to attain multiple objectives simultaneously, such as protecting a community against future floods while providing an ecological corridor and enhancing public amenities. Even so, these practices are relatively nascent, and not yet widespread or well known. This creates a host of challenges associated with the technical task of designing and implementing effective strategies, organizational challenges related to the need to bring together a wider variety of practitioners and stakeholders than might be required for a traditional technological approach, and even behavioual issues arising from the power of habitutal modes of practices[76]. This section will explore these barriers in the context of the five case studies and present strategies that have been employed to overcome them or opportunities where this could be done in the future.

The existing literature on both collective (i.e. organisational) and individual behaviour change suggests that both individual psychological and contextual or collective factors play critical roles in shaping our behavior (cf. Kollmuss and Agyeman, 2002; Stern, 2000). This literature was used as a lens through which to view the responses gathered within each case study. Added to these issues are technical challenges that were encountered in many cases, most of which were remedied through a mix of technical and behavioural solutions. In the sections that follow we apply the barrier typology presented in 4.5 (see Table 10), with a particular focus on capacity, structural or operational barriers, cultural and behavioural barriers, regulatory and legislative issues and challenges related to the political and socioeconomic context.

5.3.1 Capacity issues

The concept of capacity is closely linked to the question of action on climate. In other words, what institutional, financial or technical (i.e. knowledge-based) resources are required to support action on climate change (Yohe, 2001, Yohe and Tol, 2002, Adger *et al.*, 2007)? The concept of adaptive capacity has been linked to vulnerability and to the impacts of climate change, and it was noted that the vulnerability of human socio-economic systems depends on both economic circumstances and institutional infrastructure (Adger and Vincent, 2005; Brooks et al., 2005; IPCC, 2007). Adaptive capacity appears to specifically depend on resources such as financial, human and social capital, risk-spreading mechanisms such as insurance, decision-making capacity and availability of technological options (Yohe, 2001). Psychological elements were later added to the growing list of capacity indicators, such as perceived capacity to respond (Grothmann and Patt, 2005).

A gap in financial capacity was found in a number of the cases. These financial challenges followed particular patterns, and were related to: a) sufficiency, or whether or not the absolute level of funding was sufficient to support the project; b) predictability, or the expectation that the funding would continue throughout the lifetime of the project; and c) uncertainty, or a lack of understanding of what the financial costs might be, and how they

[76] These habits are often reinforced by standard operating procedures and implicit standards within an organizational culture or structure that create disincentives for innovative or unusual actions (Burch, 2010a).

might evolve over time[77]. In the case of the Sustainable Urban Drainage Systems (SUDS) in the neighbourhood of Augustenborg, Malmö, for instance, uncertainty was a challenge. Scholars have found that there is minimal data available regarding the real costs of operating and maintaining SUDS to ensure that they continue to perform as per their design function. This appears to be one of the primary barriers to their uptake (Duffy, et al., 2008).

Similarly, both predictability and sufficiency were key challenges for the design and implementation of the Wallasea Island project. There was initially a significant battle within the Royal Society for the Protection of Birds (RSPB), the key proponent of this project, as this is a major expenditure for them. Sufficient buy-in was obtained to purchase the land, but funds had not yet been collected to carry out the project itself. It was at this point that Crossrail (a company that is a joint venture between Transport for London and the Department for Transport) came forward with an offer of material and funding that permitted the project to move forward with more confidence. Ultimately, funding barriers were related to both obtaining sufficient funds as well as minimizing the uncertainty associated with future funding. A strong relationship with the landowner was particularly important in the early design phases of the project, as this led to the ability of Defra to take out a two-year purchase option. This meant that, for a two-year period, RSPB could purchase the majority of the island if they decided to, and the price would be fixed at the beginning of this period. This created some certainty surrounding the initial costs of the project.

Technical capacity, or knowledge and understanding of design characteristics and their implications for projects using ecosystem-based approaches, is critical in the case of new and emerging approaches. Gaps in technical capacity may take the form of a lack of understanding about the ways in which the project might interact with other biophysical systems, a lack of precedents for project type and character, materials used and other aspects of design, and challenges to combining ecosystem-based approaches with traditional engineered solutions.

In the case of Augustenborg, Malmö, for instance, important barriers emerged from implementing SUDS in the context of existing development and infrastructure as well as with residents, in situ (Kazmierczak and Carter, 2010). More specifically, there was path dependency or lock-in[78] associated with the infrastructure that was already in place, requiring considerable buy-in and capital to implement SUDS. The challenge was to develop a system that was functional, did not damage existing buildings and infrastructures, and was acceptable to residents (Kazmierczak and Carter, 2010). Further challenges regarding design (technical barrier)also emerged, such as: fitting SUDS around existing electricity, water heating and telephone infrastructure, solving health and safety issues related to nearby school grounds; and building a system that is aesthetically acceptable to residents (Kazmierczak and Carter, 2010).

In the case of the SUDS retrofit in Augustenborg, technical barriers were overcome by re-designing and in some cases not implementing certain elements of the system. Technological solutions were also utilized, and extensive consultation with local residents

[77] For more detail on the financial costs and benefits of the projects, see Section 6 of this report.

[78] Path dependency refers to the phenomenon in which contingent events based on agency and choice lead to alternative paths becoming increasing less probable over time (Mahoney, 2000; Pierson, 2004). As a result of this process, social, organizational, and technical processes tend to be characterized by sensitive dependence on initial conditions and inertia (Thelen, 2003; Pierson, 2000; Arthur, 1989).

occurred. Similarly, in the Wallasea Island case, the main solution to technical barriers was extensive modelling, environmental impact assessments, and redesign of solutions. In particular, the design of three smaller managed realignments rather than one large one helped to overcome this problem of scale. Many of the barriers have been overcome by open dialogue leading to practical (and often technical) solutions.

In the Wallasea Island case, the RSPB have worked very closely with Natural England, an important stakeholder and source of technical expertise. Furthermore, during project development, RSPB set up a technical panel of key regulators to provide help and advice during the design phase. This essentially helped them identify and overcome both technical and regulatory barriers prior to project implementation. Similarly, hiring a very experienced project manager from the outset of the project design was key to the early successes of this project. This individual was the leading UK expert on managed realignment, and brought this expertise to the design of the Wallasea Island Wild Coast project.

Human capacity is intricately related to technical capacity. Not only is it important that the requisite knowledge about ecosystem-based approaches exists, but also that communities or Members States have access to experienced practitioners who are able to work within current infrastructural constraints and development priorities. In the Wallasea Island case, for instance, project designers encountered challenges in finding examples of projects to refer to which were implemented on the same spatial scale. Furthermore, it is critical to create systems of institutional learning so that a single individual is not the sole holder of all insights and expertise gained through the implementation of an experimental ecosystem-based project. The exchange of best practices is particularly important and desired.

5.3.2 Structural or operational issues

As discussed in greater detail in Section 4.5, the barriers faced in designing and implementing ecosystem-based approaches are equally related to institutions and behaviour in addition to technical and financial issues. Structural and operational issues relate to the way that organizations are set up (such as separating the planning and engineering departments within municipal governments), the function of that organization and the mechanisms in place to allow for cross-fertilization of ideas and collaboration. These become particularly important in the case of projects using ecosystem-based approaches that require the participation of a variety of governmental and non-governmental partners.

Taking the Augustenborg, Malmö case study as an example, the initial barriers emerged during the proposal and design phases of the project's SUDS. These were most frequently related to a lack of awareness or doubts about the value of the non-engineered solutions. Also important, however, was the perception that engineers from Malmö Water were interfering with the activities of the city planners (Stahre, 2008). This reveals the complexity of organizational cultures that are often required to come together to implement innovative solutions within the context of projects using ecosystem-based approaches. Organizational uncertainty is also a challenge: In Šumava National Park (one of the two projects within the forest rehabilitation in-depth case study), the operation plan was drafted during a period marked by major restructuring of park administration and forest management (Administration of the National Park and Landscape Protected Area, 2001). The administrative instability contributed to the premature ending of project implementation in this national park, as

opposed to the more successful implementation, which took place in its counterpart, Krkonoše National Park.

In the De Doobraak case study, a host of partners were involved, ranging from the water board and province to the Dutch Organization for Agriculture and Horticulture and the Dutch Ministry of Economic Affairs. This presents the challenge of organizational complexity. In this case, however, partners played different well-defined roles (i.e. operational versus strategic) and mechanisms were explicitly set up for collaboration. There is also a further need to work across departments and governance scales, as the implementation of the adaptation principles could be affected by their mitigation and adaptation actions and it may be possible to achieve cost-effective synergies or identify required trade-offs (Paterson *et al.*, 2008; Berry, 2009).

In the Wallasea Island case, complications were created by the various isolated divisions of the Environment Agency (EA) (an issue of organizational structure). The EA have jurisdiction over the seawalls, so permissions must be obtained from one arm of the EA to do work there. Another arm of the EA is paying the RSPB to create the habitats, and yet another arm provides environmental permissions for the import of materials. The fact that the EA must buy in to the project because it is a source of compensatory habitat alleviates some of the challenges associated with this organizational complexity. Interviewees commented on this complexity, but also noted that it is simply due process and does not necessarily create conflicts.

5.3.3 Organizational culture, individual behaviour and awareness

Although the dominant rhetoric of many organizations is one of rational cost-benefit analysis and technical solutions, the reality is that organizational culture and the psychology of human behaviour deeply influence the ultimate actions that are taken in response to climate change (Burch 2010a, b). These cultural and behavioural issues range from public awareness and perception of a suggested project to combat climate change to organizational cultures of competition or collaboration and the power of habitual modes of practice to determine both project design and implementation.

In both the Peatlands Restoration (Belarus) and Wallasea Island projects, the involvement of a wide variety and number of stakeholders resulted in a more complex collection of interests that needed to be accounted for. It is particularly challenging to account for these interests in communities where language barriers or apathy are present, as may have been in the case in the SUDS retro fit in Augustenborg (Kazmierczak and Carter, 2010). Similarly, in the Belarus case, general misunderstandings/ misinformation existed on the part of some stakeholders and authorities about ecosystems, their services and functions and their interactions with their surroundings. This reconfirms the need for outreach and awareness raising activities.

Extensive public engagement, consultation processes and education campaigns were carried out during the design phases of the Wallasea Island project to justify and explain the loss of productive agricultural land, the planned breach of the sea walls, which were built over many years and to address the concerns of the oyster fishermen and recreational yachtsmen regarding a possible loss of income (also see 5.2.4). Consequently, studies were carried out and technical solutions were designed so that oyster productivity could ultimately improve and the impacts on yachting would be minimized. Furthermore, consultations with

the public required significant education about the potential impacts of climate change and the risks associated with a rise in sea level.

The barriers associated with public awareness have not been fully overcome in the Wallasea Island case, although extensive public consultation and education campaigns have helped bring public opinion onside. Public engagement helped to overcome negative public perception of the De Doorbraak project – interviewees estimated that approximately 90% of public participants changed their opinion to a positive one following iterative consultation process (also see 5.2.4). In both Belarus and Augustenborg, however, the involvement of a wide variety and number of stakeholders resulted in a more complex collection of interests that must be accounted for. Furthermore, public exhaustion can occur with regard to engagement processes (as was the case in the De Doorbraak and Augustenborg projects) and advocates can move on to other activities not relating ot the ecosystem-based projects, leading to a gap in institutional knowledge on the subject. . As such, mechanisms can be formulated to perpetuate momentum and enhance institutional memory (such as incorporating ecosystem-based principles into standard operating procedures and job descriptions, and clearly defining the purpose of public engagement procedures).

It is important to also consider stakeholders' attachment to land and a sense of place in evaluating the tradeoffs associated with a project. Simply providing compensatory agricultural land to farmers in a different location so that a project can occur, for instance, may not satisfy stakeholders. Indeed, in the De Doorbraak project, farmers represented the major detractors of the project, despite offers of more compensatory land than they would be losing to the project.

An interviewee from the Forest Rehabilitation in Krkonose and Sumava National Parks (CZ) case revealed that "the most important internal barrier was to prepare the staff to accept all chapters of the management plan. This was difficult because of new management strategies, such as leaving dead trees on the ground because that is where natural regeneration takes place, or managing pioneer species. Over time, we managed to change people's opinions on forest management." Clearly systematic ecological and technical education of the staff is necessary to avoid misunderstandings, mistakes and misplaced measures (Emmer and Sevnik, 2003). Workers involved must be assured that their work will not be redundant. A special focus could be placed on best practices and the multiple benefits associated with ecosystem-based approaches. The forest rehabilitation project also demonstrates differing organizational cultures and perception of the problem. The Dutch researchers involved and Face Foundation differed in views from the technical foresters of the Šumava National Park (NP). These foresters viewed the forest only as a place to produce wood and timber, which is currently the trend in Czech forestry, instead of supporting natural processes and ecological functioning (e.g. restoring soil functioning). Poor support of ecosystem-based approaches within park administration/forest management from a scientific point of view, together with structural barriers, impeded the long-term implementation of ecologic forest restoration in Šumava NP. Following the withdrawal of project partners in 2002, the park's management continued spruce stand restoration activities, but on sites deemed 'inadequate' (i.e. in lower altitudes and outside of the species natural distribution) by the original project funders.

Taking another example, the driving force behind the Augustenborg SUDS project and other successful sustainable urban drainage endeavours (Stahre, 2008) has been found to be a high level of active support from the top managerial levels in the city administration. "The politicians and managers of different city departments must have the courage to withstand

the critiques that inevitably will come from the traditionalists in their respective organisations" (Stahre, 2008: 95). This support and leadership may be critical to overcoming barriers that grow out of differing organizational cultures.

5.3.4 Regulations, policies and legislation

All partners must function within particular legislative and policy contexts, which have been extremely labour-intensive to produce and may be very difficult to shift. This is a specific manifestation of 'path dependency', or inertia behind policy practices and patterns of behaviour (for an explanation of path dependency, see Section 5.3.1). An example of this is the pressure to maintain a particular mix of species and habitats in a protected area (whether because of legislative edict or strong local cultural preferences for a landscape to appear and function in a certain way), rather than allowing habitats and species to shift as climate changes.

According to the UK Lawton Review, "the impact of policy on land-use is particularly clear in agriculture, where government policy drove the intensification of land-use for much of the twentieth century, while the EU Common Agricultural Policy has had a strong influence on how agricultural land is used and managed in recent decades" (Lawton *et al.*, 2010) and will continue to do so in the future. This statement demonstrates the inter-woven nature of legislative and governance barriers.

The Wallasea Island project illustrates regulatory and legislative issues, as a vast number of regulatory permissions were required in order to move forward with the project. The main one was a planning permission with Essex County Council, with 43 separate planning conditions and also a Section 106 agreement covering issues outside of this planning zone. Project proponents must pay money for road improvements, and have a local liaison group to support tourism planning activities. Work licenses are also required from Crouch Harbour Authority in order to carry out any work in the Crouch Estuary. Activities (such as this project) that affect the intertidal zone require permissions from the Marine Management Organization (under the Food and Environment Protection Act).

One interviewee suggested that policies are not sufficiently joined up as to support ecosystem-based approaches. For instance, the Environment Agency recognizes that there is a problem with low-lying land, but does not create a proper long term strategy that would generate the needed partnerships (i.e. between private sector infrastructure providers and NGOs) and funding to create sustainable solutions. Currently, the trend is actually in the opposite direction, in which farmers are being given more freedom to manage their flood defenses independently. This may mirror the localism trend that has become more prevalent in the UK since 2010, which has also challenged efforts to created landscape scale biodiversity strategies.

In the peatland restoration project (Belarus), the focus of existing local legislation for the approval of voluntary emission reduction projects is mostly on the industry and power generation sectors, for example energy efficiency, renewable energies. This issue has marginalized nature conservation approaches since the legislation lacks the necessary level of detail in this area. Furthermore, there are difficulties in importing the specialized

equipment necessary[79] for the quantification of carbon emissions in the project sites. In the De Doorbraak case, one interviewee suggested that legislative barriers could be overcome by imposing a law that requires landowners to sell their land to the project to avoid the extensive costs and time consumed by attempting to reach voluntary agreements with landowners, although this resembles expropriation and could therefore be difficult in practice. Similarly, in England, the regulatory environment doesn't state that infrastructure projects must transport their waste material to projects such as Wallasea Island. The result is deep uncertainty with regard to fill material. Such a new policy would be made a combination of Land-use Planning and the Environment Agency, but ultimately, the policy environment could be more supportive of these ecosystem-based projects.

5.3.5 Political and socioeconomic context

Ecosystem-based approaches to adaptation and mitigation are developed and implemented within particular socio-economic and political contexts, which may radically and unexpectedly shift during the lifetime of a project. The recent global economic crises for instance, may either shift attention away from environmental problems or provide a compelling opportunity to pursue new projects that simultaneously and cost-effectively deliver multiple benefits while enhancing resilience.

As politicians change, shifts can occur in the level of public support for projects, which occurred in the De Doorbraak case. This is linked to the transience described above with regard to advocates moving on from their positions and the need to enhance institutional memory, and suggests the need to embed these practices in organizations that will continue regardless of changing political winds.

While many organisational and behavioural barriers may inhibit the application of adaptation principles to biodiversity and ecosystem-based approaches to adaptation at the policy level, additional challenges are faced during actual implementation. Chief amongst these is often conflicting priorities. For instance, the Wallasea Island project was subject to local criticism due to perceived need for land for agricultural production, and this is the subject of wider national debate. Indeed, according to the 2010 Climate Change Plan, agriculture covers 75% of England's total land area and plays a critical role in the country's economy. This dominance of agriculture highlights the need to adapt the food system to simultaneously adapt to climatic shifts and support biodiversity. The England Biodiversity Strategy, however, identifies a number of risks and uncertainties (such as financial limitations on government spending and shifting agricultural trade policy) that may affect progress toward a vision of a mutually supportive relationship between conservation and agriculture (Defra, 2002). As such, public education and awareness-building campaigns must build understanding of the importance of ecosystem service provision by the natural world. Biodiversity loss cannot be tackled without addressing climate change, but it is equally impossible to tackle climate change without addressing biodiversity loss and maintaining and restoring ecosystem services.

[79] There were problems with the Belarusian border authorities in terms of import/export laws.

5.4 Concluding remarks

Taking the elementary aspects of projects using ecosystem-based approaches outlined throughout this section into account, several important conclusions can be drawn. First, there are several drivers for the implementation of ecosystem-based approaches at the project level, ranging from policy and strategic objectives at the international and EU levels to specific national and/or local policies as well as local needs and stakeholder motivations. In particular, the United Nations Framework Convention on Climate Change (UNFCC), the Water Framework Directive (WFD) and the Habitats Directive were mentioned in addition to national programmes and strategies aiming to implement EU legislation. Key objectives for these policies were climate change mitigation and adaptation, sustainable development, environmental and nature protection and/or improving ecological connectivity, which are also shared by other EU policies and thus offer further potential for the integration of such approaches. The EU Biodiversity Strategy up to 2020 and the planned initiative on Green Infrastructure can become instrumental with regards to integration.

While international, EU and national policies provide the framework for implementation; the projects are initiated and carried out at the regional and/or local level. Therefore, the needs, willingness and motivation of local stakeholders including public authorities are important for the project initiation and can act as strong drivers. Highlighting the multiple benefits provided by ecosystem-based approaches (as compared to traditional engineered solutions) and providing evidence on their cost-effectiveness can boost the uptake of such approaches.

The case studies analysed also pointed to a number of features that lead to the successful management of projects using ecosystem-based approaches. These include, *inter alia*, project management experience amongst the staff with sufficient expertise and a strong track-record in carrying out similarly complex projects, clear delineation of roles and transparent communication among project partners and commitment to the project from the relevant parties for the duration of the project. In the event of conflicting priorities (e.g. agricultural land use vs. flood prevention through wetland restoration) or the involvement of a wide variety of stakeholders, stakeholder consultation and participation processes are needed from the initial planning phase of projects onwards. Such activities might be necessary to obtain public perspectives on the proposed project design, validate its feasibility, include local and regional needs of the affected stakeholders, and thereby create support and acceptability for the project and ownership of the idea. In addition, the maintenance of the project and respectively a long-term collaboration with the involved land users/the local community can be ensured. An overall issue is to raise awareness for the current threats posed by climate change and biodiversity loss (and its implications) and the employed ecosystem-based approaches to address these threats. Highlighting the multiple benefits of the proposed project, which are linked to the ecosystem-based approaches is key within this context.

The high diversity of aims, focuses and actors involved is also linked to a wide range of possible financing sources at different levels, which may be used alone or in combination with one another for supporting ecosystem-based approaches. The two most common EU funding sources used to finance the ecosystem-based approach projects in the database are the LIFE+ and European Regional Development Fund ERDF (INTERREG) programme. However, additional EU financing sources also have the potential to support such projects in the future, such as the European Agricultural Fund for Rural Development (Common

Agricultural Policy, Pillar 2) or forestry and water policies, as highlighted in Table 23. Financing can be also provided through national and regional climate action programmes. Highlighting the multiple benefits of projects using ecosystem-based approaches for the different sectors is essential to better explore and use available public financing instruments.

Further emphasis should be on the involvement of private actors to broaden the spectrum of financing. Opportunities can include carbon markets, private-public partnerships and collaborating with companies, which are required to offset infrastructure activities and their impacts. Regarding funding, the case studies also highlighted that one important task is to secure funding levels for the duration of the project to avoid uncertainties and delays in implementation.

As shown in the case studies, monitoring activities and evaluation studies can help to assess a project's success and to inform relevant stakeholders and thereby increasing the acceptance of and support for such projects. To date, the focus of such activities is often on environmental impacts while the wider benefits are still rarely assessed, including the different types of ecosystem services delivered as well as socio-economic benefits. Specifically, this information can provide strong arguments to use ecosystem-based approaches and can increase its level of support.

One particular focus in the in-depth case studies was on the analysis of barriers experienced, which included a variety of organizational, institutional, behavioural, technical and contextual issues. The barriers, which were particularly common include:

- a lack of financial sufficiency and predictability;
- limits to technical expertise and awareness;
- organizational and institutional complexity arising out of the diversity and number of partners that must be engaged in many projects using ecosystem-based approaches;
- antecedent regulatory or legislative decisions that inhibit landscape-scale decision-making and the creative provision of funds, materials, and expertise; and
- limited public awareness about the multiple benefits associated with ecosystem-based approaches.

Even so, creative solutions to many of these challenges have been found in these five cases, which have also been partly discussed in the different sections in Section 5.2. In addition to public engagement, the active sharing of best practices has been considered as one important contribution to the solution. This will rely on constructing long-term monitoring and evaluation mechanisms so as to empirically demonstrate the cost-effectiveness and technical sophistication of ecosystem-based approaches. Finally, it appears to be critical to develop standard operating procedures and alter job descriptions so that ecosystem-based approaches can become embedded in common practice rather than be tied to the leadership of a small number of individuals. This will be a key factor in the long-term expansion and evolution of ecosystem-based approaches.

6 Cost and benefits of projects using ecosystem-based approaches

This section aims to shed light on the costs and benefits related to projects using ecosystem-based approaches. The analysis is based on the five in-depth case studies that have been conducted in this study. Project managers in the United Kingdom, Sweden, the Netherlands, the Czech Republic and Belarus were asked to provide evidence on the financial and opportunity costs as well as on the ecological and socio-economic benefits that occur in their respective ecosystem-based projects. The analysis draws on a cost typology that distinguishes between one-off and recurrent costs and on a benefits typology that distinguishes between ecological benefits provided by ecosystem services and wider socio-economic benefits related to employment effects and local GDP.

6.1 Cost and benefit typology

The project team has developed – in collaboration with the two parallel studies commissioned by DG Environment on "Design, implementation and cost elements of Green Infrastructure projects" and "Green Infrastructure implementation and efficiency" - a typology for the analysis of the costs and benefits associated with the five selected case studies.

According to this typology, the **costs** of implementing ecosystem-based approaches to climate change adaptation and mitigation broadly comprise:

- *Financial costs* – the value of the resources deployed in defining, protecting, managing, restoring and developing components of ecosystem-based approaches to climate change adaptation and mitigation, including the costs of labour, materials, energy, equipment and other purchased goods and services.

- *Opportunity costs* – the value of economic opportunities foregone as a result of ecosystem-based approaches to climate change adaptation and mitigation. These may include foregone development, restrictions on resource use, restrictions in output from land management and loss of socio-economic opportunities (e.g. use of land for regeneration or community uses).

Furthermore, a typology of costs can also distinguish between:

- *One off costs* – capital costs of activities to define, research, designate, purchase, protect, restore or create components of ecosystem-based approaches to climate change adaptation and mitigation that only need to be completed once;

- *Ongoing costs* – recurrent costs of activities to protect, manage, restore and monitor components of ecosystem-based approaches to climate change adaptation and mitigation that need to be undertaken on a regular basis.

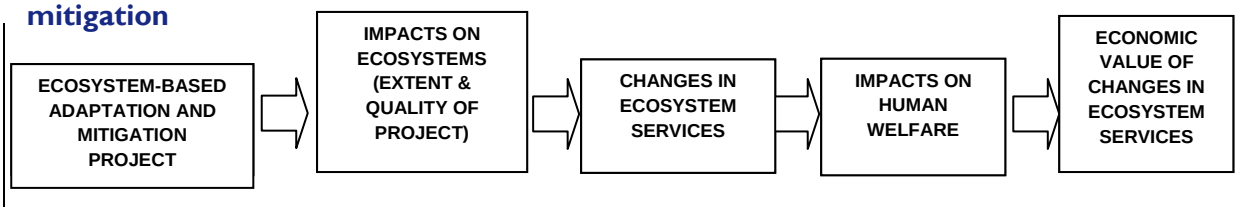
Table 16 provides a detailed overview of the cost elements, which the project team aimed to analyse in the context of the case studies.

Table 16: Typology of costs of implementing ecosystem-based approaches to climate change adaptation and mitigation

Financial Costs	One-Off Costs	Administrative, management and information costs	• Establishing management bodies • Surveys • Research • Consultation • Management plans
		Costs related to ecosystem maintenance and restoration	• Land purchase • One-off compensation payments • Maintenance of ecosystems • Restoration of ecosystems
	Recurrent Costs	Administrative, management and information costs	• Running of administrative bodies • Monitoring • Ongoing management planning • Communications
		Costs related to ecosystem maintenance and restoration	• Maintenance of ecosystems • Restoration of ecosystems • Costs of management agreements • Costs of protective actions
Opportunity Costs		Foregone development opportunities	Value of potential development foregone
		Foregone socio-economic opportunities	• Loss of regeneration opportunities • Loss of community uses of land
		Foregone output from land management	• Foregone agricultural output • Foregone forestry output
		Foregone resource use	• Loss of mineral extraction • Loss of water abstraction
		Reductions in land values	Price of land

Figure 15 provides an illustrative framework for understanding the **benefits** of implementing ecosystem-based approaches to climate change adaptation and mitigation at different stages of the value chain. It should be noted that benefits may be assessed by examining different indicators relating to changes in the ecosystem, ecosystem services, and the value of ecosystem services.

Figure 14: Benefits of ecosystem-based approaches to climate change adaptation and mitigation



Source: Adapted from Defra (2007) – Framework for Ecosystem Services Valuation (relevant ecosystem services do not only address climate change mitigation and adaptation

Table 17 provides a detailed overview of the environmental and socio-economic benefits assessed by the project team for each case study.

Table 17: Framework for assessing the benefits of ecosystem-based approaches to climate change adaptation and mitigation

Type of benefits	Explanation	Measurement examples
Environmental Benefits (Including the provision of ecosystem services)	Services that ecosystem-based approaches to climate change adaptation and mitigation provide to people, including provisioning, regulating and cultural ecosystem services. These can be quantified in different units, measuring the provision of the service and its use by people.	• Volume of carbon stored • % Reduction in flood risk • Reduction in loss of soils through erosion • Number of recreational users of green space • Number of people benefiting from enhanced air quality • Improvements in water quality • Number of people benefiting from enhanced wildlife, landscape, visual amenity • Number of people experiencing improvements in health as a result of air quality and/or recreational space • Increased resilience (qualitative measurement) • Reduced vulnerability (qualitative measurement) • Reduced CO_2 emissions (quantitative measurement (e.g. from rewetting peatlands) • Filtering the air (quantitative measurement) • Cooling of summer temperatures (quantitative measurement) • Increased habitat availability • Increased connectivity
Socio-economic benefits	The effect of ecosystem-based approaches to climate change adaptation and mitigation on the economy, measured in terms of output and employment.	• Temporary impacts of the project (employment, GVA) • Ongoing impacts of maintenance (employment, GVA) • Indirect and induced effects resulting from supplier and employee expenditures (employment, GVA) • Effects on wider economy (tourism, increasing land values, inward investment – value of investment and expenditure, effect on employment and GVA) • Increased quality of life (greening of the cities) • Improved health

6.2 Case study results

The following section summarises the evidence on costs and benefits from the case studies. The amount and the quality of evidence available varied considerably among the five case studies. Often, the costs and benefits questionnaires could only partially be completed for lack of information. Particularly on the benefits side, a lack of quantitative information hampered a comprehensive traditional cost-benefit analysis. This shows the need for an adapted analysis, which allows the full recognition and appropriate weighting of the multiple benefits, which can be derived from ecosystem-based approaches, including those which cannot be expressed in monetary terms. In the following, the most relevant findings are summarised.

6.2.1 Wallasea Island Wild Coast (UK)

In the case of the Wallasea Island project, the vast majority of costs were incurred at the beginning of the project (for modelling, planning, permissions, land purchasing etc). The financial costs of the project that are related to management and administration activities are estimated to be on the order of £190,000 (€222,000)[80] per year (excluding staff costs). Costs related to ecosystem maintenance and/or restoration include over £5 million (€5.8 million) of land purchase and physical implementation works of around £17.5 million (€20.4 million), mainly involving deposition of material on Wallasea Island and managed realignment through controlled breaches of the existing sea wall. The project also involves opportunity costs, such as the loss of farmland in the area, and potential negative impacts on recreational yachting and oyster fisheries (Eftec, 2008). It was determined, however, that these negative impacts would have been more significant in the (inevitable) event of an unmanaged breach (RSPB and ABPMer, 2008). In summary, none of the above land-use restrictions has led to reductions in land values.

On the benefits side, it was estimated that intertidal habitat is capable of capturing up to 2.2 tonnes of carbon per hectare per year, while the same land used for farming would act as a net source of carbon. The primary benefits of the project are environmental (habitat creation), but secondary benefits also include waterborne nutrient processing and provision of fish feedings and nursery habitats. The benefits generated from carbon sequestration are valued at £1.7 million over the next 50 years (€2 million) (Eftec, 2008). In addition, society at large benefits from avoided expenditures for flood defence infrastructure (ca. £5 – £10 million; €5.8 – 11.7 million) and from the avoided loss of built assets on Wallasea worth £3.1 million (€3.6 million) under moderate flood event scenarios.

Eftec (2008) estimated that implementation of the Wallasea Island Wild Coast project would have a variety of employment impacts in the local economy (Essex) and the wider EEDA region.[81] Table 18 shows that up to 16.6 net jobs can be created in the local economy and up to 20.9 in the wider region over a 10-year period.

[80] All currency conversions based on 2011 exchange rates.
[81] http://www.eeda.org.uk/the-region.asp

Table 18: Estimated employment impacts of the Wallasea Island Project, full-time equivalent (FTE)

Economic activity	FTE jobs safeguarded		
	Local Economy (Essex) over 10 yrs	EEDA Region, over 10 yrs	Longer-term (10 - 20 yrs), EEDA Region
Oyster fishery	10	10	10
Wallasea infrastructure	c 100	c. 100	c. 100
Total jobs safeguarded	**110**	**110**	**110**
	Additional FTE jobs created		
Direct employment at site	8.9	10.9	4
Site development spending	5.2	7.5	0
Sheep grazing	0	0	0.7
Oyster fishery	2.5	2.5	5 -10
Visitor spending	1	1	0 - 5.9
Gross jobs created	17.6	21.9	9.7 - 20.6
Lost agricultural employment	- 1	- 1	0
Net jobs created	**16.6**	**20.9**	**9.7 - 20.6**

6.2.2 Augustenborg, Malmö (SE)

In the case of the Augustenborg project, the total sum invested in the area added up to around SEK 200 million (€22 million). Costs related to project planning amounted to approximately SEK 6 million (€660,000) and infrastructure investments (pumping station and storm water pipes) amounted to approximately SEK 17 million (€1.9 million). Ongoing costs of maintenance equal SEK 155,410 (€17,000) per year. No opportunity costs related to foregone land-use were reported; however, there were potential foregone recreational uses (i.e. large open fields used for sports, were to be used for retention ponds) in the initial design of the project.

The benefits provided by the project are mainly associated with improved water regulation in the area: the system of swales, retention ponds, green roofs and other elements of the Sustainable Urban Drainage System serve to protect the neighbourhood of Augustenborg from flooding and regulate surface runoff. However, WWF and RSA (2011) reported additional benefits, including:

- improved water quality;
- reduced carbon emissions:
- reduced pluvial and sewer flood risk;
- aquifer recharge (relieving stress in water scarce areas);
- enhancement of urban spaces; and
- increased biodiversity.

Habitat creation has led to an enhanced level of ecosystem resilience. As a side-effect, the project contributed to increased aesthetic and amenity values of the landscape and resulted in increased eco-tourism in the region. The City of Malmö has become known for sustainable architecture, innovative ecosystem-based adaptation and mitigation and a high quality of life

for residents. Moreover, a neighbourhood in decline has been transformed into a recreational hub (as a result of the many new parks, ponds etc.) and symbol of social sustainability.

6.2.3 De Doorbraak (NL)

The financial costs of the De Doorbraak project amount to approximately €60 million. For management and administration costs, land purchase costs of €5-10/m² and monitoring costs of €100,000 per year have been reported. Table 19 gives an overview of the total costs incurred.

Table 19: Total costs of the De Doorbraak project

Phase	Section	Implementation	Development costs [€ million]	Land purchase costs [€ million]	Total costs per phase [€ million]
1	Mokkelengoor	2002 - 2005	ca. 6	ca. 2	ca. 8
2	Bornerbroek	2006 - 2008	ca. 7	ca. 4	ca. 11
3	Tusveld	2009 - 2011	ca. 7	ca. 4	ca. 11
4	het Fleer	2012 - 2013	ca. 7,2	ca. 3,6	ca. 10,8
Total		**2002 - 2013**	**ca. 27,2**	**ca. 13,6**	**ca. 40,8**

It is estimated that the costs related to maintaining the 'dry' land add up to approximately €200/ha/year. No opportunity costs related to foregone land-use were incurred, although agricultural land in the De Doorbraak area had to be 'moved' outside of the project area.

The main benefits relate to flood prevention from peak discharges and drought protection. In addition, the project contributes to:

- biodiversity protection (fish species and amphibians);
- the provision of green corridors to other regions;
- ecosystem resilience;
- landscape and amenity improvements; and
- the provision of recreational values.

Five full-time jobs are provided which account for approximately 10% of the total costs (administrative costs) of the project. Based on a previous study (van der Veen and Kalfagianni, 2006), it can be expected that the project has a multiplier effect of 1.7% of every Euro invested within the province of Overijssel.

A study carried out within the project showed that if De Doorbraak would not have been built (no-action scenario), floodings in parts of Almelo could have resulted in costs up to €30 million. Taking this estimate as a basis, the overall benefits of the project may easily outweigh the total costs of €40,8 million.

6.2.4 Forest Rehabilitation Krkonose and Sumava National Parks (CZ)

It has been estimated that between 1992 and 2002, about €15 million was spent on infrastructure investments (€4.5 million) and research and reforestation (€10.5 million) in the two investigated Czech forest rehabilitation projects. Costs related to reforestation are expected to decrease rapidly in the future. Restrictions in timber extractions have resulted in opportunity costs and a total foregone income of €56/m^3. Additional opportunity costs relate to mining activities, processing iron, glass production, charcoal extraction and agriculture (breeding meadows).

The benefits provided by the project relate mainly to climate change mitigation, i.e. the sequestration of 9.8 million tonnes of CO_2. Reforestation also helped to address soil erosion and improve soil and air quality. In addition, biodiversity and the level of ecosystem resilience increased and the gene pools have been protected and strengthened. The water retention capacity of the area was increased, soil erosion was reduced and a de-acidification of the soil and water bodies could be observed (promoting water purification). Furthermore, cultural ecosystem services are provided, such as knowledge generation (education to the public at large about ecosystem services and close-to-nature forest management) and recreation and tourism (e.g. walking and trekking in the summer and skiing in the winter). It is estimated that 140 people are being employed by the project for 7-8 months/year. The project also helps to secure the tourism sector, which is an important source of income for the region. The local population is also allowed to sustainably harvest wood from a designated zone.

6.2.5 Restoring peatlands in Belarus (BY)

During the period from 2010 to 2011, one-off costs related to administration and management of the Restoring Peatlands project are estimated to add up to approximately €391.000; one-off costs related to ecosystem maintenance and restoration are estimated to be around €42.000. Recurrent administrative, management and information costs are estimated to add up to €235.000. Table 20 gives a detailed overview of the financial costs of the overall project and the Dokudovskoe site specifically, which is located in the west of Belarus close to the city Lida. Prior to drainage, the site used to be the largest fen mire in Grodno region, with a bog in the centre. Peat was extracted between 1960 and 1993.

Table 20: Financial costs of the restoring peatlands projects

	Type of activity	Specified activity	Costs [€]
One-Off Costs	Administrative, management and information costs	Carbon Module Budget. May 2010-April 2011	Implementations: 130,940.00 Travel Costs: 9,000.00
		Biodiversity Module Budget. May 2010-April 2011	Implementations: 15,000.00
		Biomass Module Budget. May 2010-April 2011	Implementations: 105,566.00 Travel Costs: 1,660.00
		Communication Module Budget. May 2010-April 2011	Implementations: 8,292.00 Travel Costs: 1,000.00
		Management Module Budget. May 2010-April 2011	Implementations: 2,700.00 Travel Costs: 35,271.00

	Type of activity	Specified activity	Costs [€]
		Scientific justification of the project *(Dokudovskoe)*	5,000.00
		Development of the engineering project *(Dokudovskoe)*	7,000.00
		Equipment for monitoring GHG emissions (used for all the project sites)	70,000.00
	Costs related to ecosystem maintenance and restoration	Rewetting Module Budget. May 2010-April 2011 *(Dokudovskoe)*	Implementations: 5,831.00
		Hydro-construction works including equipment, services, operation. *(Dokudovskoe)*	36,406.90
Recurrent Costs	Administrative, management and information costs	Staffing Costs AOP May 2010-April 2011	68,908.00
		In-kind contribution of UNDP - Project Manager's salary and travel expenses	Salary: Oct. 2008-Apr. 2009: 5,922.22
			Salary: May 2009-Apr. 2010: 11,501.31
			Travel Expenses: May 2009-Apr. 2010: 672.47
		Co-funding from RSPB - Salaries RSPB staff	Dec. 2008-Apr. 2009: 22,500.00
			May 2009-Apr. 2010: 15,000.00
		Co-funding from RSPB - Salaries of the two CIM Experts	Dec. 2008-Apr. 2009: 70,003.88
			May 2009-Apr. 2010: 46,669.25
		Salaries (monitoring staff - *Dokudovskoe)*	June 2009-May 2010: 3,410.59
			June 2010-May 2011: 1,497.18
		Social Payments to the Fund for social protection of the population/ State insurance company *(Dokudovskoe)*	June 2009-May 2010: 1,146.47
			June 2010-May 2011: 564.68
		Income tax *(Dokudovskoe)*	June 2009-May 2010: 262.18
			June 2010-May 2011: None reported
	Costs related to ecosystem maintenance and restoration	Repairing of water regulating devices: 1 man-day (Average monthly salary: 210 €/month) *(Dokudovskoe)*	38.18 €/yr (supposing 4 reparations in the year)

An initial analysis suggests that the approximate cost of avoiding a tonne of CO_2 emissions is €7.11. The nature of the measures dictates that a large portion of the above costs will decline over time after the initial investments and re-wetting measures have been implemented. Salaries, engineering and construction costs will remain stable. In terms of opportunity costs, the peat industry and forestry could suffer from reduced yields based on the restricted availability of land for this purpose.

On the other hand, carbon emissions reduction via sequestration and storage (estimated at 2.9 t CO_2/ha/year) is the major benefit provided by the project. Furthermore, the avoided

emissions from peat fires add to the climate change benefits provided by the project. A main category of benefits is also related to climate change adaptation, as the project contributes to:

- Micro-climate regulation (control of frost and humidity) benefiting neighbouring agricultural lands;
- Protection from soil degradation;
- Water regulation and retention through the construction of dams and reservoirs (stabilization of the water level); and
- Prevention of peat fires.

Furthermore, provisioning ecosystem services such as food production benefit the local population. The economic value of provided cranberries, blueberries, mushrooms and fish is estimated to be around €2,300 per year.

Socio-economic benefits include the avoided expenditure from peat fire prevention and from the reduced frequency of peat fires, adding up to approximately €11,000. Table 21 provides an overview of the benefits related to peatland fire prevention and control:

Table 21: Benefits related to peatland fire prevention and control

Determining factors	Before rewetting		After rewetting	
	Concept	Cost	Concept	Cost
Personnel	5 fire fighters permanently and exclusively available	4,725 € (210 €/month* 4.5months* 5 persons)	No permanent availability or exclusivity is necessary	No exclusive cost
Machinery	1 machine permanently and exclusively available	N/A	No permanent availability or exclusivity is necessary	No exclusive cost
Resources necessary to control fires	80 men-days	763.64 €/fire	0,166 men-days	1.59 €/fire
Frequency of fires	8-10 per year	6,872.76 €/yr	1 per year	1.59 €/yr

In the short term, the project is expected to provide jobs through the research, construction, supervisory, maintenance and monitoring work. In the long run, biomass-harvesting jobs could emerge and the Academy of Sciences plans to set up a laboratory for GHG emission measurements. At the moment, about 25 management jobs are being provided through the project. In the future, the project might also have a positive impact on eco-tourism in the region. Table 22 provides a detailed overview of the benefits provided by the case study site, while Box 6 presents briefly the results of nation-wide study aiming to estimate the value of the ecosystem services of natural peatlands in Belarus.

Table 22: Benefits of the overall project and Dokudovskoe site

Type of benefits	Explanation	Estimation of benefits
Environmental Benefits	Carbon emissions reduction via sequestration and storage (ca.50% of peat composition is C)	Estimated 2.9 tCO_2e/ha*year Estimated 2.5 tCO_2e/ha*year (average of all sites)
	Genetic/species diversity maintenance	Estimated 200-300% increase in biodiversity
	Avoided emissions from peat fires	N/A
	Erosion and peat storm control	N/A
	Landscape and amenity values	Aesthetic conditions of the area were considerably enhanced
Socio-economic benefits	Avoided expenditure from peat fire prevention	€ 4,725
	Avoided expenditure from reduced frequency of peat fires	€ 6,871.17
	Food production	• Cranberry: approx. €1,670 /yr (1 ton/yr at market price: €1.67/kg) • Blueberry: approx. €490/yr (0.5 ton/yr at market price: €0.84 to €1.12 /kg) • Mushrooms: N/A • Fish: approx. €222.6/yr (5kg/day at market price: €0.84/kg) (total absence before rewetting) • Game: N/A
	Biomass production	N/A
	Cultural values and inspirational services	World War II partisans used peatland as a hideout. The establishment of a museum is planned in the area. This will include an exposition about peatland.
	Ecotourism and recreation	Two ecological paths for education and bird-watching purposes were established and a third one is planned.

Box 6: Valuation of ecosystem services of natural peatlands in the Republic of Belarus

In 2010, a nation-wide study has been conducted that estimated the value of the ecosystem services of natural peatlands in Belarus. A comprehensive cost-benefit analysis was carried out, which included:

a) an assessment of the ***benefits resulting from the preservation and sustainable use of peatbogs*** based on the ecosystem services provided; and

b) an assessment of the ***direct costs associated with ecosystem protection and the net lost benefits from the implementation of alternative utilization options*** involving, mainly, commercial exploitation of peat deposits.

The authors conclude that from the economic point of view the scenario of commercial exploitation of peat deposits of semi-intact peatland ecosystems of Belarus is not competitive versus the scenario of restoration, conservation and sustainable use of their ecosystems' services.

6.3 Comparison to traditional engineered approaches

Comparing the costs and benefits of ecosystem-based projects to those of engineered approaches (i.e. the construction of traditional flood prevention systems or traditional habitat management practices) is rather difficult. The limited evidence base from the conducted case studies did not allow for a profound monetary assessment of costs and benefits to be compared to those associated with traditional engineered approaches. However, evidence from the case studies suggests that investment and management costs are not necessarily higher than in the case of traditional engineered approaches. For instance, the costs of dyke redevelopments are estimated to be as high as €1 million per km. In the case of forest fire prevention, traditional approaches such as controlled burning, strategic tree cutting and removal of fuels by handcrafts are also rather cost-intensive solutions. In the United States, suppression operations for a single wildfire are reported to be as high as $1 million (€730,000).

In conclusion, one can say that the additional ecological and socio-economic benefits likely outweigh those of traditional engineered approaches and thus result in a positive benefit-cost ration. Six benefit categories have been identified as being of major importance, as follows.

Climate regulation

The main benefit provided by the vast majority of ecosystem-based projects is the potential to mitigate climate change by increased carbon sequestration. In comparison to traditionally engineered approaches, ecosystem-based projects sequester carbon or reduce carbon emissions by maintaining or restoring natural ecosystems. Evidence from the case studies shows that - depending on the habitat type - between 2 and 2.9 t of carbon per hectare per year are being sequestered. Assuming a social cost of carbon of €70 per t, this adds up to benefits of €203 per hectare per year. Brenner-Guillermo (2007) estimate the benefits from climate regulation in urban green space to be $830 (€605) per ha per year. If a traditional engineered approach would have been implemented, the land might have been a net source of carbon. In the case of the peatland restoration project in Belarus, estimates indicate that the costs of avoiding a tonne of CO_2 emissions amount to approximately €7.11. For

comparison, CO_2 abatement costs resulting from carbon capture and storage (CCS) projects are estimated to be between €35 and €105 per tonne CO_2 (UK Parliamentary Office of Science and Technology, 2005) while large-scale application of this technology is not yet in sight.

Water purification, regulation and supply

Some of the investigated ecosystem-based projects aim at regulating flood events by providing additional retention areas along rivers and coasts. Using these methods, the constructed or maintained ecosystem often provides regulating services such as nutrient processing and aquifer recharge. The latter aspect is particularly relevant when it comes to the mitigation of climate change effects, such as the prevention of peat land and forest fires. The construction of traditional embankments and dykes, on the other hand, usually leads to increased water drainage and has a negative impact on water purification and local water supply. Gedan et al. (2011) provide an overview of the ability of coastal wetlands to stabilize shorelines and protect coastal communities. They find that ecosystem-based approaches (mainly mangrove and salt marsh vegetation) can protect the shoreline from erosion, storm surge, and potentially small tsunami waves. Such ecosystem-based approaches may reduce wave heights, property damage, and human deaths in the affected regions. Brenner-Guillermo (2007) estimated the benefits of water flow regulation in urban green space at $15 (€11) per ha per year.

Habitat creation

In general, ecosystem-based projects protect the local ecosystem and often lead an increase in biodiversity and ecosystem resilience. Often, ecosystem-based projects function as green corridors by allowing fauna to migrate. Beaumont et al. (2008) estimated that the benefits related to the genepool preserved in marine ecosystems in the United Kingdom to be £4.98 (€5.80) per ha per year and Brenner-Guillermo (2007) valued the genetic diversity of forests in Spain between $20(€14.60) and $2,200 (€1,600) per ha per year.

Landscape amenities

Project managers stated that the local population reacts positively on the landscape effects of ecosystem-based projects. Landscape amenities were report to have lead to a better quality of urban space and to an upward revaluation of the neighborhood in the case of the Augustenborg project. Although this aspect is highly dependent on the preferences of the local population, one can assume that the physical appearance of (natural) ecosystems is valued more highly than that of engineered substitutes. Thibodeau and Ostro (1981) estimated the aesthetic value of protected wetlands to be as high as $781 (€570) per ha per year, while a more recent study (Gerrans, 1994) estimated a value of about $3,900 per ha per year. De la Cruz and Benedicto (2009) estimated the marginal value of attractive forest landscapes at $650 (€474). In addition, there are significant health benefits. The evidence base is constantly growing; one example is the Healthy Parks Healthy People initiative being taken by the Australian Government.[82]

[82] See http://www.environment.gov.au/parks/hphp.html

Recreational opportunities

The recreational opportunities provided by an ecosystem-based project depend on the location of the project and the ecosystem characteristics. In the case of (semi-) aquatic ecosystems, the recreational potential can be considered to be the highest. Compared to traditional engineered approaches, opportunities for water sports, fishing and hiking are usually higher. Beaumont et al. (2008) estimate the recreational benefits of marine biodiversity to be as high as £730 (€851) per ha per year in UK territorial waters. Zandersen et al. (2005) estimated the recreational benefits of forests in Denmark at €4.373 per ha per year.

Socio-economic effects

Projects using ecosystem-based- approaches provide employment opportunities either directly (through management, administration and construction) or indirectly through jobs that are being created in tourism and landscape management (e.g. forestry) sectors. In the investigated case studies, between 5 and 25 full-time jobs are directly provided through the projects. Although it was difficult to estimate indirect employment effects, there is evidence that particularly local tourism benefits from the implementation of ecosystem-based projects. In most of the investigated cases, the loss of jobs due to land-use restriction was negligible resulting in a positive net effect on jobs in the region. Compared to traditional engineered approaches, ecosystem-based projects are assumed to create additional employment, as project management and administration are relatively human resource-intensive. A study on the economic impact of the water boards Regge and Dinkel on the regional economy assumes a multiplier effect of 1.7% of every Euro invested through the project (van der Veen and Kalfagianni, 2006). The amount of jobs and business opportunities through greening cities could be particularly high.

Targeted primary research is necessary to assess the benefits specifically associated with ecosystem-based projects in monetary terms. To date, such an assessment could only be conducted on the basis of benefit transfer. The recently established TEEB database (van der Ploeg and de Groot, 2010) could serve as a helpful tool in this context. Benefit transfer, however, is subject to significant uncertainties; therefore, commissioning primary valuation studies in selected ecosystem-based projects is recommended.

6.4 Concluding remarks

It has been shown that the traditional estimation of costs and benefits of projects using ecosystem-based approaches is subject to a number of limitations. First, the amount and quality of evidence available varies considerably among the selected case studies. While data on the financial costs related to the projects are generally available, there is a clear knowledge gap with regard to possible opportunity costs and to (quantifiable) ecological and socio-economic benefits. Within most projects, no proper cost-benefit assessment has been commissioned; therefore, the available information is often based on the estimation of the projects managers. As a result, opportunity costs and benefits are often only expressed in qualitative terms.

The comparability of costs and benefits among the selected case studies is also difficult. The use of different cost accounting systems was a major issue in this context. For instance, it

was not always possible to clearly distinguish between one-off and recurrent costs or to define the timeframe over which the costs occur. On the benefits side, the lack of quantitative data forced the project team to draw rather rough comparisons. In general, the lack of monetary values for opportunity costs and ecological and socio-economic benefits prevented the project team from a comprehensive assessment of costs and benefits.

However, the available evidence indicated that the majority of projects using ecosystem-based approaches can be considered beneficial from an economic point of view if one takes account of the long-term social and ecological benefits that are associated with the projects. In the long run, benefits arising from the sequestration of CO_2 and the prevention of natural disasters are likely to outweigh the financial and opportunity costs associated with a project, thus making those projects using ecosystem-based approaches potentially more cost-effective than traditional engineered approaches. The available literature (e.g. Doswald and Osti, 2011) supports this view.

In order to come to a comprehensive EU-wide assessment of the costs and benefits associated with projects using ecosystem-based approaches, there is a need for detailed assessments at the local scale. In particular, the monetary assessment of the associated benefits will require environmental valuation studies to be commissioned. In this context, the use of shared protocols and guidelines is highly recommended in order to allow for a subsequent scaling-up of the results. The cost and benefit typology presented in 6.1 and applied in the case studies could provide a relevant basis for such assessments.

7 Lessons and recommendations for future projects using ecosystem-based approaches

This section should inform developments on the implementation of the EU biodiversity strategy to 2020 and upcoming EU Green Infrastructure Strategy, given the overlaps and similar objectives of green infrastructure and ecosystem-based approaches, and accordingly provide recommendations for the EU Member States and relevant stakeholders at the regional level. Some general recommendations, which are valid for all spatial levels, target the cross-sectoral integration of ecosystem-based approaches in policies and pertinent action plans, strategies and programmes. Above all, such action requires a political commitment to promote ecosystem-based approaches to climate change mitigation and adaptation. It should be clearly outlined that while ecosystem-based approaches can complement technological solutions to address climate change, they can also act independently.[83] The implementation of these approaches allows for the harnessing of synergies and promotes collaboration. It involves wide groups of people and contributes to building responsibility, perhaps paving the way to solidarity.

The analysis has shown that many useful examples of ecosystem-based approaches to adaptation and mitigation exist. Furthermore, these approaches represent integrated approaches, which can address the objectives of several EU policies simultaneously.

7.1 Application of ecosystem-based approaches in Europe

Implementation at project level

The project level analysis suggests that ecosystem-based approaches in Europe are making a growing contribution to climate change mitigation and adaptation and also have the potential to further contribute to these climate goals (see Section 3). The database that was compiled for the purpose of the study included a total of 153 projects that addressed climate mitigation and/or adaptation. Of these 153 projects 109 were found to implement measures exclusively for adaptation, 15 focused solely on mitigation, and the remaining 29 projects addressed both objectives. Here, it needs to be kept in mind that any project, which implies maintenance and restoration of vegetation always also contributes to mitigation through carbon sequestration. This finding is in line with the results of the Doswald and Osti (2011) study, which identified 100 relevant ecosystem-based projects and revealed that nearly half of these projects had adaptation as primary objective whereas less than 15% of projects focused primarily on mitigation.

The ecosystem-based projects, whether they explicitly target adaptation or mitigation or whether their results indirectly contribute to these objectives, are integrative in their nature. They usually need to draw on involvement of various sectors at the same time, many different stakeholders and authorities, and span different policy areas; they lend themselves

[83] The latter option has been primarily focused on throughout this study.

well to the achievement of integrated land management, which in turn is essential for effective climate policy.

The project database clearly indicates that ecosystem-based projects address issues that are relevant for multiple sectors and which require the development of integrated approaches. For example, activities in the agricultural and water sectors are often closely interlinked, and have further implications for forestry, nature protection or regional planning. While covering a range of environmental issues relevant for mitigation and adaptation, the review of different projects has also shown that nature protection and water management are by far the most common areas addressed. On the other hand ecosystem-based approaches have not yet been widely applied in the transport and health sectors, in spite of the obvious opportunities, in particular for the latter as greening cities contributes to the health of its citizens.

The projects identified in the database target protection of a wide range of habitats and ecosystems, such as rivers, coastal areas, forests, wetlands (including peatlands), or arable farmland. They contribute to multiple environmental objectives, including carbon storage and sequestration in soils and biomass, soil protection more broadly, protection of water supply and water quality, reduction of flooding risks, or protection and restoration of valued habitats. In terms of specific activities, the study illustrates that habitat restoration, biodiversity conservation and maintenance and protection of natural areas are the most commonly planned and performed actions within ecosystem-based projects. Awareness raising through the sharing of knowledge and information may not be generally regarded as the principal action in which the projects engage; nonetheless, it appears frequently as a secondary or complementary measure.

It is important to note that many ecosystem-based projects may not have been labelled as climate mitigation and adaptation projects, emphasizing instead more discrete objectives such as habitat restoration or flooding protection. Mitigation and/or adaptation are more often explicit objectives within the framework of a climate-funding programme (for example, UNFCCC joint activities implementation or the German International Climate Initiative (ICI)[84] or within structural funds, such as the Cohesion Fund (INTERREG programmes) where climate objectives are already well established. As climate discourse and objectives are further integrated in individual policy fields, the visibility of ecosystem-based approaches at project level is likely to increase.

Integration in policies and strategies

The concept of ecosystem-based approaches has not frequently been an explicit element of European and national strategies relevant to mitigation and adaptation. In the White Paper on adaptation, for example, there is no direct use of the term ecosystem-based approaches, although the term ecosystem approach is mentioned in relation to Common Fisheries Policy and Maritime Policy (see 4.1). The Water Framework Directive in its emphasis on river basin management explicitly recognizes the importance of an ecosystem-based approach. More frequently, however, there appears to be an implicit understanding of the importance of the concept at the European level. The term has recently gained currency in policy and is highlighted in, for example, the CBD COPX33 on Biodiversity and Climate Change and

[84] See http://www.bmu-klimaschutzinitiative.de/en/home_i

mentioned in consecutive Environment Council Conclusions (22/12/2009 on International Biodiversity; 14/10/2010 on International Biodiversity; 14/03/2011 on Follow-up to Cancun), but remains poorly represented overall (see 4.1).

At the national level, little specific mention of ecosystem-based approaches can be seen in the six national adaptation strategies that were examined. Although three of these countries advocate the use of ecosystem-based approaches (UK, Finland and Belgium), it is often difficult to see whether such approaches had either been applied or been the underlying driver in decisions made regarding which actions should be undertaken. The analysis also shows that ecosystem-based approaches are less frequently applied in the EU 12 Member States, which also have developed less advanced, specialized and demanding adaptation strategies in comparison with the EU 15 Member States. This confirms the findings of Doswald and Osti (2011), which identified most ecosystem-based projects as being implemented in Northwestern European countries. Nonetheless, the literature review showed that efforts have recently been taken to promote best practices and share knowledge (see 4.2).

The sectoral strategies revealed that agriculture, forestry, biodiversity, water and coastal and marine areas are the sectors most relevant for the application of ecosystem-based approaches. This is similar to project findings, which most frequently address nature protection and water management. Strategies provide little detail on the particular approaches and how they could be employed. All sectoral documents that were reviewed indicate that adaptation measures were being / would be applied but these were not always ecosystem-based and there was little evidence or mention that they were actually implemented. Sector specific documents were more likely to discuss the ecosystem-based nature of adaptation items proposed than country documents. There is some variability in which measures are planned but all sectors are ‘taking practical action now’. And all countries are either ‘maintaining and increasing ecological resilience’ or ‘taking practical action now’. However, it is not clear whether there is a specific intent to use ecosystem-based approaches to adapt to climate change or whether the adaptation is a positive side-effect. Significantly fewer sectors and countries are applying ecosystem-based approaches to mitigation, possibly due to the nature of documents selected for review, and again, the intent of applying ecosystem-based approaches is not clear (see 4.3).

It is difficult to evaluate the actual implementation of ecosystem-based actions on the basis of the examination of EU, country and sectoral documents. At an EU level, although recognition is given to the benefits provided by ecosystem-based actions, little specific mention is made of actions for their implementation. At the country and sectoral levels, protected areas, ecological connectivity and ecosystems as carbon stores are the most frequently mentioned ecosystem-based action categories but not much detail is provided on their implementation.

Since the national adaptation strategies and the sector policy/communications documents are guiding documents, it is not surprising that they remain at a strategic level focusing on aspirations and goals without specific obligations for implementation. As noted by other studies, these strategies provide the first impulse for action by placing the issue on national policy agendas (see Biesbroek et al. 2010); ultimately, additional action plans and concrete obligations are needed to promote implementation.

7.2 Strengthening the integration of ecosystem-based approaches at EU level

This section highlights the actions that could be undertaken at the EU level to strengthen the integration of ecosystem-based approaches to climate change adaptation and mitigation in relevant policies and strategies and thus to provide an enabling environment for its uptake and implementation at project level.

Promote the concept of ecosystem-based approaches

There is a clear need to raise awareness about ecosystem-based approaches and the concept behind it. One of the main barriers identified is the lack of awareness and understanding of ecosystem-based approaches at all levels, from the EU to the local level. To date, the term ecosystem-based approach is not used coherently (if at all) in relevant policy documents and strategies. Moreover, there is a lack of understanding about the multiple functions and (co-) benefits of ecosystem-based approaches to climate change mitigation (EbM) and adaptation (EbA) and ecosystem-based approaches in general. Therefore, targeted public awareness activities are needed, such as a simple concept note based on current international level work and on the definition provided in this text. Such a concept note should i) explain EbA and EbM in clear terminology, ii) highlight its relevance to cope with climate change and further environmental challenges and iii) outline the opportunities and linkages to different policy sectors. Providing examples of relevant ecosystem-based measures that can be undertaken in the different sectors (such as agriculture, forestry, water etc.) can also help to increase the understanding of this approach. The overall aim should be to convey the message that the ecosystem-based approaches are a means to meeting several targets (not just for protecting biodiversity).

The Belgian National Adaptation Strategy, for example, outlines the aspiration of applying ecosystem based approaches as follows: “Ecosystem-based approaches represent potential triple-win measures: they contribute to preserving and restoring natural ecosystems, mitigating climate change by conserving or enhancing carbon stocks or by reducing emissions caused by ecosystem degradation and loss, and providing cost-effective protection against some of the threats that result from climate change.” This definition could provide a good basis to develop a simple concept note of ecosystem-based approaches to climate change and also reflects the idea of green infrastructure.

Not only a clear terminology of ecosystem-based approaches is needed to strengthen the integration of such approaches, but also knowledge on potential financing need to be made available. As shown in the analysis, there is a lack of knowledge about which financing instruments are available for the Member States. Thus, existing financing opportunities (including EU funds, national/regional possibilities and private financing) also need to be highlighted for increased understanding by practitioners and those interested in implementing ecosystem-based approaches.

There are different tools available to disseminate the developed concept of ecosystem-based approaches among the different EU policy divisions, Member States, NGOs, private and social actors, regional authorities and further relevant actors. Such tools could include, for example, the official and relevant websites of the European Commission, a policy brief, a fact sheet or a strategy. In addition, targeted policy conferences or events at an international and

EU level should be used to promote the concept of the ecosystem-based approaches and their development and use.

Emphasis should be on the implementation of the EU Biodiversity Strategy up to 2020 and the work on the planned EU Green Infrastructure strategy (expected in fall 2012). Specifically, target 2 of the EU biodiversity strategy to 2020 states that: "By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems"; this provides a good basis for advocating ecosystem-based approaches. Ecosystem-based approaches are also a smart way to tackle the issues within the three Rio Conventions in an integrated manner, as is recognized through the joint outreach activity "the Rio Conventions Pavilion"[85] which has been organized in the margins of the Conferences of the Parties (COPs) since CBD COP 10 in Nagoya. Moreover, as the integration of EbA and EbM actions support the call for climate change and biodiversity loss to be addressed together, they also help address the Aichi targets. The Rio Conventions Pavilion is a step in the right direction, but organizational structures, which create silos still hamper this integrated approach in mainstream negotiations.

As highlighted in the literature and by different actors at the EU, national and local levels, evidence of how effective the activities have been in terms of mitigation (e.g. how much carbon is sequestered) or adaptation (e.g. how much flooding damage has been avoided) is still lacking, but the multiple benefits aspect can be a powerful tool for advocating the use of ecosystem-based approaches (Doswald and Osti 2011: 32). The current financial crises provide real opportunities to pursue ecosystem-based approaches as they have the potential to be more cost-effective (in particular in the long-run) and can deliver multiple benefits as compared to traditional engineered solutions. Therefore, evidence on the costs-effectiveness of such approaches should be provided where available and further research (e.g. in the form of cost and benefits analyses for selected projects) should be undertaken to gather further evidence.[86]

Strengthen cross-sectoral integration of EbA/EbM in EU policies

In order to increase the uptake of ecosystem-based approaches and to make use of all potential benefits, increased cross-sectoral integration is needed. The analysis of the EU sector strategies revealed that the lack of integration is an obstacle for coherent and efficient implementation on different levels, including the local, national, EU and international levels. To date, there are only a few EU policies that explicitly support ecosystem-based approaches. The EU Biodiversity Strategy and Policy are the most important ones, including the Birds and Habitats Directives. The ecosystem-based approach is moreover well applied in the fields of marine and water policy (i.e. it is part of the Marine Framework Strategy Directive and the Water Framework Directive). Also, the agricultural policy already deploys EbA and EbM to some extent through its agri-environmental measures. Lessons could be learned from these policies for embedding ecosystem-based approaches in other high level policies.

[85] See http://ecosystemspavilion.org

[86] One potential source represents the "The Economics of Ecosystems and Biodiversity"-database, http://www.teebweb.org/

However, a precondition for improved cross-sectoral integration of ecosystem-based approaches is an increased awareness about the concept, the link between EbA and EbM and various sectors and the potential benefits offered. In addition, incentives that might hamper the uptake of ecosystem-based approaches[87] and encourage unsustainable and short-term-profit seeking solutions to respond to climate change need to be removed. On the other hand, incentives to reward biodiversity and further (public) benefits are needed; this has recently been incorporated into the UNFCCC language and a report on ecosystem-based approaches will be discussed at UNFCCC COP17 in Durban in December 2011.

In order to create coherency and greater consistency between various areas of EU policy - both in intention and in implementation – the sectors are required to state how they would/could work together to achieve integration with the other sectors in order to effectively address climate change. To date, only a few sectors (biodiversity, agriculture, urban/regional planning and water) discuss for example, how adaptation measures can be 'integrated across all partners and sectors' in their strategic policy documents. One reason might be that the sector documents are specifically concerned with outlining measures to be undertaken in their own sectors. When designing climate protection strategies, there is also a need to identify synergies between adaptation and mitigation measures and highlight these. Thus the effectiveness and efficiency of measures can be strengthened and prioritized.

A number of sectoral policy documents include objectives to respond to climate change as well as initiatives that, given their nature, may be labelled as ecosystem-based (without identifying them as such). However, some policies also bear the risk of hampering the implementation of ecosystem-based approaches. Table 23 outlines the links between international and EU policies with EbA and EbM.

Table 23: Link of international and EU policies with EbA and EbM

Sector	**Policy specific examples** (non exhaustive)
Climate	**UNFCCC**[88] - Although in the early days the focus of the UNFCCC was mainly on mitigation, adaptation is now recognised as an important component of any response to climate change. Article 4.1(e) calls on all countries to "cooperate in preparing for adaptation to the impacts of climate change, develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas... affected by drought and desertification, as well as floods." Articles 4.8 and 4.9 also refer to the need to address vulnerability to the adverse effects of climate change. **White Paper on Adapting to Climate Change COM(2009)147**[89] **(and Impact Assessment**) – with this paper, the EU shows a strong commitment to climate change adaptation and mitigation. The paper recognizes that "strategies focused on managing and conserving water, land and biological resources to maintain and restore healthy, effectively functioning and climate change-resilient ecosystems are one way to deal with the (climate) impact" and that "working with nature's capacity to absorb or control impact in urban and rural areas can be a more efficient way of adapting than simply focusing on physical infrastructure". In includes an action point on integrated approaches to "explore the possibilities to improve policies and develop measures which address biodiversity loss and climate change in an integrated

[87] For example, funding provided by the Cohesion Funds for building grey infrastructure.
[88] http://unfccc.int/
[89] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0147:EN:NOT

Sector	**Policy specific examples** (non exhaustive)
	manner to fully exploit co-benefits and avoid ecosystem feedbacks that accelerate global warming". Thus, it provides a strong and appropriate policy context for the development and implementation of EbA and EbM. Its impact assessment identifies the following categories of adaptation: "grey" infrastructure, "green" structure and "soft" on-structural approaches and gives examples of using ecosystem-based approaches (highlighting the wide variety of application areas).
Agriculture	**Common Agricultural Policy (CAP)**[90] has pursued the integration of environmental concerns through a series of reforms, including the last completed round of reforms in 2003. The most relevant measures that have been included over time, for example, are agri-environment measures under the Rural Development Programmes (RDPs) and the standards for good agricultural and environmental condition of land (GAEC). These measures provide incentives to reduce the intensity of production in terms of artificial inputs and damaging management practices (such as ploughing grasslands) and have positive benefits for ecosystems, both on the farmland itself and in areas surrounding these lands. A further move in the direction of stronger environmental performance in the agricultural sector is made in the legislative proposals for CAP post-2013 (Oct. 2011),[91] including climate adaptation and mitigation as central objectives. The envisaged joint and collaborative initiatives by farmers (in the RDPs) can be particularly well suited for implementation of ecosystem-based approaches.
Built Environment	**Directive on Energy Performance of Buildings (**Directive 2002/91/EC**)**[92] - a reduction of energy consumption and the use of energy from renewable sources in the buildings sector constitute important measures needed to reduce the EU's energy dependency and GHG emissions. This Directive requires a maximization of the energy performance of all buildings wherever possible as a cost effective way to fight climate change.
Energy	**Renewable Energy Directive (**Directive 2009/28/EC**)**[93] – includes targets to increase the proportion of biofuels used in energy generation, thereby reducing harmful emissions by using energy and natural resources more efficiently and sustainably. The Directive also encompasses sustainability criteria, which *inter alia* prohibits raw material obtained from land with high biodiversity value (e.g. primary forest, highly biodiverse grassland, areas designated by law or for the protection of rare, threatened or endangered ecosystems or species) or land with a high carbon stock (e.g. wetlands, continuously forested areas) (Article 17). However, the increased demand for bioenergy crops could also lead to indirect land use effects, which are not yet covered by the Directive (e.g. fodder cropping shifts to nature protection/ extensively used areas). Such effects can negatively impact ecosystems and thus also their potential to respond to climate change.
Fishery	**Common Fisheries Policy (CFP)**[94] - in April 2008, the EC published a Communication on the role of fisheries management in implementing an ecosystem approach to marine management. More generally, the policy is committed to sustainability and applying the precautionary principle to fisheries management to avoid the risk of exposing fish stocks and fishers to major negative impacts in the case of sudden changes in the ecosystem, such as climate change. This means, above all, not over-exploiting fish stocks to the point where the least change in their

[90] http://ec.europa.eu/agriculture/index_en.htm
[91] http://ec.europa.eu/agriculture/cap-post-2013/index_en.htm
[92] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:001:0065:0071:EN:PDF
[93] http://europa.eu/legislation_summaries/energy/renewable_energy/en0009_en.htm
[94] http://ec.europa.eu/fisheries/cfp/index_en.htm

Sector	**Policy specific examples** (non exhaustive)
	environmental conditions could provoke their collapse. **Marine Strategy Framework Directive** (Directive 2008/56/EC)[95] **-** embraces the ecosystem approach for the management of human activities having an impact on the marine environment, integrating the concepts of environmental protection and sustainable use. Under the Directive, the MS are required to develop Marine Strategies, which serve as Action Plans and which apply an ecosystem-based approach to the management of human activities.
Forestry	**UNFCCC** – supports the implementation of 'Land Use, Land Use Change and Forestry' under Kyoto Protocol (afforestation and reforestation activities); the REDD+ mechanism, although only for tropical forests in developing countries, could serve as an example for mechanisms in all countries and for dealing with other ecosystems including boreal forests, grasslands, wetlands, oceans etc. **EU Forest Action Plan** (COM(2006) 302)[96] – outlines the potential for more widely implementing sustainable forest management, aiming to optimise carbon sequestration, forest biodiversity, health and resilience as well as habitat restoration and afforestation.
Health	**Environment and Health Strategy** (COM(2003) 338)[97] - does not directly address EbA or EbM, but warns about chemicals and other hazardous substances that could affect human health; as these chemicals can also affect biodiversity, their reduction can be seen as an indirect measure to protect biodiversity and their respective ecosystems. Here, the initiative 'Healthy Parks Healthy People'[98] is promising.
Tourism	**EU Communication on Tourism** (COM(2010) 352)[99] - supports sustainability within the sector, including the responsible use of natural resources, accounting for the environmental impact of activities (e.g. production of waste, pressure on water, land and biodiversity) and using 'clean' energy.
Transport	The policy analysis showed, that the transport sector aims to reduce GHG emissions from transport (e.g. road vehicles running on both petrol and diesel, aircraft and sea-going ships) through demand reduction and discusses developing knowledge and planning strategically as one particular adaptation measure. On the other hand, the **Trans-European Networks (TEN)**[100] can also lead to further fragmentation of landscapes and ecosystems
Urban and regional planning	**European Spatial Development Perspective**[101] **–** aims for the "prudent management of natural and cultural heritage" and is committed to the restoration of biodiversity, respect for protected areas (Natura 2000) and preservation and restoration of large wetlands endangered by excessive water extraction. Under the objective "territorial polycentric development and new rural-urban relationship," the perspective points out the importance of green spaces in cities. The link to health in cities should be further explored.

[95] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0056:EN:NOT

[96] http://ec.europa.eu/agriculture/fore/action_plan/index_en.htm

[97] http://europa.eu/legislation_summaries/environment/general_provisions/l28133_en.htm

[98] http://www.hphpcentral.com/

[99] COM(2010) 352 final: Europe, the world's No 1 tourist destination a new political framework for tourism in Europe, 2010

[100] http://ec.europa.eu/ten/index_en.html

[101] http://europa.eu/legislation_summaries/regional_policy/management/g24401_en.htm

Sector	**Policy specific examples** (non exhaustive)
Green growth	**Roadmap to a resource efficient Europe (COM(2011) 571)**[102] **–** recognizes the need to protect natural capital such as ecosystems in order to ensure economic prosperity and human well-being. A proper valuation of these resources and the importance of investing in natural capital are emphasized as such investments often "often bring higher returns than constructed or manufactured alternatives, with lower up-front costs". Here, investments in green infrastructure are specifically cited.
Water	**Water Framework Directive** (Directive 2000/60/EC)[103] - aims to prevent further deterioration of and protects and enhances the status of aquatic ecosystems and related terrestrial ecosystems and wetlands, promotes sustainable water use by protecting available water resources, ensures the progressive reduction of pollution of groundwater and prevents its further pollution. The Directive also contributes to mitigating the effects of floods and droughts by supporting, e.g. non-engineered flood management ('giving space to rivers') and reduced developments in floodplains. **Floods Directive** (Directive 2007/60/EC)[104] – aims to restore or establish habitats (e.g. wetlands) to support water quality and reduce flooding risk and damage. It focuses on preventative action, such as avoiding the construction of houses and industries in flood-prone areas and promoting appropriate land-use, agriculture and forestry practices.
Biodiversity	**Habitats Directive** (Council Directive 92/43/EEC)[105] - includes specific measures to maintain or restore the coherence of the Natura 2000 network (Article 3(3) and Article 10), recognizing the importance of ecological coherency and habitat quality. Here, Member States (MS) are required to consider improving the ecological coherence of the Natura 2000 network in their land-use planning and development policies and to encourage the management of features of the landscape that are of major importance for wild flora and fauna. The MS are also required to undertaken surveillance of the conservation status of the natural habitats and species and to implement a system for the protection of animal species.

Source: adapted in part from own analysis and in part adopted from IEEP et al (2011), http://unfccc.int/resource/docs/publications/adaptation_eng.pdf and http://ec.europa.eu/environment/water/marine/ges.htm

Highlighting the link between EbA/EbM and policies also helps to identify potential EU financing instruments in addition to already used ones (such as LIFE+, ERDF (INTERREG) and the EAFRD mainly representing the nature protection, water, agriculture and forestry sector). In addition to EU financing, opportunities provided by the private sectors such as public-private partnerships, carbon markets, corporate social responsibility and regulative instruments (e.g. off-setting environmental damages through the polluter pays principle) also need to be explored further (also see 5.2.2 and 7.3).

Ensure knowledge transfer and exchange

The Green Paper[106] (which preceded the White Paper) led to a stakeholder consultation and feedback pertinent to ecosystem-based approaches to adaptation and mitigation including: an emphasis on the importance of protecting ecosystems and biodiversity; the need to

[102] http://ec.europa.eu/resource-efficient-europe/

[103] http://ec.europa.eu/environment/water/water-framework/index_en.html

[104] http://ec.europa.eu/environment/water/flood_risk/index.htm

[105] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0043:EN:NOT

[106] COM(2007) 354, http://europa.eu/legislation_summaries/environment/tackling_climate_change/l28193_en.htm

exchange best practices; and general agreement on the need to exploit the synergies between mitigation and adaptation efforts. The finding and promoting of good practice examples was one of the actions suggested by Berry et al. (2011) as a means of helping to overcome barriers to action on adaptation. The White Paper stated that "it was clear that stakeholders found it easier to identify problem areas than to propose concrete action EU White Paper, Impact Assessment, 2009: 6). Therefore, promoting and encouraging the exchange of best- practice examples are crucial tasks, which should be coordinated at the EU level; the project database could serve as a foundation for such a compilation of useful case studies. This would include *inter alia* the financing of pilot studies (good examples of concrete actions, which also provide evidence on cost-effectiveness), facilitating the exchange of knowledge via developed guidance documents and platforms and linking these media to relevant platforms and programmes (e.g. green infrastructure, sustainable land use) at all spatial levels. The White Paper on Adaptation to Climate Change will also play a crucial role in this context as it helps to develop the knowledge base, as well as the "European Climate Change Impacts, Vulnerability, and Adaptation Clearinghouse"(to be operational in 2012).[107] This knowledge base will provide important information including GIS data, satellite data, research findings etc.) to Member States. Thus the EU is adopting a key role in creating and spreading knowledge, coordination and research in the area of climate change adaptation. This role is also supported by the general agreement that adaptation is a much more local matter than mitigation, thus the EU must bring the knowledge to the local level. Integrating the concept of ecosystem-based approaches and its relevance for climate protection in this knowledge base is essential for reaching a wider audience working at the international, EU, national as well as local/regional level.

In addition to coordinating knowledge transfer, promoting research and encouraging the uptake of best-practice practices, there is a need to i) clearly outline the EbA/EbM actions to be undertaken in the different policy sectors and pertinent programmes, strategies and action plans and ii) report on the implementation of these measures. As shown by the analysis to date there is still often little or no written evidence that the measures had actually been implemented see Section 4)

7.3 Success factors enhancing the integration and implementation of ecosystem-based approaches at national and regional level

Drawing on the analysis of national adaptation strategies and in-depth case studies, this section presents factors, which have been found to support the successful implementation of ecosystem-based projects and the integration of ecosystem-based approaches at a national and regional level. This section will accordingly provide recommendations regarding the creation of strategies and supporting policies and present the findings regarding knowledge management and capacity building, project management structures and financing. Possible solutions developed to overcome the barriers encountered in the case studies are outlined in

[107] Given the fragmented and scare nature of information and research on climate change impacts/vulnerability and on the costs/benefits of adaptation measures, the White Paper calls for improving knowledge management by establishing a web-based information system (the Clearinghouse) (see http://ec.europa.eu/clima/sites/change/what_is_eu_doing/index_en.htm).

Table 24, focusing on enhancing project implementation from the design and inception phases onwards.

Create strategies and supporting policies

Augmenting the effectiveness of efforts to adapt to and mitigate climate change requires supporting policies and the creation of additional legislative items where they are currently lacking. A national framework is also central, providing a direction and long-term strategy for the Member States level which complements EU policies and guides and motivates the implementation of coordinated EbA and EbM measures at the national and local/regional levels. The explored in-depth case studies revealed that this role of the government is crucial in implementing and carrying out ecosystem-based approaches given that future perspectives and major decisions regarding resource use are made at the local and regional levels by the corresponding authorities and government organisations. It was often found that alignment must exist between the government's interests and the project objectives in order to take the initiatives forward. In order to allow for the sustainability of project goals and efforts, such an alignment should be a permanent compromise.

An analysis of national strategies revealed that legislation often targets distinct EbM and EbA related objectives (directly or indirectly) and supports relevant actions accordingly, but the lack of integration of EbA/EbM into strategies and policies limits the potential for effective action addressing climate change and restricts the sustainability of implemented measures. Important here would be to improve the coherency between existing policies and strategies, acknowledging the complex nature of ecosystem-based approaches and their relevance for multiple sectors. Policy that integrates multiple sectors by enhancing the links between them would also allow for common acknowledgement of ecosystem-based approaches. Additionally, supporting more comprehensive assessments of how policies affect ecosystem services and the ecosystem structure and functions that underpin them would also be beneficial in creating new strategies and policies.

While the environmental ministries in the respective Member States have generally dealt with such issues to date, there is a need for national strategies to emphasize the relevance of ecosystem-based approaches and the need for buy in and support by other ministries, such as economic and finance (in addition to the environmental ministries). Conveying the multiple benefits of using ecosystem-based approaches within national policies should be communicated to policy makers and the general public, emphasizing that the natural environment should be seen as enabling rather than hindering progress towards a sustainable green economy; here, guidance for policy makers on applying the tools supporting ecosystem-based approaches as well as best practice case studies and pilot projects demonstrating associated benefits are recommended (Christie and Mudge 2009). The encouragement of partnerships by national governments could play a role here, namely by increasing the opportunity for sharing expertise and knowledge and for supporting innovative financing through, for example, investments in public private partnerships (see 5.2.2).

Enhance knowledge management and capacity building

Given the importance of technical capacity highlighted in the case studies explored, an increased knowledge and understanding of specific design characteristics for projects using ecosystem-based approaches and their implications should further be supported. Both positive experiences as well as barriers encountered (and perhaps overcome) during the implementation of ecosystem-based approaches can serve as a useful foundation for increasing the success and efficiency of emerging projects and work within this field. Systems of institutional learning can enhance these efforts, ensuring that knowledge can be transferred to a wider audience and that the utilization of lessons learned is maximized.

More generally, however, public awareness should be raised about ecosystem-based approaches and the value of both ecosystem-based mitigation as well as adaptation measures, synergies between both and the ecosystems services they aim to restore and protect. Targeted public awareness raising and education campaigns are useful tools to achieve this aim, tailoring the definition and message delivered to the relevant (sectoral) audience. Inclusive, iterative mechanisms for public engagement based on clearly identified roles and goals should also be part of such schemes (see 5.2.4).

A review of National Adaptation Strategies (NAS) revealed that only a few recognise the mitigation potential of dedicated ecosystem-based adaptation measures. Moreover, there needs to be a stronger link between mitigation and adaptation measures. Existing and potential synergies between relevant measures and a prioritization of the most effective actions providing multiple benefits should be supported by national and regional governments as well as by EU financing. Additionally, the NAS could be re-evaluated and subsequently revised to include mitigation considerations and emphasize the value of integrating both aspects into national strategies. This in turn would likely boost the recognition of ecosystem-based approaches, which often address both adaptation and mitigation.

Establish adequate management structures and ensure stakeholder involvement

Several enabling factors were identified in the case study analyses, which were found to be helpful in ensuring a successful management of ecosystem-based projects. Among others, two main success features were (1) establishing a suitable management structure and (2) involving stakeholders from the inception phase onwards.

Regarding management and the project set-up itself, the need was raised for a clear delineation of roles and transparent communication amongst all project partners. Implied is a strong commitment to the project from the relevant parties throughout as well as the assurance of a secure funding flow for the duration of the project to avoid uncertainties and delays in implementation. Regarding the selection of partners and staff, interviewees recommend a high level of experience amongst the staff and sufficient expertise as well as the involvement of practitioners who have already carried out similarly complex projects. Given the scope and complexity of ecosystem-based projects, the participation of a number of different public and private actors from a range of relevant sectors is recommended.

The delivery of ecosystem-based projects can further be enhanced by ensuring that the management structure contains appropriate mechanisms and processes for information sharing, awareness raising, and stakeholder participation from the project inception phase

forward. These factors will contribute to the creation of good conditions for cooperation between specialists, develop a sphere of responsibility (both individual and common) and enhance the idea of a need for change (see 5.2.4). Christie and Mudge (2009) suggest several features, which are likely to benefit project success in the area of stakeholder involvement, namely:

- Involving those people who benefit from the habitats, species, and sites (and the services they provide) and those involved in managing them in decisions about project action;
- Making use of local knowledge and seeking a commitment from stakeholders to achieving a shared vision for the relevant area;
- Transferring responsibility for delivery of local targets to the local area; and
- Encouraging collaboration amongst neighbouring land managers to contribute to action for local priorities.

Local actors can serve to validate a project's feasibility, incorporate local and regional needs into project design, and increase the acceptability and ownership of the idea. Maintenance of the project post-implementation can also be carried out by local stakeholders, assuming they were involved throughout the design and implementation processes and have a sufficiently strong drive to continue their involvement.

While these success factors are relevant on their own as guiding principles, they are also useful for targeting responses to specific barriers, which may arise during the various project phases. Accordingly, Table 24 places the aforementioned enabling features as well as additional considerations within the context of barriers encountered by practitioners of ecosystem-based approaches.

Table 24: Barriers to and possible solutions for successful implementation of the ecosystem-based approach at project level

Barrier	Example or clarification	Possible solution
Capacity barriers	Financial Capacity: Sufficiency, predictability, and uncertainty	• Create agreements early on the in the project design process that secure funding for the lifetime of the project • Carry out research and analysis that further reveal the financial costs and benefits of a project, and how these will evolve over the project's lifetime
	Technical and human capacity	• Develop strategies for enhancing institutional learning so as to avoid the loss of critical expertise and insights as individual project proponents move to different positions or retire • Set up networks through which best practices and lessons learned can be shared
Structural/operational issues	Organizational complexity	• Clearly identify the roles of various partners, such as strategic versus operational functions • Create formalized and frequently-utilized mechanisms for collaboration and cross-fertilization

Barrier	Example or clarification	Possible solution
Cultural/ behavioural barriers	Public awareness and perception of the climate change risk	• Create inclusive, iterative mechanisms for public engagement based on clearly-identified roles and goals
	Habits and standard operating procedures within organizations	• Tackle sources of inertia by creating incentives for innovation and opportunities for collaboration amongst disciplines/departments
Regulatory and legislative barriers	Jurisdiction	• Explore opportunities for enhancing policy consistency by considering potential inter-jurisdictional conflicts • Match a strong national mandate for ecosystem-based approaches with local capacity-building and awareness-raising efforts
	Antecedent regulatory decisions	• Evaluate and connect disparate policies that influence the capacity to pursue landscape-scale or systems-oriented ecosystem-based approaches • Identify synergies and trade-offs between various sectoral strategies and their implications for ecosystem-based adaptation and mitigation
Contextual barriers	Political landscape and changing leadership	• Institutionalize or embed ecosystem-based approaches in legislation and standard operating procedures of organizations to ensure continuing momentum and social learning. • Build public, political, and practitioner awareness so that action on climate change is resilient to shifting political priorities and economic downturns.
Structural barriers	Complex organizational structure	• Clearly define roles with the organizations involved in the projects and establish mechanisms for frequent collaboration • Embed climate change adaptation and mitigation throughout the organizational structure of key partners to reveal synergies and trade-offs with other environmental, economic and social priorities.

Ensure and explore financing

In addition to playing a central role in the design and implementation of projects, national governments also play a decisive role regarding financing. Despite public funding from national and regional governments being the most frequently utilised financing source in the explored projects, lacking financial resources was nevertheless found to be a limiting factor in a number of the case studies examined. More specifically, challenges arose in connection with the sufficiency of funds to support project activities, the predictability of funding (e.g. consistent provision of funds over time) and the uncertainty of costs associated with said projects. At the national level and to some extent at the regional level, the government's role in addressing these barriers should be in working towards ensuring sufficient and reliable financial support for projects using ecosystem-based approaches. On a project level, agreements between funders and project managers guaranteeing financing commitments should be created early on in the project design process to secure funding for the lifetime of the project and perhaps even beyond.

Several recommendations for increasing the availability of financing for supporting ecosystem-based approaches were provided by the in-depth case study interviewees as well as from the wider literature. Ecosystem services such as flood regulation and carbon sequestration, for example, could be better incorporated into financial instruments affecting land use (Christie and Mudge 2009). This entails, for example, incentivizing the maintenance and protection of ecosystems and removing perverse incentives, which encourage activities damaging ecosystems and compromising the provision of ecosystem services. Here, regulative instruments could require the restoration or renaturalisation of damaged sites (e.g. those used for extraction purposes, following the 'polluter pays principle') or compensation actions to offset environmental damages resulting from the construction of new infrastructure (e.g. highways, energy lines, housing complexes etc.). However, it should be noted that compensation alone will not be sufficient to achieve agreed restoration targets.

Additionally, innovative financing mechanisms such as payments for ecosystem services could be more frequently utilized. Carbon markets, which trade carbon credits from emissions reductions, for example, have the potential to raise funds for protecting ecosystems, which efficiently store carbon (e.g. as planned for the peatbogs in the Belarus in-depth case study) and serve as a self-financing mechanism for such projects. Charging increased rent from the residents profiting from a regenerated area with increased environmental and aesthetic benefits is another example of such an approach, as illustrated in the Swedish in-depth case study.

The potential for public-private partnerships in providing financing is also significant and can be integrated into the aforementioned financing models or exist alone. Here, the private sector can potentially demonstrate corporate social responsibility and improve their image of being environmentally responsible while enabling governments and NGOs to carry out the desired projects and thereby address relevant national or regional objectives. Foundations are another useful category of potential funders, alongside businesses, landowners and larger NGOs. In order to encourage investment in projects using ecosystem-based approaches, however, national governments should support the collection of increased evidence regarding the cost-effectiveness of and delivery of multiple co-benefits associated with such actions and projects. Further research is necessary in this regard, particularly in the form of targeted case studies, which could serve as demonstrative examples. However, this must not be taken as an excuse for non-action. Existing knowledge is sufficient to allow swift implementation of ecosystem-based approaches.

In conclusion, the government can be seen as needing to serve a guiding role and act as a motivating actor providing impetus to action at the local level. Amongst other actions, the government should demonstrate political commitment to and provide a legislative and policy framework for ecosystem-based approaches and support such projects both financially and in terms of awareness raising (including exchanges of knowledge and best practices).

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Annex A: EU Policy papers and strategies reviewed

Sector	Policy papers and strategies reviewed
Climate	• White paper: Adapting to Climate Change – Towards a European Framework for Action (COM(2009) 147 final) • Adapting to climate change: Towards a European framework for action: Impact assessment (SEC(2009)387)
Agriculture	• Communication from the Commission to European Parliament and the Council: A simplified CAP for Europe - a success for all. COM(2009)128 final • The Common Agricultural Policy Explained. European Commission Directorate-General for Agriculture and Rural Development. No date given. • Communication from the Commission to the Council and the European Parliament - Biodiversity Action Plan for Agriculture. COM(2001)0162 final • Agriculture and the environment: Introduction - http://ec.europa.eu/agriculture/envir/index_en.htm. Accessed 1 May 2011 • Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future. COM(2010)672 final
Built Environment	• Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast) • Integrated Environmental Mangement: Guidance in relation to the Thematic Strategy on the Urban Environment. European Commission Technical Report - 2007-013 • Communication from the Commission to the Council and the European Parliament on Thematic Strategy on the Urban Environment SEC(2006)16. COM/2005/0718 final • Commission proposes strategy to improve the environment in Europe's cities. IP/06/34. Brussels, 13 January 2006 • Green paper on urban environment. Communication from the commission to the council and parliament. COM(90)218 final • Urban sprawl in Europe: The ignored challenge. EEA report No 10/2006 • Commission staff working document: Annex to the Communication from the Commission to the Council and the European Parliament on Thematic Strategy on the Urban Environment Impact Assessment. COM(2005) 718 final. SEC(2006)16 • Making our cities attractive and sustainable: How the EU contributes to improving the urban environment. Luxembourg: Publications Office of the European Union. 2010. ISBN 978-92-79-16298-5 • Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products
Energy	• Communication from the Commission: An EU Strategy for Biofuels. SEC(2006)142

Sector	Policy papers and strategies reviewed
	• Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Region: Energy 2020: A strategy for competitive, sustainable and secure energy. COM(2010) 639 FINAL • Communication from the Commission to the European Council and the European Parliament: An energy policy for Europe. COM(2007)1 final • Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond. COM(2007)2 FINAL • Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC • Proposal for a Directive of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006. COM(2008)18 final • Directive 2009/31/of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006
Fishery	• Common Fisheries Policy: A user's guide. Luxembourg: Office for Official Publications of the European Communities. 2009. ISBN 978-92-79-09874-1 • Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy • Directive 2008/56/of the European Parliament and of the Council of 17 June 2008: establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) • Communication from the Commission to the Council and the European Parliament - Biodiversity Action Plan for Fisheries. COM(2001)0162 final
Forestry	• Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Addressing the challenges of deforestation and forest degradation to tackle climate change and biodiversity loss. COM(2008)645 FINAL • Commission staff working document. Annex to the Communication from the Commission to the Council and the European Parliament on an EU Forest Action Plan. COM(2006) 302 final • Communication from the Commission to the Council and the European Parliament: Reporting on the implementation of the EU Forestry Strategy. COM(2005)84 final • Communication from the Commission to the Council and the European Parliament on an EU Forest Action Plan. COM(2006)302 final

Sector	Policy papers and strategies reviewed
Health	• White Paper. Together for Health: A Strategic Approach for the EU 2008-2013. COM(2007)630 final • Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions on the health strategy of the European Community. COM(2000)285 final • Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee: A European Environment and Health Strategy. COM(2003)338 final • Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee - "The European Environment & Health Action Plan 2004-2010" SEC(2004) 729
Tourism	• Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Europe, the world's No 1 tourist destination – a new political framework for tourism in Europe. COM(2010)352 final
Transport	• Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions. Air Transport and the Environment: Towards meeting the Challenges of Sustainable Development. COM(1999)640 • Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions Reducing the Climate Change Impact of Aviation. COM(2005) 459 final • Communication from the Commission to the Council and the European Parliament: Thematic Strategy on air pollution. COM(2005)446 final • Decision No 1753/2000/EC of the European Parliament and of the Council of 22 June 2000 establishing a scheme to monitor the average specific emissions of CO2 from new passenger cars • Directive 1999/62/ of the European Parliament and of the Council of 17 June 1999 on the charging of heavy goods vehicles for the use of certain infrastructures • Directive 2006/38/ of the European Parliament and of the Council of 17 May 2006 amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures • Directive 2001/14/EC of the European Parliament and of the Council of 26 February 2001 on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification • Directive 2007/58/ of the European Parliament and of the Council of 23 October 2007 amending Council Directive 91/440/EEC on the development of the Community's railways and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure • Directive 1999/94/EC of the European Parliament and of the Council of 13 December 1999 relating to the availability of consumer information on fuel economy and CO2 emissions in respect of the marketing of new passenger

Sector	Policy papers and strategies reviewed
	cars • Commission Directive 2001/27/EC of 10 April 2001 adapting to technical progress Council Directive 88/77/EEC on the approximation of the laws of the Member States relating to measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles • Council Directive 70/220/EEC of 20 March 1970 on the approximation of the laws of the Member States relating to measures to be taken against air pollution by gases from positive-ignition engines of motor vehicles • Sustainable Urban Transport Plans: Preparatory Document in relation to the follow-up of the Thematic Strategy on the Urban Environment. European Commission Technical Report - 2007/018
Urban and Regional planning	• European Spatial Development Perspective Towards Balanced and Sustainable Development of the Territory of the European Union. European Commission. 1999
Water	• 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 • DECISION No 2455/2001/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy and amending Directive 2000/60/EC • Groundwater Protection in Europe the New Groundwater Directive – Consolidating the EU Regulatory Framework. Luxembourg: Office for Official Publications of the European Communities, 2008. ISBN 978-92-79-09817-8 • Water Framework directive summary. European Commission 2010.
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NAS – National Adaptation Strategy (http://www.eea.europa.eu/themes/climate/national-adaptation-strategies)

NC5 - Fifth national communication (http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php)

Annex B: Detailed adaptation actions for biodiversity

The detailed adaptation actions associated with each adaptation principle as outlined by Smithers et al. (2008) are listed in the following.

Maintain and increase ecological resilience

- Conserve range and ecological variability of habitats
- Conserve range and ecological variability of species
- Maintain existing ecological networks
- Create buffer zones around high quality habitats
- Take prompt action to control spread of invasive species

Accommodate change

- Understand change is inevitable
- Make space for the natural development of rivers
- Make space for the natural development of coasts
- Establish ecological networks through habitat restoration
- Establish ecological networks through habitat creation
- Aid gene flow
- Consider the role of species translocation
- Consider the role of ex-situ conservation
- Develop the capacity of institutions to cope with change
- Develop the capacity of administrative arrangements to cope with change
- Develop the capacity to learn from experience
- Respond to changing conservation priorities

Develop knowledge and plan strategically

- Undertake vulnerability assessments of biodiversity
- Undertake vulnerability assessments of ecosystem goods and services
- Undertake scenario planning
- Implement no regrets actions
- Pilot new approaches
- Monitor outcomes of new approaches
- Identify potential (cross-sectoral) win-win solutions
- Ensure cross-sectoral knowledge transfer
- Monitor actual impacts of climate change
- Research likely future impacts of climate change
- Improve understanding of the role of biodiversity in ecosystem services
- Research knowledge gaps with stakeholder participation

Integrate across all partners and sectors

- Integrate adaptation and mitigation measures
- Integrate adaptation policy across relevant economic sectors
- Integrate adaptation practice across relevant economic sectors
- Build and strengthen partnerships
- Raise awareness of benefits of the natural environment to society

Take practical action now

- Conserve and restore existing biodiversity
- Conserve protected areas
- Conserve high quality habitats
- Reduce sources of harm not linked to climate
- Use existing biodiversity legislation
- Use existing biodiversity international agreements