Nathalie Doswald and Matea Osti

Ecosystem-based approaches to adaptation and mitigation – good practice examples and lessons learned in Europe

Federal Agency for Nature Conservation

BfN-Skripten 306

2011

UNEP WCMC

Ecosystem-based approaches to adaptation and mitigation – good practice examples and lessons learned in Europe

Nathalie Doswald
Matea Osti

BfN
Federal Agency for Nature Conservation

Cover picture:
Photo credit for image on front cover: “Managed Realignment at Paul Holm Strays Humber Estuary, UK”, courtesy of the Environment Agency, UK.

Authors’ address:

Dr. Nathalie Doswald
M.Sc. Matea Osti

UNEP-WCMC
219 Huntingdon Road
Cambridge CB3 0DL
United Kingdom
E-Mail: nathalie.doswald@unep-wcmc.org
matea.osti@unep-wcmc.org

Scientific Supervision at BfN:

Dr. Horst Korn
Dipl.-Biol. Jutta Stadler
M.Sc. Kathrin Bockmühl

Biodiversity Unit (II 5.1)
German Federal Agency for Nature Conservation
Branch Office Isle of Vilm
18581 Putbus, Germany
E-Mail: horst.korn@bfn-vilm.de
kathrin.bockmuehl@bfn-vilm.de

This publication is included in the literature database “DNL-online” (www.dnl-online.de).

The BfN-Skripten are not available in book trade but can be downloaded in a pdf version from the internet at: http://www.bfn.de/0502_skripten.html

Publisher: Bundesamt für Naturschutz (BfN)
Federal Agency for Nature Conservation
Konstantinstrasse 110
53179 Bonn, Germany
URL: http://www.bfn.de

Printed by the printing office of the Federal Ministry of Environment, Nature Conservation and Nuclear Safety.

Printed on 100% recycled paper.

ISBN 978-3-89624-033-0

Bonn, Germany 2011

Contents

Acknowledgements:

Heads of European Nature Conservation Agencies (ENCA network) group members,
Sandra Naumann (Ecologic Institute, Berlin), Karin Zaunberger (European Commission), Ariane Meier (The Nature Conservancy), Robert Munroe (BirdLife International), Bram Vreugdenhil (Provincie Gelderland, The Netherlands), Kate Carver (The Wildlife Trust for Bedfordshire, Cambridgeshire, Northamptonshire & Peterborough), Philip Winn (Environment Agency UK), Sue Manson (Environment Agency UK), Olly Watts (The Royal Society for the Protection of Birds (RSPB)), Zbig Karpowicz (The Royal Society for the Protection of Birds (RSPB)), Rob Field (The Royal Society for the Protection of Birds (RSPB)), Stephan Tretter (Bavarian Ministry of State, Germany), Ingrid Cloos (Senate Department for Urban Development, Berlin), Nicholas MacGregor (Natural England), Clive Walmsey (Countryside Council for Wales), Horst Korn (Federal Agency for Nature Conservation (BfN), Germany), Jutta Stadler (Federal Agency for Nature Conservation (BfN), Germany), Kathrin Bockmühl (Federal Agency for Nature Conservation (BfN), Germany), Sonja Otto (Federal Environment Agency (UBA), Germany), Barney Dickson (UNEP-WCMC), Moritz Gies (Leibniz Institute of Ecological Urban and Regional Development), Robert McCall (Countryside Council for Wales), Katharina Lang (WWF Germany), Mirjam Galičič (Institute of the Republic of Slovenia for Nature Conservation), Felix Grützmacher (Nature and Biodiversity Conservation Union (NABU)), Annie Cung (Secretariat of the Convention on Biological Diversity), Christian Wilke (Technical University of Berlin), Linda Dalen (Directorate for Nature Management, Norway), Helmut Franz (Nationalpark Berchtesgaden, Germany), Ruth Walters (Natural England), Franz Essel (Federal Environment Agency, Austria), Ainhize Butrón (Gobierno Vasco, Spain), Aimo Saano (Metsähallitus Natural Heritage Services, Finland).

1. Executive summary

This report documents and analyses good practice examples of ecosystem-based approaches to climate change mitigation and adaptation in Europe. Ecosystem-based approaches to mitigation (EBM) are defined as the use of ecosystems for their carbon storage and sequestration service to aid climate change mitigation. Ecosystem-based approaches to adaptation (EBA) are defined as the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change; these approaches may include sustainable management, conservation and restoration of ecosystems, as part of an overall adaptation strategy that takes into account the multiple social, economic and cultural co-benefits for local communities.

Compilations of case studies relating to EBM and EBA are found in the literature, though these mainly focus on activities undertaken in developing countries. However, mitigation and adaptation activities are being undertaken in Europe. This study aims to show what is being and can be done to help people in Europe mitigate and adapt to climate change using ecosystem-based approaches.

European case studies of EBM and EBA were sought along with examples of adaptation in nature conservation, which are sometimes indistinguishable from EBA case studies and can also inform the undertaking of future EBA projects. Case studies were gathered through sending questionnaires to experts and through literature searches. This study compiled 101 case studies: 13 are EBM, 49 are EBA and 39 are from adaptation in nature conservation (nine of which were used to inform EBA), covering over 17 European countries (some projects were regional). The majority of case studies came from the United Kingdom, followed by Germany and The Netherlands.

Case studies on ecosystem-based approaches to mitigation involved peatland restoration or conservation (11 projects) and forest conservation, restoration and reforestation (2 projects). The main additional benefits from these approaches were nature conservation of important ecosystems, as well as adaptation benefits through the areas providing water regulation.

Case studies on ecosystem-based approaches to adaptation were divided into inland waters (28 projects), coastal zone (10 projects), agriculture and forestry (11 projects) and cities (9 projects).

Inland waters case studies addressed freshwater flooding through river restoration or watershed management. The majority of these project addressed both adaptation and mitigation to climate change through their implementation and the main additional benefits were new space created for recreation.

Coastal zone case studies addressed sea level rise and storm surges through managed realignment and management of beaches (sand nourishment, dune restoration and creation of hanging beaches). Managed realignment has been undertaken in many areas in Europe, mainly as compensation for lost wetland habitats but more recently as part of an integrated adaptation scheme which also includes technical or structural adaptation measures (e.g. sea walls).

Adaptation to climate change for both the forestry and agricultural sector encompasses a broad range of techniques (e.g. sustainable management techniques for crops and soil, use of different species suitable for new conditions, etc.). There were 6 agricultural/farming projects including 2 aquaculture projects, and 3 forest management projects. These were varied in their adaptation approach. These studies showed that ecosystem-based approaches provided extensive interlinked benefits.

Ecosystem-based approaches to adaptation in cities involved the creation of green and blue space, which aids urban cooling and reduces freshwater flooding. Some of these projects started out as urban environment improvement and nature conservation projects, which overtime realised the adaptation benefits these projects provide.

Many of the case studies found were not labelled as EBA or EBM, or were only labelled as such at a later stage (their original purpose being for nature conservation). This indicates that many countries are and have undertaken projects relating to EBA and EBM, and that therefore there may be more examples to find.

The review of all the projects showed that ecosystem-based approaches to adaptation and mitigation bring a number of environmental, social and economic benefits in addition to adaptation or mitigation. Many of the EBA approaches also contribute to EBM and vice-versa. Despite these benefits, the studies showed that there are a number of barriers to adopting EBA and EBM approaches. The three main barriers are: the need for considerable land, opposition from communities and lack of funding.

The lessons learned from the case studies indicated two key elements of success: Stakeholder engagement and communication, and monitoring and adaptive management. Stakeholders need to be informed of all aspects of the project and consulted to minimise conflict and gain their buy-in. Furthermore, involving stakeholder participation in the project can be beneficial for the sustainability of the project. Monitoring and adaptive management are project components that often do not take place, usually due to a lack of funding or poor project design. Nevertheless, these are essential components of good practice and several of the projects indicated their importance. Furthermore, from a climate change perspective where uncertainty of changes is high, adaptive management is the only way to ensure success.

2. Introduction

This report provides an overview of different projects that are being undertaken in Europe to mitigate and help people and ecosystems adapt to climate change using ecosystem-based approaches. Through the case studies, the report shows what is being and can be done, and provides an assessment of good practice, barriers and lessons learned in Europe.

The climate has changed over the last 100 years, with a global increase in temperature of 0.74 °C, changes to precipitation patterns and an increase in extreme weather events (Solomon et al. 2007). According to the European Environment Agency‘s global and European temperature indicator, the average temperature for the European land area for the last decade (2001 - 2010) was 1.2 °C above the 1850 - 1899 average, which is higher than the global mean (EEA 2011). Projected global future climate change of between 1.1-6.4 °C, as well significant changes to precipitation and weather events over the next 100 years (Solomon et al. 2007), signifies the need to not only mitigate as far as possible but also to adapt to new conditions. In Europe, projected changes for the period 2080 - 2100 compared with the 1961 - 1990 indicate average temperature increases of 2.5-7 °C, with higher increases in Southern Europe in the summer and higher increases in Northern Europe in the winter; average projected summer precipitation ranges from -60 % in Southern Europe to +20 % in Northern Europe and average projected winter precipitation ranges from -20 % in Southern Europe to +50 % in Northern Europe (van der Linden & Mitchell 2009).

The uncertainty and variability surrounding projected changes is high. Nevertheless, the need to continue efforts to mitigate further changes in climate and prepare for change – to adapt – has been recognised by governments through the United Nations Framework Convention on Climate Change (UNFCCC), which aims to stabilise atmospheric greenhouse gas concentrations to prevent dangerous interference with the climate system. Climate change mitigation refers to activities that reduce and remove greenhouse gas emissions. These can involve the use of more efficient cleaner or greener energy and reducing emissions from land use, land use change and forestry. European mitigation activities undertaken are currently regulated and reported under the Kyoto Protocol, which ends in 2012; at the same time many European countries have or are starting to prepare their national adaptation plans and strategies, given that some degree of climatic change is now inevitable.

Ecosystems are a vital part of the climate system as they help regulate the climate, including through sequestering greenhouse gases (mitigation through emission removals), and regulating water flow, which can aid adaptation to flooding and drought; and therefore ecosystems should be an important part of strategies relating to climate change. In 2009, the European Commission adopted a White Paper on ‗Adapting to climate change: Towards a European framework for action‘, which indicates the importance of biodiversity and ecosystems and lays out a broad framework for action along four pillars: 1) increasing knowledge; 2) integrating adaptation into policy; 3) policy instruments; and 4) international cooperation (COM 2009). European countries vary widely with respect to the state of their national adaptation strategies (NAS). An analysis published in 2009 noted that seven European countries had adopted a NAS and a further six were in preparation (Swart et al.

2009). The current status of NAS can be found on the European Environment Agency‘s website[1], which indicates that twelve European countries have adopted a NAS.

The ‗European Environment: State and Outlook 2010 on Adapting to climate change‘ (EEA 2010b) describes European vulnerabilities to climate change under seven headings: 1) Inland waters (glaciers and headwaters; river floods; drought and agriculture; water scarcity); 2) Coastal zones (sea level rise; coastal flooding due to extreme events); 3) Terrestrial biodiversity and ecosystems (wildlife and nature conservation); 4) Economic sectors (agriculture and forestry; energy; tourism and recreation); 5) Cities and the built environment (situation and urban design); 6) Human health (heat stress; disease spread); 7) Damage costs (economic losses from weather and climate related events).

The NAS vary with regard to the extent and emphasis that they place on the above vulnerabilities and associated climate change impacts. For example water stress is a greater concern in Southern European countries, and flood risk more a concern of many central and northern European countries (Swart et al. 2009).

Adaptation to climate change refers to ‗adjustments in natural and human systems in response to actual or expected climate change impacts, which moderate harm or exploit beneficial opportunities‘ (Solomon et al. 2007). The European Environment State and Outlook 2010 (EEA 2010a) describes adaptation measures as including ―technological solutions ('grey' measures); ecosystem-based adaptation options ('green' measures); and behavioural, managerial and policy approaches ('soft' measures)".

2.1 Ecosystem-based adaptation and mitigation

The role of biodiversity and ecosystem services in both climate change adaptation and mitigation has been acknowledged in both the Convention on Biological Diversity (CBD)[2] and, albeit more obliquely, in the UNFCCC[3]. They are ―natural solutions" to help society adapt to and mitigate against climate change; and measures involving these have been labelled as ecosystem-based approaches for adaptation and mitigation (EBA and EBM; see Definitions Box). They involve the use of environmental or natural resource management for carbon sequestration and storage, climate regulation, for climate change adaptation. In so doing, they improve the resilience of ecosystems, maintain, enhance and restore ecosystem services and ultimately sustain people‘s livelihoods and wellbeing in a changing climate (CBD 2009). Using these ‗green‘ measures for adaptation can be beneficial for mitigation and vice-versa, and hence, synergies are clear. They can also be used in conjunction with ‗grey‘ measures to provide integrated climate change mitigation and adaptation approaches. EBA and EBM can also be supported by efforts of adaptation in nature conservation (see Definitions Box). Furthermore, adaptation in nature conservation can also in some instances be an example of EBA (e.g. river restoration to conserve biodiversity, which also reduces flooding) or provides climate change mitigation benefits.

Studies and reviews of these ecosystem-based measures to climate change indicate that these also provide communities with benefits in addition to climate change adaptation and mitigation and are often more cost-effective and viable in the long-term than technical

---

[1] http://www.eea.europa.eu/themes/climate/national-adaptation-strategies
[2] CBD COP 10, Decision X/33
[3] UNFCCC COP16: REDD+ mechanism as climate change mitigation; Adaptation actions that include ―building resilience of socio-economic and ecological systems, including through economic diversification and sustainable management of natural resources"

solutions (Campbell et al. 2009). EBM options are a relatively well developed and agreed climate protection measure. Indeed, the evolution of REDD+ (Reducing emissions from deforestation and forest degradation in developing countries, including sustainable management of forests, conservation and enhancement of forest carbon stocks) is a sign of this; although the role of other ecosystems in mitigation is still largely ignored in global policy. EBA on the other hand is an emerging concept, but one that has backing from many NGOs (e.g. IUCN, TNC, BirdLife International, ELAN) and IGOs (e.g. UNEP, UNDP).

Since the concepts of EBA and EBM were developed, a number of case-studies and good practice examples have emerged across the world[4], though some of these have been retrospectively called EBA and EBM. Most of these documented case studies come from outside Europe, though interest in compiling European case studies is growing[5]. European countries are engaging in adaptation and mitigation projects, some of which are ecosystem-based. Some of these projects are government-led but many are NGO-led. Compiling and analysing these examples enables knowledge transfer in this new subject field and the drawing out of some of the key lessons learned to allow good adaptation and mitigation practice.

Definitions

Ecosystem-based approaches to adaptation – the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change (CBD 2009); and may include sustainable management, conservation and restoration of ecosystems, as part of an overall adaptation strategy that takes into account the multiple social, economic and cultural co-benefits for local communities. Adaptation is facilitated through both specific ecosystem management measures (e.g. managed realignment) and through increasing ecosystem resilience to climate change (e.g. watershed management, conserving agricultural species genetic diversity).

Ecosystem-based approaches to mitigation – the use of ecosystems for their carbon storage and sequestration service to aid climate change mitigation. Emissions reductions are achieved through creation, restoration and management of ecosystems (e.g. forest restoration, peat conservation).

Adaptation in nature conservation – conservation action that increases the resilience of species and ecosystems to climate change and facilitates their adaptation (e.g. facilitating movement of species across the landscape to enable shifts in distributions, reducing other sources of harm known to interact with climate effects, conserving species genetic diversity to maximise chances of adaptation and maintain ecosystem services, creating or modifying habitat to reduce climate effects).

[4] E.g. http://www.elanadapt.net/good-practices; http://www.worldresourcesreport.org/case-studies
[5] EC Study on the Potential of Ecosystem-based approaches to climate change adaptation and mitigation in Europe (forthcoming)

3. Methods

3.1 Compilation of case studies

European EBM and EBA projects, as well as projects of adaptation in nature conservation, were sought. Although the focus was on the former two, examples of the latter are often tied in with EBM/EBA or can inform these. Only projects with some component implemented at the field level were sought. A multi-pronged approach was employed to achieve a good overview of case studies. An initial literature search for EBM/EBA projects was conducted, including both grey and peer-reviewed literature. Searches were performed in Google and predominately in English. Case studies were also compiled through two phases of expert consultation. In the first instance, experts provided website locations as potential resources for case studies. In the second instance, a questionnaire was developed (see Annex I) and sent to adaptation experts, predominately from the European Nature Conservation Agencies (ENCA) network.

The questionnaire was also used to document case studies found in the literature search. The compilation exercise also extracted several case studies from a database kindly provided by the Ecologic Institute. In collaboration with the Environmental Change Institute, the Ecologic Institute is developing a database of projects and resources showcasing the evidence for cost-effectiveness of EBM/EBA approaches, as part of a project for the European Commission[6].

Although the compilation exercise succeeded in producing a robust dataset, there are some limitations in the results. One limitation is the proportion of projects from the UK. This bias may arise from a) searches made in English and b) the fact that some UK NGOs provided multiple examples. Although it may also be that the UK is currently show-casing more (ecosystem-based) adaptation projects than elsewhere in Europe (Swart et al. 2009). Completeness of questionnaire responses was another limitation, particularly for analysing the data; a significant number of responses lacked information in fields considered key for analysis of good practice (e.g. project implementation, results, and lessons learned). In such cases, further online research was conducted in an attempt to extract information for such fields to the greatest extent possible.

Factors that have limited the comprehensiveness of this study include conducting searches only in English, sending out questionnaires to a limited number of potential respondents (mainly from the conservation sector), and not undertaking a systematic search of case studies in different sectors. Finally, any future efforts to compile case studies of relevance to Europe may also want to consider drawing from case studies located elsewhere in the developed world, for example, North America, Australia, and Japan.

3.2 Quality control

Some EBA projects submitted through questionnaire responses were ultimately excluded because there was insufficient evidence to provide a link to *ecosystem-based* adaptation

[6] "Assessment of the potential of ecosystem-based approaches to climate change adaptation and mitigation in Europe" (Contract-N° 070307/2010/580412/SER/B2), commissioned by the European Commission, DG Environment, Project Team: Ecologic Institute, Environmental Change Institute, University of Oxford

approaches; rather, such projects showcased the use of ‗grey measures' for adaptation undertaken in ecosystems. Other projects had to be carefully scrutinised to distinguish between those that employed ecosystem management for reasons that did not relate to climate change adaptation (e.g. for biodiversity conservation in general, or to fulfil national or regional environmental laws or directives), and those which employed ecosystem management specifically to address the threat of climate change. A liberal interpretation was adopted in cases where a project may have started out for other reasons (e.g. to fulfil the EU Habitats Directive), but where contribution of the project as an ecosystem-based mitigation or adaptation measure was identified at a later point in time. This study also included EBA approaches which were combined with traditional forms of adaptation.

3.3 Analyses

The case studies are divided into mitigation and adaptation (though in some cases this distinction is arbitrary since ecosystem-based approaches often address both). Adaptation case studies are presented in the following categories: inland waters, coastal zones, agriculture/forestry, cities and nature conservation. An overview of the total number of case studies per category, primary and secondary aims of each case study, and countries where case studies were taking place, is provided.

The aim of the project is to document and analyse good practice examples of EBM and EBA in Europe. Projects of adaptation in nature conservation can provide good lessons for both EBA and EBM. Furthermore, in some cases these projects had a secondary aim to help people adapt to or to mitigate climate change. Therefore, projects of adaptation in nature conservation listed in the database that had the capacity to inform or had secondary aims to provide EBA and EBM were, for the purposes of good practice analyses, included in the relevant EBM and EBA categories. Information on the remaining adaptation for nature conservation case studies, and all other case studies consulted in this study, can be found in the accompanying database.

‗The guiding principles for adaptation to climate change in Europe' (Prutsch et al. 2010) (Table 1) provide guiding principles for good practices in adaptation:

Table 1: The guiding principles for adaptation to climate change in Europe (Prutsch et al. 2010)

1	Initiate adaptation, ensure commitment and management
2	Build knowledge and awareness
3	Identify and cooperate with relevant stakeholders
4	Work with uncertainties
5	Explore and prioritise potential climate change impacts
6	Explore a wide spectrum of adaptation options
7	Prioritise adaptation options (inclusive win-win…)
8	Modify existing policies, structures and processes
9	Avoid maladaptation
10	Monitor and evaluate systematically

The Climate, Community and Biodiversity Standards provide guiding principles for land-based carbon projects (CCBA 2008) and are a good guide for ecosystem-based mitigation projects. These cover project design (assessment of the condition of the area, baseline projections, stakeholder involvement, management, legal status, positive climate impacts with no leakage, and monitoring) and multiple benefits (net positive community and biodiversity impacts should arise).

Drawing on these principles for adaptation and mitigation, a framework to evaluate good practice for EBA and EBM case studies was developed (Table 2). This framework establishes the factors that make good practice when undertaking EBM and EBA. The questionnaire (see Annex) was set out in such a way so as to collect information relating to the framework. The case studies collected were examined to find out whether they showed evidence of the following good practice factors:

Table 2: Framework to evaluate ecosystem-based adaptation and mitigation

Good practice factors	**Elaboration**
1 Strong collaborations and stakeholder involvement	The project is built on strong partnerships between different agencies and involves stakeholders in all aspects
2 Integration in a climate change strategy and into multi-sectoral policy	The project is part of a larger climate change strategy and in multi-sector policies
3 Consideration of scale	The project is undertaken at the appropriate scale and considers multi-scale effects
4 Vulnerability and impact assessment	The project is based on the best available science (and traditional knowledge) on vulnerabilities/climate impacts. The project also examines the environmental/social impact of adaptation options
5 Adaptive management cycle	The project manages, measures, evaluates and adapts its management (includes a strong monitoring scheme)
6 Sustainability	The project has provision for the future in terms of funding, management, monitoring, stakeholder buy-in and considers the long-term (avoiding mal-adaptation)
7 Multiple benefits	The project achieves its purpose and provides benefits aside from its primary purpose

The analysis of good practice draws out the relevant elements of good practice from case studies. The case studies that achieved a maximum of good practice coverage (dependent on data availability) were chosen and described in more depth. Given the number of case studies, and the lack of information for many of these aspects in the case studies, conclusions on good practice were not inferred from the analyses of case studies.

4. Case studies

4.1 Overview of findings

The final dataset contained a total of 101 mitigation and adaptation case studies spanning projects conducted in more than 17 European countries, some projects being regional or involving many countries (see Figure 1). Nearly half of the case studies found (44) came from the United Kingdom. Case studies for Germany, The Netherlands and regional were the next most numerous, followed by Norway and Austria. The number of countries and the number of case studies found per country is unlikely to be a true reflection of the European practice of EBA and EBM approaches, but is rather an artefact of the limitations of this study. Nevertheless, the underlying tendency found in the data may be based on some measure of truth (Swart et al. 2009).

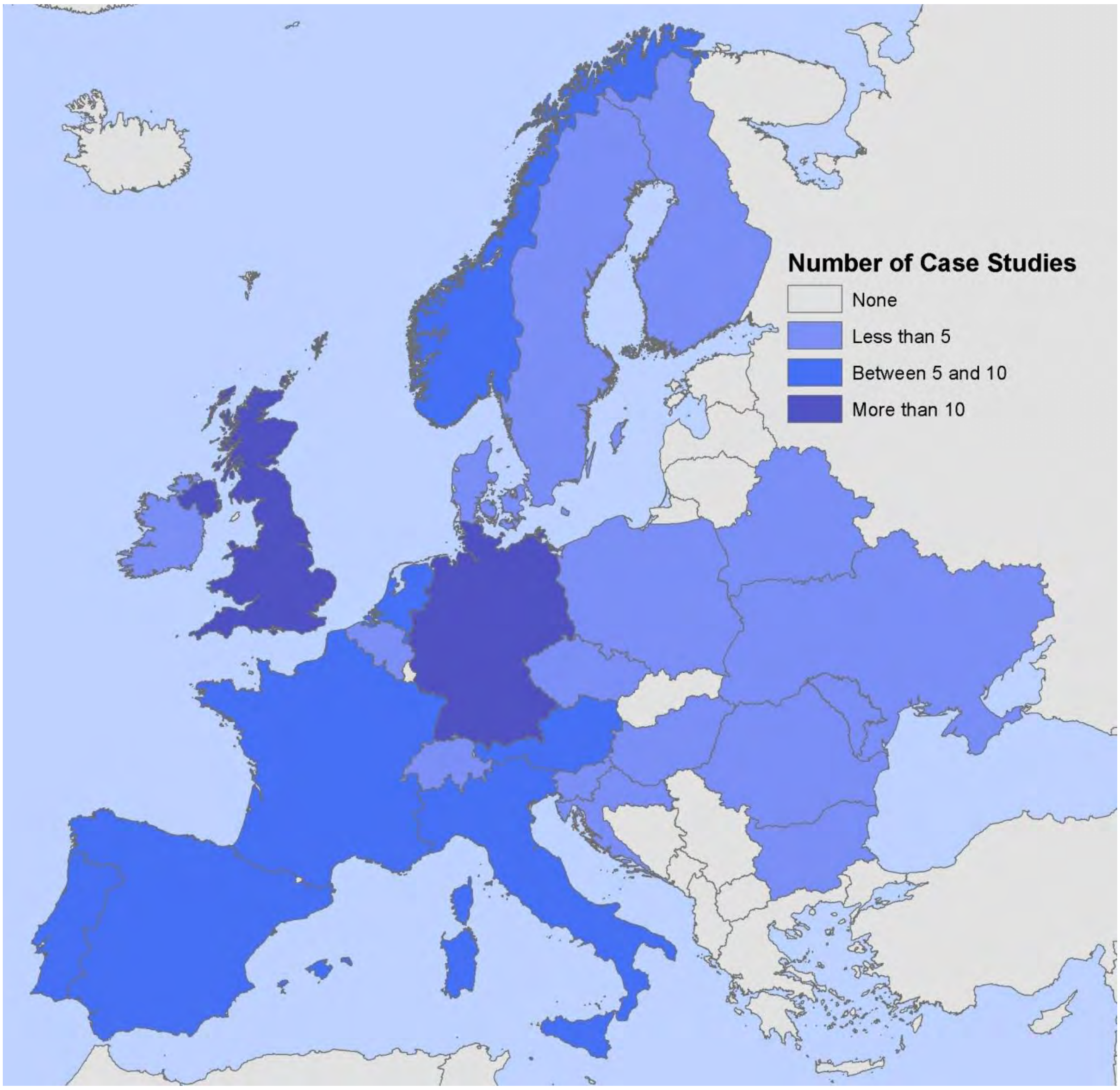


Figure 1: Density map of European ecosystem-based approaches to adaptation and mitigation case studies found within this study, including case studies operating at regional (e.g. Mediterranean) level.

Figure 2 shows the distribution of ecosystem-based case studies, divided into EBM, EBA and adaptation in nature conservation. EBA case studies were the most numerous followed by adaptation in the nature conservation and finally EBM. Many of the case studies had more than one aim; for example, some EBA projects also aimed to facilitate adaptation for nature conservation and/or to mitigate climate change. The lighter colours in Figure 2 reflect the number of projects where mitigation or adaptation was a secondary aim.

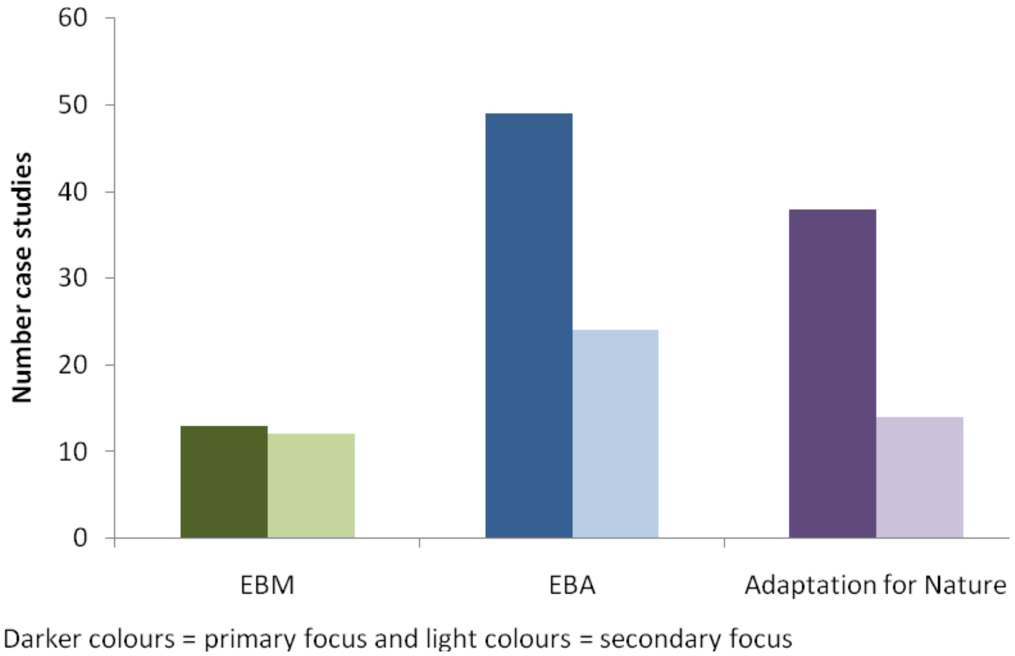


Figure 2: Ecosystem-based approaches to adaptation and mitigation: Number of case studies with ecosystem-based mitigation (EBM) focus, ecosystem-based adaptation (EBA) focus and adaptation for nature conservation.

There were 13 EBM case studies where EBM was listed as the primary aim and a further 16 case studies where EBM was an additional component of the project. Figure 3a shows the proportion of these 29 case studies per country, while Fig. 3b shows the aims of the mitigation projects and what proportion of 29 case studies pursued those aims. Soil carbon conservation and sequestration were the most numerous EBM aims, followed by biomass carbon conservation and sequestration.

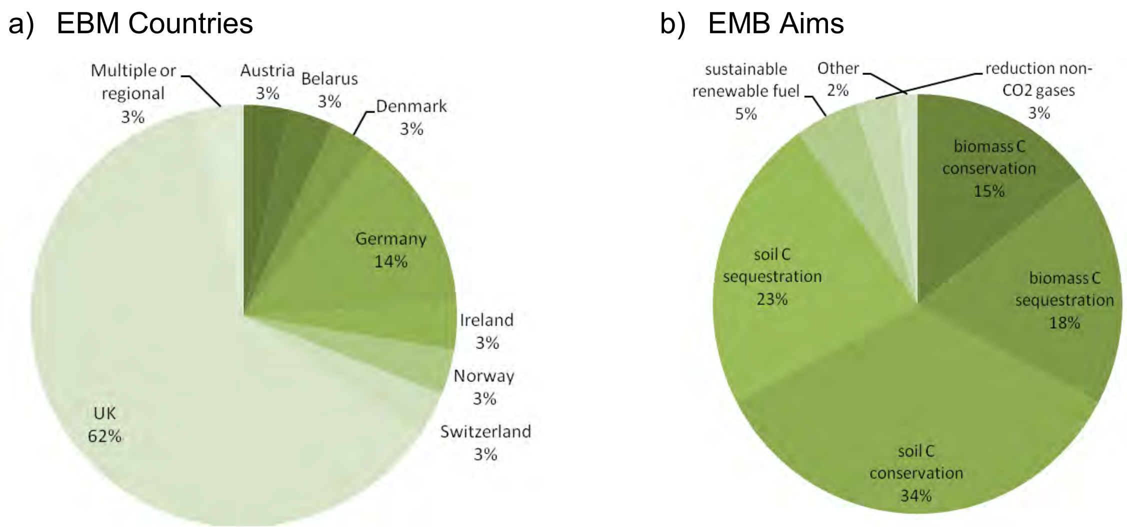


Figure 3: Ecosystem-based Mitigation (EBM) projects: a) proportion of case studies found in over 9 countries; b) aims of the different EBM projects and their proportion in the case studies

There were a total of 49 EBA case studies of which 25 related to inland waters, 4 to coastal protection, 11 to agriculture and forestry, and 9 to cities. Figure 4a shows the proportion of these case studies per country, while Fig. 4b shows the aims of the adaptation projects and what proportion of case studies pursued those aims. Flooding and water management account for half of the case study aims, which is not surprising given that these are two important issues in Europe (Swart et al. 2009; EEA 2010). The limited amount of coastal case studies is an artefact of the project rather than reality. Indeed, there exist many more cases of managed realignment across Europe than those found in this study (see Coastal Zone section). This is also likely to be the case for other aims such as urban cooling.

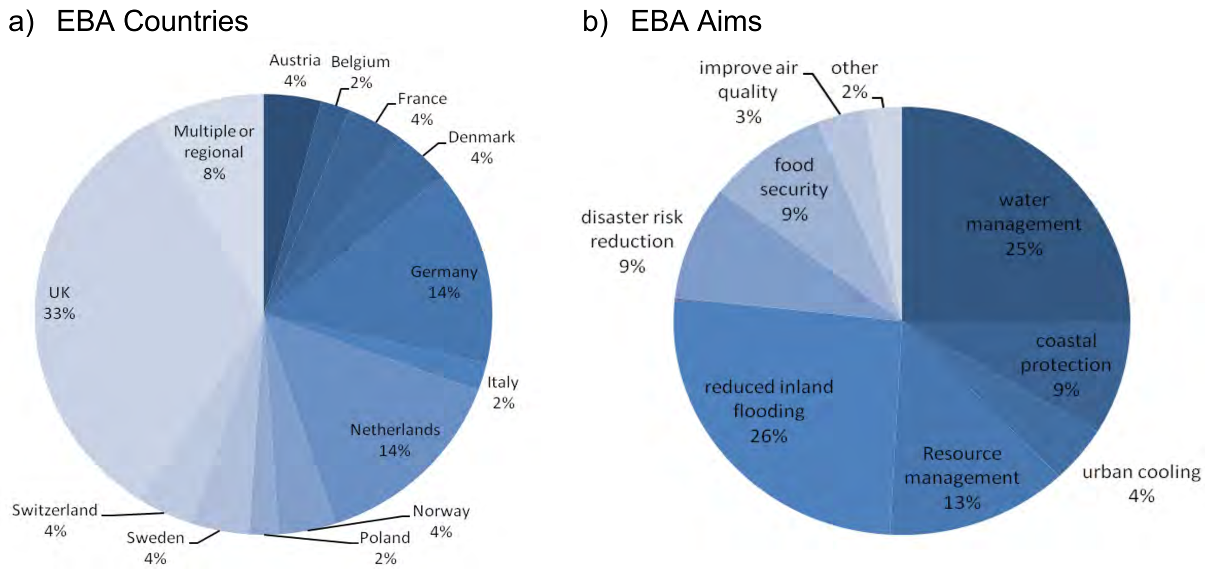
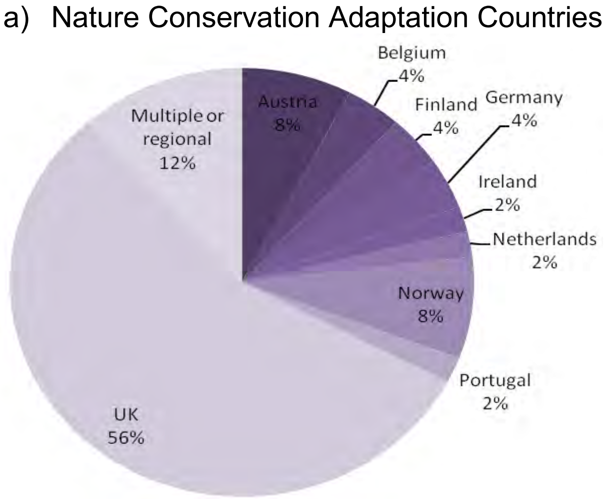


Figure 4: Ecosystem-based Adaptation (EBA) projects: a) proportion of case studies found in over 13 countries; b) aims of the different EBA projects and their proportion in the case studies

There were a total of 39 adaptation for nature conservation case studies, while a further 14 EBA/EBM case studies also aimed to help species and the natural environment adapt. Figure 5a shows the proportion of the 53 adaptation for nature conservation studies, while Fig. 5b shows the aims of the adaptation projects and what proportion of case studies pursued those aims. Enhancing resilience and connectivity were the main aims of these projects.



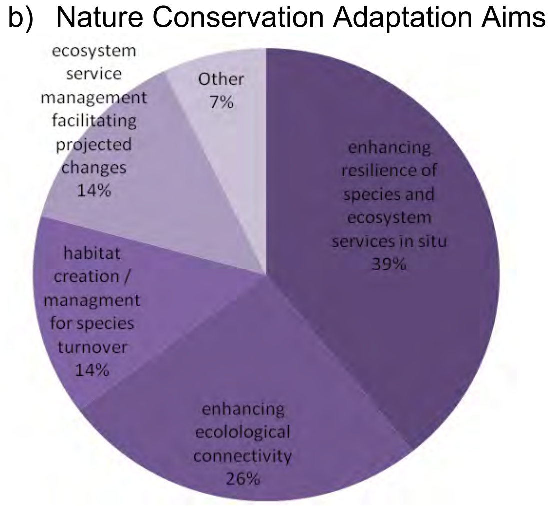
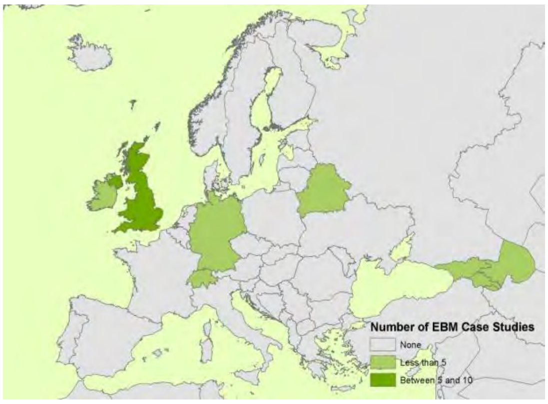


Figure 5: Adaptation for wildlife and nature projects: a) proportion of case studies found in over 8 countries; b) aims of the different projects and their proportion in the case studies

The majority of projects were run in partnership by a combination of national agencies and non-governmental organisations (NGOs). Project start dates ranged from 2000 to 2012. Out of the 54 project where information concerning their status (end date) was available, 12 projects have been completed. In the following sections, EBM and EBA projects are analysed. Nine of the adaptation for nature conservation case studies were included in EBA (as these were informative for these) for the following analyses.

The following sections provide an analysis of good practice for ecosystem-based approaches to mitigation and adaptation, with adaptation being split into the above mentioned categories. Highly detailed analysis of good practice for these case studies was limited by incomplete information for some studies, which in turn affected the overall degree of conclusiveness that could be made. For example, approximately 60 % of case studies did not have information entered into all the fields consulted during the analysis of good practice (Table 2). For the 40 % of studies that did have the necessary fields, approximately 75 % recorded positive information. If these projects could be counted as a random sample, it would indicate favourably for the remaining projects. However, negative information is notoriously difficult to find, as many reports avoid recording these issues, hindering shared learning.

4.2 Ecosystem-based mitigation



Number of projects: 13

Countries: United Kingdom (8[7]); Switzerland (1); Germany (1); Belarus (1); Ireland (1[8]); Caucasus (1)

Major landscapes: forest/woodland; mountain; river/floodplain; grassland; wetland; moorland; bog; peatland; uplands; fens

Mitigation main objectives: biomass carbon conservation; biomass carbon sequestration; soil carbon conservation; soil carbon sequestration; reduction of non-CO_2 gases

Actions that help stabilize and reduce concentrations of greenhouse gases in the Earth‘s atmosphere are integral to reducing the negative effects of anthropogenic emissions on the world‘s climate system. Such mitigation actions can include the reduction of greenhouse gases from the energy sector, for example, through integration of renewable energy policies or reducing public energy demand for fossil fuels and encouraging energy-efficient behaviour. They can also include greenhouse gas emission reductions and removals from actions associated with land use, for example, through the management of ecosystems to maintain or enhance their carbon storage capacities. These ecosystem-based mitigation approaches are diverse, and can incorporate measures such as forest conservation, conservation and restoration of peatlands and wetlands, protection of the ocean sink, improved grassland management, and environmentally sound agricultural practices (Trumper et al. 2009; Cowen et al. 2009).

In Europe, common ecosystem-based approaches to mitigation (EBM) include peat conservation and restoration (particularly in the Northern and Western regions, which hold the most extensive areas of peatland) and forest conservation. The majority of EBM projects (11 of 13) in the database were peatland conservation and restoration projects, which had soil carbon conservation and sequestration as a mitigation goal. A further two projects focused on forest conservation and restoration.

Many European countries are undertaking EBM type activities under the UNFCCC, and particularly the implementation of ‗Land Use, Land Use Change and Forestry‘ (LULUCF) project activities under the Kyoto Protocol. The ―Annual compilation and accounting report for Annex B Parties under the Kyoto Protocol for 2010”[9] reported that 28 Parties accounted for LULUCF, reporting on activities such as forest management, grazing and cropland management and revegetation; and 37 Parties provided information on anthropogenic GHG emissions by sources and removals by sinks from LULUCF activities, including from afforestation and reforestation activities. There is therefore potentially a large area from which to gain experience and lessons for EBM. Under the joint implementation, however, only one project related to LULUCF – afforestation of degraded agricultural land in Romania[10] – has been undertaken.

[7] 2 examples from Ecologic Institute project: Restoring active blanket bog of European importance in North Scotland; and restoration of Scottish raised bogs
[8] 1 example from Ecologic Institute project: Restoring raised bogs in Ireland
[9] http://unfccc.int/resource/docs/2010/cmp6/eng/05.pdf
[10] http://ji.unfccc.int/JIITLProject/DB/UUPQK3EXX9F5KBJQ4PGDO6WWTDLRD7/details

The majority of case studies found for this report, however, are EBM activities that are not currently eligible under LULUCF and therefore offer insight to other mitigation activities.

Peatland conservation and restoration

The peatlands of Europe are most extensive in Norway, Finland and Sweden though are found in many Northern European countries and are important carbon stores (Montanarella et al. 2006). Over the last hundred years, Europe has witnessed a significant decline in its peatlands, mainly attributed to peat extraction for fuel and draining of peatland for activities related to agriculture or forestry. The loss and degradation of peatlands results in biodiversity loss and greenhouse gas emissions.

Peatland conservation and restoration projects deliver on more than one front, providing climate change mitigation, biodiversity conservation and water regulation. The majority of peat restoration projects were originally started because these habitats are important from a conservation perspective and are undertaken by NGOs, usually in reserves or other protected areas. Subsequently these projects took into account the climate change mitigation benefits. Rewetting peatland can also trigger private public partnerships (PPPs). Some of the peat restoration projects have been funded by EU‘s LIFE Programme, which supports environmental and nature conservation projects (e.g. restoring raised bogs in Ireland project led by Coillte Teoranta (Irish Forestry Board)). In the UK and Ireland, restoration activities concern blanket or raised bogs (e.g. two UK RSPB reserves: Lake Vyrnwy in Wales and Forsinard in Scotland). Activities involve ditch blocking, water management and revegetation or afforestation.

Given the nature conservation focus of the above mentioned projects, mitigation benefits are mainly secondary to the primary conservation aim. However, three projects explicitly mention carbon and climate change mitigation: Germany‘s ―Moorschutz am Theikenmeer" project, rewetting of large areas of the Theikenmeer nature reserve, Belarus‘s peatland restoration (see Good Practice Example), and England‘s North East ecosystem services pilot areas.

Forest conservation, restoration and reforestation

Two forest-based mitigation projects were found, which, considering the well-known contribution of forests to climate change mitigation, is not a lot. A variety of factors account for this limited number of forest-based projects, such as the role of forests in LULUCF, the focus on tropical forests (e.g. REDD+), and the importance of European forests for other purposes, such as forestry, biodiversity conservation, watershed management, flood regulation, and disaster risk reduction – see EBA section).

The first project is a carbon market project by the OAK Schwyz in Switzerland which owns 9036 hectares (ha) of FSC forests. The project aims to increase the biomass content by increasing the standing timber volume through improved forest management, and sell CO_2 certificates in the voluntary market in Switzerland. It tried and failed CCBA (Climate, Community and Biodiversity Alliance) standard validation, mainly because of the potential for double counting carbon credits (see Barriers to EBM approaches).

The second project is a large WWF-led project in the Caucasus (Armenia, Azerbaijan and Georgia) aiming to reforest selected areas for the purpose of long-term carbon mitigation and also climate change adaptation (reduce impacts from flooding and landslides). The project has resulted in increased adaptive capacity of forests and restored forest areas that the stakeholders involve aim to be register as a Clean Development Mechanism (CDM) project.

EBM good practice analysis

All projects reviewed have a wide stakeholder involvement, with volunteers and the community helping with the restoration work, educational and guided visits and other outreach events.

Vulnerability assessments do not tend to be undertaken for mitigation, though these could be useful in terms of informing long-term management strategies to ensure permanence; and hence we did not find information suggesting that the projects had undertaken any. However, environmental impact assessments and extensive monitoring were undertaken in the majority of projects.

The likelihood of sustainability of the peatland-based projects is high. The fact that many of the projects are on reserves and other protected areas ensures that the peatlands are conserved. For the other projects, links created at the local and national level (e.g. in Ireland, Germany, Belarus) in the projects may help sustain the conservation efforts.

The multiple benefits from both peatland and forest projects include biodiversity conservation, new foraging opportunities for local communities (e.g. berries and mushrooms), as well as recreation (e.g. bird watching). Furthermore, peatlands also help to regulate water flow and thus contribute to adaptation. The Exmoor Mire restoration project in the UK received an award in the 2009 Water Industry Achievements Award in recognition of the work to retain water on the moorlands of Exmoor and thus reduce high river flows following rainfall. The forest conservation projects also aid adaptation and protect local communities from the likes of rock fall and erosion.

Barriers to EBM approaches

Nature conservation is likely to remain the primary driver for peatland conservation and restoration. Leveraging carbon finance for forest mitigation projects in Europe can be hindered by the fact that forest carbon is likely to be reported by respective governments in their Kyoto Protocol accounting; and therefore single projects in country can be seen as double counting the emission reductions and removals.

More generally, the lack of funding and resources available to a project are the main barriers that many of the projects have encountered. Funding sometimes only covers part of a project (e.g. set up) and does not make provision for long-term management. Monitoring, especially post-implementation, also requires long-term funding.

Projects engaging a large number of stakeholders, government actors, and undertaking community involvement/participation increase the time for set up and implementation of the projects, as well time spent reaching consensus.

Lessons learned

Strong project design, including clear goals, monitoring and adaptive management, as well as good stakeholder involvement/buy-in were highlighted in some of the projects as key recommendations for future projects. Making use of more volunteers can help when resources are limited and is a good outreach strategy. Use of local labourers creates local income and raises awareness.

Ecosystem-based Mitigation Good Practice Example

Renaturalisation and sustainable management of peatlands in Belarus

This Global Environment Facility (GEF) project addressed peatland degradation in Belarus (2005-2010), with a long-term goal to promote integrated approaches to ecosystem management on degraded peatlands, so as to ensure multiple global benefits by combating land degradation, conserving biodiversity and mitigating climate change (GEF et al. 2010). Implemented by the Ministry of Forestry in Belarus, the project's main objective was to strengthen the enabling environment for ecosystem-based management on degraded peatlands, and show how multiple global benefits could be generated feasibly through the management of several pilot sites.

The GEF project restored the wetland ecosystem of 15 drained and degraded peatlands with a total area of 28,207 hectares, and it is estimated that the emission reductions from the rewetted peatlands are approximately 311,000t/CO_2/annum. Furthermore, fire outbreaks have ceased since the rewetting and monitoring results show restoration of mire flora and fauna. Following this project, some of partners involved continue with peatland restoration[11] (KfW Peatland Project).

Why good practice in mitigation?

The project is a **collaborative partnership** between many different agencies, including the Ministry of Forestry of Belarus, the GEF, United Nations Development Programme, The Royal Society for the Protection of Birds (RSPB), KfW Bankengruppe. Numerous other **stakeholders**, such as the National Academy of Sciences of Belarus, regional and local executive committees and local people were also involved (see GEF 2010).

The **sustainability** of this work is ensured through long-term commitment to renaturalisation at the **policy** level and through the continued work by the different stakeholders, as well as through plans for carbon finance.

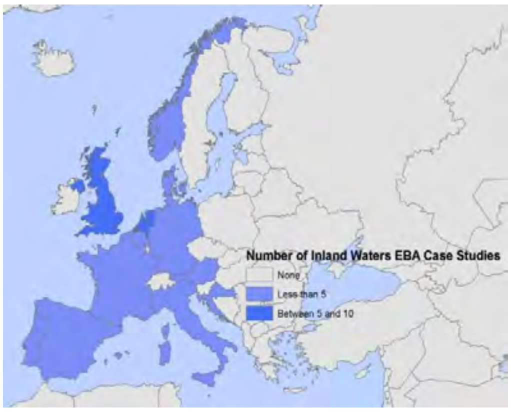
The project brings **multiple benefits**, in addition to adaptation and mitigation, to both the environment (e.g. biodiversity conservation) and to society (e.g. medicinal plants, game, berry harvesting, and ecotourism). These benefits have been evaluated versus the cost of losing commercial peat exploitation and the results showed that the conservation scenario provided more benefits[12].

---

[11] http://restoringpeatlands.org/index.php?option=com_content&view=article&id=47&Itemid=28&lang=en
[12] http://restoringpeatlands.org/images/stories/belarus/apb.pdf

4.3 Ecosystem-based adaptation

Inland waters



Number of projects: 28

Countries: United Kingdom (9[13]); Netherlands (6); France (2); Austria (2[14]); Danube Basin countries (1); Mediterranean (1); Denmark (1); Germany (4); Norway (1); Belgium (1)

Major landscapes: river/floodplain; wetland; forest; agricultural land; grassland; mountain

Major climate change impacts of concern: precipitation change; flooding; extreme weather; drought; water quality; sea level rise

Primary threats to and opportunities for people arising from impacts: damage to property, people, and land; water shortage; change in water quality

Adaptation main objectives: reduced inland flooding; water management; coastal protection

Adaptation projects involving inland waters are prevalent because flooding and droughts are major current problems in Europe. Indeed, between 1950 and 2009, 44 major flood disasters have been recorded in Europe, while many areas frequently experience water shortages (EEA 2010). Adaptation options for flooding and water management include structural defences on rivers and floodplains and irrigation during drought. Ecosystem-based approaches to adaptation are already used to help regulate watersheds in many regions (e.g. protecting watershed forests) and are increasingly being used to mitigate river flooding (e.g. multi-functional land use concept; Nijland & Menke 2005).

Regulating rivers

River and floodplain renaturation and/or restoration are the main ecosystem-based approaches that are being used to mitigate current flooding risk. The main activities that are carried out are riverbed alterations, dyke relocation, habitat restoration, creation or protection, and invasive, alien species removal.

River renaturation involves restoring rivers and canals to more natural meandering rivers and restoring the surrounding landscape. The ―renaturation of the Regge River" in the Netherlands, a WAVE project (see Good Practice Example), for example, is reinstating meanders in the riverbed and restoring the surrounding landscape, including water storage areas, in a bid to reduce flooding but also to create climate resilient multi-functional landscapes (e.g. including recreation).

River restoration is a widespread technique to reduce flooding risk. For example, the European Centre for River Restoration (ECRR)[15] is gathering river restoration projects to share knowledge and its database currently contains over 50 projects, nearly half of which are for flood/floodplain protection. An excellent example is the ―Sustainable Development of Floodplains (SDF) project", which ran between 2003-2008 at 12 locations along the river Rhine in the Netherlands and Germany. Although this project was not undertaken using a ‗climate change adaptation' lens, it provides a good example of an EBA activity, by taking an

---

[13] 3 examples from Ecologic Institute project: Parrett Catchmement Project; Cornwall Rivers Project; Sustainable River Catchments for the South East (SuRCaSE)

[14] 1 example from Ecologic Institute project: Restoration of Danube river banks

[15] http://www.ecrr.org/projects-river-restoration.html

ecosystem-based approach to flood mitigation. Restoration can also involve removing invasive/alien species to increase riverbank stability and resilience to floods (e.g. the ―Combating *Impatiens glandulifera* along riverside" project in Lier Municipality in Norway).

In some cases, restoration projects have been undertaken not primarily for people but for nature conservation and its adaptation to climate change. For example, WWF is leading a project to restore the river banks of the Danube (in Bulgaria, Moldova, Romania and Ukraine) to create a ―Lower Danube Green Corridor", which aims to protect biodiversity while improving water quality and improving livelihoods. Also, as part of the WAVE project (see Good Practice Example), the UK‘s Royal Society for the Protection of Birds (RSPB) is managing its Greylake site to increase the resilience and adaptability of the river wetlands to climate change, conserving biodiversity but also providing the continuation of important ecosystem services.

Good practice analysis

Nearly all the EBA river regulation projects involved strong collaborations between many different partners, involving both governmental and non-governmental organisations. These projects are for the most part large-scale complex projects requiring extensive consultation and plans and, as such, are usually at an appropriate scale – that is they take into account the river system – and are based on the best available science. In most cases, good management strategies have been put in place for the duration of the projects and in a few cases involved adaptive management (e.g. IAS project in Norway).

Stakeholder involvement in the case studies was found, for the most part, to involve some sort of consultation and outreach.

Nearly all case studies found that using ecosystem-based approaches to adapt to flooding results in benefits for both people and nature. Recreation and tourism are the major benefits from the creation of multi-functional land use, and the restoration of riverine and wetland habitats is excellent at increasing and protecting biodiversity.

Barriers to EBA approaches

The need to make use of significant areas of land is often the greatest challenge in river EBA projects. Planning permissions and legal processes take time. Furthermore, communities can be opposed to changes in land, either due to loss of land or through perceived security issues, which can lead to legal proceedings. Land purchase or financial compensation is therefore sometimes necessary.

Lessons learned

Early communication with local communities can forestall the common challenges with these types of projects, as well as enabling better land use zoning and ensuring the derivation of maximum benefits to the communities by understanding what is wanted or needed.

There is a need to make the case for using EBA approaches. Demonstrating and communicating the science behind EBA would help both decision-makers and the public make informed choices. Demonstration projects can also help illustrate the effectiveness of these approaches.

Finally, some of the projects found that having a solid strategy and work plan is essential and that large cooperative projects, involving different partners, are good opportunities to exchange learning and a conduit for innovative ideas.

Inland Waters EBA Good Practice Example

WAVE project – Water Adaptation is Valuable to Everyone

WAVE is a collaborative project (2008-2015) involving six regional partners in the Netherlands, the UK, France, Belgium and Germany to prepare for climate change impacts in water systems. There are three main objectives: 1) developing policies that prevent damage and address opportunities of climate change in the water system, 2) reducing the vulnerability of stakeholders and nature to climate change impacts, and 3) outreach on water issues.

This multi-national project involves 13 implementation projects (4 in UK, 3 in Germany, 2 in the Netherlands, 1 in Belgium, and 2 France) designed to reduce flooding and manage water resources more sustainably and make the environment more resilient to climate change. Ecosystem-based adaptation measures used include wetland preservation, tree planting, river restoration, rainwater collection, sustainable agriculture and renewable energy utilisation.

Why good practice in adaptation?

This is a large trans-national **collaborative project** involving stakeholders from both government and non-governmental organisations. **Stakeholder involvement** includes an expansive outreach programme in the regions, a dedicated website[16] and newsletter, stakeholder meetings and volunteer involvement in some sub-projects.

Each project partner **assesses the vulnerability** of its water system to climate change, and takes regional climate predictions into account when designing adaptation measures. Many of the projects have been placed within a **local adaptation strategy** (e.g. in UK projects entrenched in the Somerset County Council Climate Change Strategy).

The **scale** of the projects is appropriate; for example, the renaturation plans for the Regge River (The Netherlands) cover 85 % of the river length, while in Germany extensive floodplains are being created at Geraardsbergen to protect citizens.

The **Sustainability** of many of the sub-projects is likely as complementary funding is being sought. The projects will have numerous **benefits** including recreational and learning between project partners in different regions.

[16] http://www.waveproject.eu/

Watershed management

Watershed management encompasses a whole host of activities, many of which are ecosystem-based, such as revegetation or afforestation to control erosion and regulate water flow. The EBA case studies found that fall within this category are consequently also varied in nature, ranging from conversion of arable to grassland, improving land management practices to afforestation.

Seven of the nine case studies also have climate change mitigation benefits; and in four of the cases studies, mitigation benefits are an integral part of the projects. These four projects are peat restoration projects. The other three projects also include peat restoration and afforestation.

The projects all aim to regulate water flow, with particular emphasis on attenuating flooding. Furthermore, many of these adaptation projects take into account future[17] climate change. For example, an afforestation project in Denmark is using species suitable for the projected future conditions. The Great fen project (see Good Practice Example), for example, is part of a larger project, called ―Climate proof areas"[18], which includes projects in 5 different countries with an aim to build strategies and projects that contribute to adaptation and are climate resilient.

Good practice analysis

The EBA projects related to watershed management often involved multiple partners. Nearly half the case studies included work undertaken on protected landscapes (e.g. reserves). This is unsurprising since ecosystem-based approaches are maybe more often considered in the conservation sector. Nonetheless, all projects involved ‗non-conservation' partners and one of main focus of these projects are to attenuate flood risk to people.

The case studies also indicate a good level of community engagement, including public consultations, stakeholder workshops, or working closely with farmers (e.g. UK's Bassenthwaite Ecosystem Services Pilot Project, South Pennines Ecosystem Services Pilot, and Parrett Catchment Project).

Climate change considerations in all its aspects (adaptation and mitigation) are at the heart of the majority of these projects. Indeed, it is one of the main strengths of ecosystem-based approaches that both adaptation and mitigation benefits arise. Consequently, many of these projects are well designed and based on good scientific assessments.

Barriers to EBA approaches

Data availability can hamper the scientific assessments required for informed decision-making for EBA. Although not explicitly mentioned in these case studies, land requirements may be a problem, which would explain why many of the case studies found involve land already set aside for nature conservation.

Lessons learned

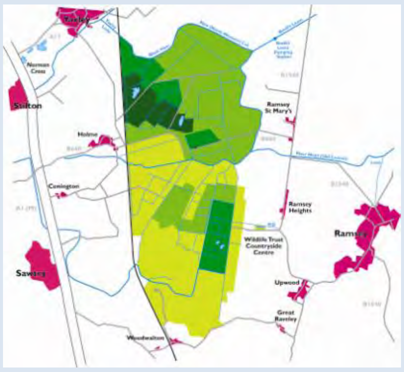
The lessons reported from these case studies point to stakeholder consultation and engagement and provision of good information to these stakeholders and the public as key to success.

---

[17] As opposed to current climate change.
[18] http://www.climateproofareas.com/

Inland Waters EBA Good Practice Example

The Great Fen project



© The Wildlife Trust

The great fen project[19] aims to restore over 3,000 ha of fenland habitat in South East England UK. The project is undertaken by a partnership involving The Wildlife Trust for Bedfordshire, Cambridgeshire, Northamptonshire and Peterborough, Natural England, Huntingdonshire District Council, the Environment Agency, and the Middle Level Commissioners.

The project will result in a multi-functional landscape, providing flood risk protection to the surrounding communities and help mitigate climate change through carbon storage and sequestration. It is a long-term project, which started early 2000s. Restoration work is currently being undertaken. In 2010, it completed its master plan for the project, which won a prestigious UK planning award. This plan outlines the vision for the future.

Why good practice in adaptation?

The Great Fen project is **collaborative project** with a dedicated project team. **Stakeholder involvement** includes public consultation, the use of volunteers and a wide outreach programme, which includes education events.

The project involves land use planning, and is **based on thorough assessments**, including socio-economic studies and climate change assessments.

It is a long-term project, including management and monitoring plans, which promotes **sustainability**.

This project encompasses ecosystem-based adaptation and mitigation as well as adaptation for nature conservation. The project therefore has numerous **benefits** to both people and nature.

[19] http://www.greatfen.org.uk/

Coastal zones

Number of projects: 10

Countries: United Kingdom (7); Denmark (1); Netherlands (2)

Major landscapes: coast

Major climate change impacts of concern: precipitation change; sea level rise; flooding; extreme weather

Primary threats to and opportunities for people arising from impacts: damage to property, people, industry, infrastructure, landscape, history, wildlife

Adaptation main objectives: coastal protection; reduced inland flooding

Adaptation to climate change in coastal zones typically involves activities to reduce the risk to communities from the impacts associated with sea level rise and with extreme weather events (e.g. storm surges), such as coastal flooding. In Europe, where approximately one fifth of the EU population lives within 10 km of the coast (EEA 2006), and where many densely populated coastal areas are already below sea level, adaptation strategies are necessary and already in place in many areas. Adaptation options usually involve dykes and sea walls. Ecosystem-based approaches to adaptation in coastal zones include managed realignment, and creation of habitats (e.g. wetlands, estuary habitats, sand nourishment), which help to buffer against encroaching tides and damage resulting from storm surges. Managed realignment is by far the most common approach, though has sometimes been used as a compensatory mechanism (to re-address habitat loss) rather than as an adaptation activity (e.g. Wallasea managed realignment project).

Although not always branded as an ecosystem-based approach to adaptation, managed realignment projects in Europe have existed for some time and are generally well documented, with information being available in the public domain. The OMReG Database[20] developed and operated by ABPmer, a leading UK marine environmental consultancy, maintains a collection of managed realignment and regulated tidal exchange in the UK and Western Europe. Currently, the database holds information on 102 completed projects, including details on key lessons learned and project drivers, constraints and successes. One of the Database aims is to assist practitioners working on future projects through the provisions of information that will help the learning and public communication process.

It is not uncommon for adaptation projects along coastal zones to include a combination of hard defences as well as ―natural solutions" (see Good Practice Example below). Depending on the objectives of the project, different approaches will be more or less suitable; however, there is evidence that natural systems, such as coastal wetlands, can be more (cost) effective than hard defence structures in protecting coastal areas from flooding and erosion (Constanza et al. 2008). Indeed, hard structures require costly upkeep, and cannot adapt to changes, as ecosystems can and they can be harmful to ecological processes (wave dynamics, etc.). The economics of managed realignment have been investigated and indicate that it often has lower maintenance costs and can be more cost-effective than hold

[20] http://www.abpmer.net/omreg/default.aspx

the line options, adding additional benefits of habitat creation and flood storage areas (Tinch & Ledoux 2006).

Of the case studies gathered for this report, eight were examples of managed realignment projects (mostly UK-based), one was a dune restoration project and another was a sand nourishment project, the latter two located in the Netherlands (Climate Buffers project[21] and Climate Proof-areas project[22]). Only four out of the ten projects had adaptation for people as a primary aim (EBA-focus).

Some work under the Humber flood risk management strategy in the UK (see Good Practice Example) and Freiston Shore managed realignment in the UK have been realised. The Green Blue Plan of municipality of Dragør in Denmark, which includes ecosystem considerations and use of coastal ecosystems in their defence strategy, and the Climate Buffers project in the Netherlands are currently ongoing.

The other six projects are being undertaken as adaptation in nature conservation. However, the approaches used and the end result of these projects will benefit people and could be EBA approaches in their own right. These approaches include managed realignment (mainly UK RSPB-led projects), sand nourishment and the creation of hanging beaches and shellfish reefs (Climate Proof area project). The reason for these not being primarily EBA is due to these projects being NGO-led with a conservation focus. Nevertheless, these six projects offer good experience and lessons for EBA and were thus included in this section.

Good practice analysis

Most of the coastal zone adaptation projects surveyed had undertaken work in collaboration with other partner organisations. Half of all projects reported community engagement with stakeholders, such as statutory authorities and the local community.

Almost all projects had undertaken some form of impact assessment, and one indicated the presence of an adaptive management cycle.

Seven projects reported the presence of a monitoring system, with varied monitoring portfolios including: physical, biological and ecological monitoring; monitoring of sedimentation and erosion/accretion; monitoring impacts to selected habitats; and monitoring of sea defences. Five of these seven projects reporting monitoring were adaptation in nature conservation projects (rather than EBA). The greater prevalence of monitoring in these cases is probably due to the fact that most of these projects are based on reserves and come from the conservation community where monitoring is seen as essential.

Additionally, these projects are likely to be more sustainable in the long-term due to their placement on reserves.

All projects identified benefits additional to the primary aim of adaptation, such as recreation and ecotourism.

Barriers to EBA approaches

The major obstacle to EBA approaches in the coastal zones is the negative stakeholder perception of such approaches, resulting from either fear (of these being less effective than hard structures) or anger at loosing land. Land use trade-offs and land use legislation are

[21] http://www.klimaatbuffers.nl/eng/index1.asp?menu=1&sub=100
[22] http://www.climateproofareas.com/

other barriers. Land purchases or financial compensations are sometimes required, adding to the overall project budget.

Monitoring results from Freiston and other managed realignment schemes in the UK suggest that ecosystem thresholds exist that may affect ecosystem resilience and vulnerability to future changes. These thresholds still need to be adequately quantified. Moreover, it is not always clear what needs to be monitored because knowledge of ecosystem functioning may be limited. Continued comprehensive monitoring is desirable for this but adds to the implementation costs.

Lessons learned

The projects found that stakeholder and community engagement is essential and that it takes time to build trust. The Humber community project, undertaken prior to the Humber flood risk management strategy, found it took approximately two years of dedicated community staff time to gain the community's trust.

The continued monitoring of site conditions before, during, and after implementation is critical. Many of the projects have monitoring built in but have not necessarily monitored all the necessary components (including the benefits to adaptation). Balancing monitoring needs can be difficult.

Coastal Zone EBA Good Practice Example

Humber flood risk management strategy

The Humber flood risk strategy is a holistic project with the primary aim to protect people and industries situated in low lying land around the Humber Estuary from tidal flooding risks associated with sea level rise, whilst protecting the landscape and wildlife. The project involved employing a combination of traditional ―hard defence" measures, as well ecosystem-based adaptation approaches, such as managed realignment to protect against sea level rise, and creation of washland, wetland and saltmarsh habitat to buffer the force of incoming waves and tides. Prior to the launch of the strategy in 2008, the coastal futures Humber community project was undertaken between 2005 and 2008 to engage communities on the north bank of the outer estuary affected by coastal change.

Why good practice in adaptation?

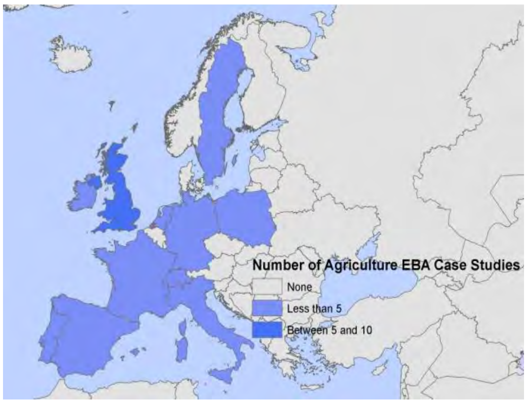
Prior to the launch of the strategy, extensive **stakeholder and community engagement** was undertaken, with one of the elements a collaborative **partnership**, developed by the RSPB, Environment Agency and Natural England, with funding from Defra. This outreach work is captured in a report titled ‗Humber Community Project: Lessons learned and best practice in community engagement on changing coasts' (Coastal futures n.d.).

Work thus far under the strategy has resulted in completion of realignment and new habitat creation in several areas along the Estuary (four new intertidal wetlands have so far been created, more are planned). The project implementation phase involved an **environmental impact assessment**, **adaptive management**, and **monitoring** of topographic, avifauna, benthic and saltmarsh communities. Work will continue along the estuary, with a number of collaborative/independent projects also taking place.

The aim of the strategy is to ensure **sustainable flood risk management for the next 25 years**, which includes traditional flood risk management options but also considers ecosystem-based approaches, such as managed realignment and flood storage.

The project has also provided a number of **benefits** in addition to its primary adaptation goals. Creation of new habitat to buffer the force of incoming waves and tides has contributed to conservation adaptation goals, in particular, increasing wildlife habitats lost to climate change. Other benefits include those to the community (e.g. increase of cultural services in terms of new walks in new habitats, and income associated with that recreation from people visiting, income from recreation), water retention and carbon sequestration service through restoration of wetlands.

Agriculture and forestry



Number of projects: 11

Countries: Regional (4[23]); United Kingdom (3[24]); Sweden (1); Switzerland (1); Poland (1[25]); Germany (1)

Major landscapes: Agricultural land; forest; mountain; marine

Major climate change impacts of concern: Change in temperature; change in precipitation; drought; flooding; change in the growing season

Primary threats to and opportunities for people arising from impacts: loss of crops/timber/fisheries from climate variability, drought and disease; flooding damage to people; avalanche/landslide risks

Adaptation main objectives: Resource management; food security; disaster risk reduction; reduced inland flooding

Changes to the growing season, as well as changes in temperature and precipitation, are affecting and will continue to affect European agriculture and forestry. The climate change consequence to date has led to increases in agricultural production and, in some cases, decreases in timber harvest, though the occurrence of increasing extreme events, which are set to be more frequent in the future, have led to major losses (EEA 2010b).

Adaptation to climate change for both the forestry and agricultural sector encompasses a broad range of techniques ranging from maintaining (genetic) diversity, genetic-breeding, irrigation, rain-fed/rainwater harvesting techniques, sustainable management techniques for both crops and soil, using different species suitable to new conditions, etc., many of which are ecosystem-based. The EC (2007) report provides a detailed analysis of climate change impacts and adaptation options in the agricultural sector and includes ecosystem-based options.

The case studies found for ecosystem-based approaches to adaptation in this sector can be divided into agricultural/farming practices (six projects) including aquaculture (two projects), and forest management (three projects).

Agriculture

The good management of soil is an EBA approach that aids the regulation of water (e.g. reducing soil compaction which leads to runoff), and at the same time can help reduce soil carbon losses through soil disturbance thus contributing to climate change mitigation. The Parrett catchment project in the UK, works with farmers to sustainably manage both soil and nutrient to decrease runoff and maintain healthy soils.

One novel case study found in the UK (Otter farm), exploited new opportunities brought by climate change. The farm grows different crop varieties from warmer/drier climates thus decreasing ‗air miles‘.

[23] 1 example from Ecologic Institute project: PISCES - Partnerships Involving Stakeholders in the Celtic Sea Ecosystem

[24] 1 example from Ecologic Institute project: Parrett Catchment project

[25] 1 example from Ecologic Institute project: The Conservation of Agricultural Biodiversity in Wigry National Park: Restitution of Local Breeds of Farm Animals and Restoration of Old Apple Cultivars

The remaining case studies from the agricultural sector, all include an element of conservation: conservation of genetic diversity (The conservation of agricultural biodiversity in Wigry National Park in Poland), habitat protection for water regulation and important protection species, such as pollinators, (EBA by small-holder farmers in Sweden), and land use zoning (The Cambrian Mountains Initiative in the UK). These conservation-based initiatives tend to be undertaken by small-scale farming. EBA approaches are probably more suited to this kind of agriculture, though these practices are also important for larger scale operations. Indeed the delivery of important ecosystem services, such as water regulation, nutrient cycling and pollination are highly desirable to the agricultural sector. EBA approaches, such as those used in these examples, demonstrate their value to help adapt the sector to climate change.

The two aquaculture projects (PISCES[26] in the Celtic Sea and ACIDBIV[27] in the Mediterranean) found were currently at the investigation stage though implementation is likely to entail sustainable management and habitat protection.

Forestry

Management approaches of forests under climate change is being investigated by a large transboundary project (ForeSTClim[28]) involving 21 partners with a wide range of experts from United Kingdom, Germany, France, The Netherlands and Luxemburg. These strategies will be both ecologically and economically sound and are consequently good EBA approaches. One EBA measure is the use of species suitable for a changing climate, an option that was used in an afforestation project in Demark, whose primary aim was water regulation (see Inland waters watershed management section), and that was also used by the Bavarian Forest Administration (see Good Practice Example).

Indeed reforestation, afforestation, restoration and sustainable management as approaches are a good EBA because they regulate water flow and quality, and reduce the risks of disasters. Swiss legislation recognises the protective function of its forests in reducing the risk to people from avalanches and landslides and manages them accordingly (NaiS project). The Swiss SilvaProtect-CH study started in 2004 and due to end 2011 examines the protective capacity of forests against avalanches and related hazards through computer modelling (ProAct Network 2008).

Finally, forests sequester carbon and deliver wood, which stores carbon for a certain time and can be used to save energy and produce renewable energy, both leading to a reduction of fossil energy consumption. Forests thus contribute to climate change mitigation (See EBM).

Good practice analysis

The case studies found were a mix of small scale personal operations (e.g. Otter farm and farmers in Sweden) to large multi-partner collaborations (e.g. ForeSTClim, PISCES, The Cambrian Mountains Initiative). This variety is expected since adaptation options for the agricultural and forestry sectors also vary in their scale.

---

26 http://projectpisces.eu/about_us/what_will_we_achieve/implementing_pisces/
27 http://www.circle-med.net/index.php?pagename=acidbiv&itemid=103&PHPSESSID=44d165621e0560ed79bdbdb6912f0016
28 http://www.forestclim.eu/index.php?id=2

Over half of the case studies found had very good community engagement, with stakeholder workshops and networks, outreach such as newsletters or blogs (e.g. Otter farm) and awareness nature trails (e.g. NaiS project).

Adaptive management and monitoring are known to be used in four of the 10 case studies found. Monitoring for these projects is more closely tied to management than for effectiveness evaluation, involving the monitoring of biological indicators to indicate planting and harvest times (e.g. Birch leaf size for sowing time; Tengo & Belfrage 2004).

EBA approaches provide extensive interlinked benefits. By sustainably managing and protecting the environment, EBA approaches ensure the continued delivery of services necessary for agriculture and forestry, thus protecting livelihoods and the economy; they provide water regulation, disaster risk reduction and also contribute to climate change mitigation. Finally, they also offer biodiversity conservation and recreation possibilities, especially in the forested landscapes.

Barriers to EBA approaches

Certain policies and subsidies can be a substantial barrier to using EBA approaches. Although EU agri-environmental schemes, currently under the EU Rural Development policy, provide a large number of actors to engage with on EBA they still may cause restraints due to (perceived) financial, administrative and land use requirement difficulties. Furthermore, lobbying by chemical and plant breeding companies, combined with short term food security and economic considerations, may tip the balance away from some EBA approaches. Indeed, pesticides, chemical fertilizers and other chemicals currently are a solution to changing pest/disease patterns and climate change impacts on soil quality, though alternative environmental approaches to such inputs do exist (e.g. use of control species, manure, etc).

EBA approaches also require a strong connection between the farmer and the environment because adaptive management is necessary. Experimentation is also part of this process, which takes time and a potential loss of resources in the short term that farmers may not be ready to make.

Lessons learned

Stakeholder engagement in large projects is important to create ownership and avoid conflict. Furthermore, understanding the market, informing consumers and good marketing can be beneficial and lucrative to further novel EBA approaches (e.g. Otter farm in the UK).

The case studies mentioned that technical support, such as climate change risk mapping, and financial support are important to help these sectors adapt to climate change. Subsidies to farmers and forest owners are a powerful tool to enable widespread adaptation.

Networks between farmers are important mechanisms to exchange important knowledge on EBA practices. Indeed, old practices can inform adaptation to climate change and experimentation with new practices can yield benefits. Finally, adaptive management is essential to dealing with climate change.

Agriculture/Forestry EBA Good Practice Example

Conversion of forests to adapt to climate change in Bavaria

In 2006, the Bavarian Forest Administration started its work to develop its climate change plan, which is a part of the Bavarian Climatic Program (2008-2011) preceded by extensive study, to make its forests fit for climate change. For example, research was undertaken to develop climate change maps of the region and climate models for different species.

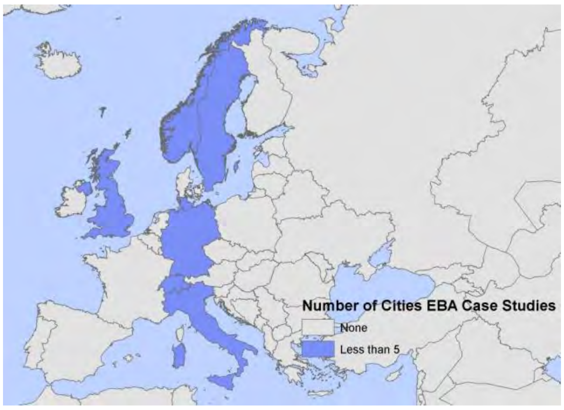
Forests will be made more resilient and adapted to climate change by converting 260,000 ha private and community owned conifer stands into mixed stands, 100,000 ha until 2020. (Furthermore about 165,000 ha in state forests will be converted and stabilized between 2008 and 2033 by *Bayerische Staatsforsten* – public enterprise Bavarian State Forest). More specifically, it is replacing Norway spruce and pine stands to mixed stands with broadleafs, such as beech and oak, to promote more future climate tolerant species. Moreover, it is making forests more natural and managing these in such a way that increases and protects biodiversity. Also a special set of measures are planned for the adaption of the alpine forests in Bavaria to climatic change. The former Bavarian State Forest Administration (split up in 2005 in Bavarian Forest Administration and Bayerische Staatsforsten) has been undertaking this type of conversion since the mid seventies as these mixes are more resilient to both abiotic and biotic stress as well as being economically beneficial (Ammer et al. 2008; Matthes & Ammer 2000).

Why good practice in adaptation?

This work takes place within Bavaria‘s forest **policy.** The plan undertaken by the Bavarian Forest Administration is **science-based**, based on good assessments and models and extensive long-term research. Furthermore, it is actively aiming to manage forests in a way that promotes biodiversity, whilst maintaining the forestry sector‘s objectives. It also helps the forest itself be more resilient to climate change, as well as aiding climate change mitigation, thus maximising **benefits** to people.

The work follows a long-term plan at a large **scale** that ensures **sustainability**. Furthermore, it involves the relevant **stakeholders** (forest owners) to help implementation of the plan through subsidies. Finally, community outreach and education are being undertaken.

Cities



Number of projects: 9

Countries: United Kingdom (3); Norway (1); Germany (2[29]); Switzerland (1[30]); Italy (1[31]); Sweden (1[32])

Major landscapes: cities

Major climate change impacts of concern: temperature change; precipitation change; drought; flooding; extreme weather; air quality; and water quality

Primary threats to and opportunities for people arising from impacts: increased mortality and health problems due to urban heat; damage from flooding; increased runoff; loss or degradation of urban park and recreation spaces from drought and heat; degraded water quality from sewage water system overflow after heavy rainfall; lower quality of life

Adaptation main objectives: development and extension of urban green and blue spaces and infrastructure; tree planting; reopening of streams and water systems; sustainable drainage systems

Climate change impacts on urban environments have the potential to be significant, particularly in areas where population density is high, infrastructure is poor and where the coast is of close proximity. In European cities, heat waves, floods and droughts are already impacting water supplies and building and transport infrastructures, and contributing to deterioration of public health and quality of life. Such impacts are expected to exacerbate in the future, as global temperatures increase and climatic zones shift northwards (EEA 2010).

At the same time, urban environments are in a unique position to address adaptation to climate change. Several cities around the world are playing a pioneering role in addressing climate change mitigation and adaptation, in many cases being ahead of national legislation on climate change. A new global forum (Resilient Cities[33]) has emerged to increase learning, cooperation and networking on all aspects of urban resilience and adaptation to climate change.

Adaptation options in a city are likely to differ according to its population, geographic location, local and regional climatic conditions, urban design and layout, physical infrastructure characteristics and other associated factors. ―Traditional" approaches to adaptation can include constructing more resilient buildings and installing hard defence structures (e.g. sea walls to buffer against coastal flooding), among others. Ecosystem-based adaptation options in urban environments can encompass green infrastructure and space (e.g. green roofs, urban tree planting and parks/recreational ground) and blue infrastructure and space (e.g. lakes and ponds). These approaches help to reduce impermeable surfaces and heat island effects, improve air quality, water storage capacity and soil functions, and provide vital habitat for species.

[29] 1 example from Ecologic Institute project: Berlin: The biotype Area Factor (BAF)
[30] 1 example from Ecologic Institute project: Building regulations for green roofs in Basel, Switzerland
[31] 1 example from Ecologic Institute project: Extra cubature for developers in return for green space
[32] 1 example from Ecologic Institute project: Augustenborg, Malmö: Retrofitting SUDS in an urban regeneration area
[33] http://resilient-cities.iclei.org/

Green and blue infrastructure and space

The development of green and blue infrastructure and space in urban environments is a popular and effective approach for reducing impacts associated with the heat island effect in cities, as well as improving overall urban ecology and biodiversity. A fair amount of research exists on green and blue infrastructure and space in cities and towns around the world, partly because the first urban greening projects were initiated several decades ago, as a mechanism to improve urban ecology and nature conservation.

The GRaBS Database[34], an initiative of the Green and Blue Space Adaptation for Urban Areas and Eco Towns (GRaBS) project[35], is a database of case studies on green and blue infrastructure projects in cities and towns as a method of adaption to climate change. The case studies span Europe, North America and Japan, and are particularly useful in their coverage of the processes which have supported the implementation of adaptation measures in urban areas, and inclusion of stakeholder engagement, and key messages from projects.

Good practice analysis

All of the nine EBA projects contained in the database were administered either by local councils or government agencies. Partnerships between different government departments were common, and often necessary to ensure that regulations or incentives were harmonized and consistent across multiple sectors of government. Many projects involved (and to a certain degree, relied upon) community involvement, especially in maintaining green or blue areas into the future. For example, the community woodland scheme undertaken by the Somerset County Council as part of the WAVE project is dependent on community volunteers to maintain the woodlands that have been created as a result of the project.

A couple of projects were explicitly linked to local or national climate change adaptation strategies. A relevant example is Norway‘s Cities of the Future project, and aims to foster cooperation between cities on developing measures to encourage greener urban environments. It is integrated into the Norwegian Adaptation Programme, whose secretariat assumes responsibility for the coordination of climate change adaptation efforts related to the Cities of the Future project.

Depending on the type of initiative and its specific objectives, the scale of green and blue infrastructure implementation in cities varied widely, from focusing on a specific city district or socioeconomic group of interest, to incorporating entire (and in some cases, multiple) cities and municipalities. For example, the City of Manchester‘s Green Streets Project has implemented tree planting in low income areas of the city in recognition of projections that low income areas are more likely to be vulnerable to future climate change impacts, such as heat waves. Norway‘s Cities of the Future initiative, on the other hand, is significantly larger scale, incorporating 13 of Norway‘s largest cities.

Many of the projects have existed for a long time, with greening initiatives for some cities starting in the 1980s and 1990s (although in such cases, greening initiatives were started for objectives related to urban ecology and nature conservation, rather than adaptation; See Berlin, Biotop Area Factor – Good Practice Example). A relevant example is the building regulations for green roofs project in the City of Basel, Switzerland, which began an incentive

[34] http://www.grabs-eu.org/casestudies.php
[35] http://www.grabs-eu.org/

programme in the mid 1990s to increase energy efficiency, and ultimately led to building regulations being implemented in 2002. These are now considered an established element of the planning system and have ongoing impact in the city (Kazmierczak & Carter 2010).

Barriers to EBA approaches

Common barriers to urban greening, reported in the case studies, are those related to costs and resources (including staff and volunteer time availability) for maintaining green measures once they have been implemented. Some projects have attempted to address this challenge through the creation of trust funds. Tensions between different government departments can also exist when priorities are being considered. Another barrier is extent of uptake by the target community; in some cases, places where greening measures are voluntary may result in lower implementation success than areas where the practice is mandatory, though there are many examples of successful voluntary initiatives.

Lessons learned

There needs to be a sufficient level of community engagement, to ensure proper outreach and subsequent community interest and involvement. Working with partners can lead to more opportunities for funding and support and a cross-sectoral approach.

Working with developers and providing clear guidelines for green and blue infrastructure in the early design stages will ensure that developers are aware of council requirements and the various options available.

A combination of mechanisms, from incentives to regulations, can result in wider public uptake of greening projects than if only one policy approach were to be employed.

Cities EBA Good Practice Example

Initiated more than two decades ago, the Biotope Area Factor (BAF) programme is an innovative landscape planning regulation, which requires a certain proportion of development area to contain green space. The programme is administered by the Senate Department for Urban Development in Berlin, and forms part of the city‘s wider policy (*Landscape Programme including Nature Conservation*).

The premise behind the BAF is that decentralised and incremental green infrastructure can have a positive impact on urban ecology (Ahern 2007). There are different BAF targets according to the land-use purpose. Developers then have the choice of selecting a variety of greening techniques, each of which are weighted based on the individual technique‘s contribution to the programme goals and calculated as a percentage of site area to give the resulting BAF (Ahern 2007), which should meet or exceed the assigned BAF target. Implementing the BAF into development projects is mandatory in certain zoned sections of the city centre; outside these areas the programme is voluntary.

Why good practice in adaptation?

The programme has involved **collaboration** between both landscape planning and land use planning government departments (Kazmierczak & Carter 2010). **Public consultation** was undertaken prior to implementation, and Department‘s website features information and tools on the BAF.

The programme is implemented at the **individual building scale**, which allows for a flexible urban greening approach combining individual developers‘ needs and circumstances with overarching city level goals for improvements in green space area and urban ecology. The **long-term viability and sustainability** of the BAF programme is well documented through its continued operation for more than 25 years. The city also conducts monitoring of the urban climate, urban species diversity, and water quality and runoff to determine collective effectiveness of greening techniques (Ahern 2007).

The BAF programme was not initially implemented as an EBA measure; the primary driver for the programme was nature conservation and improved urban ecology. Over time a recognised **further benefit** of the programme has been its role in enabling adaptation of the city to impacts associated with climate change. Finally, the concept of the BAF has led many other cities[36] to adopt similar approaches to urban greening (Cloos 2009).

[36] such as those in Canada, Denmark, Finland, Italy and Puerto Rico

5. Conclusions

This study compiled 101[37] case studies of ecosystem-based approaches to mitigation (EBM) and adaptation (EBA) including adaptation for nature conservation projects. The review showed that many of these projects did not start out as mitigation or adaptation projects. For example, introducing urban blue and green space can contribute to adaptation, but was originally focused on improving the urban environment; similarly, many peat restoration projects have been undertaken for the sake of biodiversity conservation. The analysis has also shown that of the considerable number of EBA projects being undertaken in Europe, many have not adopted the climate change discourse, being labelled instead as disaster risk reduction or landscape management initiatives. This is particularly true of projects related to water management (e.g. floodplain restoration and watershed management) or crops (change in planting dates, diversifying, etc.). The possibility exists, therefore, that EBA and EBM approaches are being undertaken more frequently than thought. However, what the dedicated adaptation projects show, is that future climate change is explicitly being considered by the projects through the use of climate change projections. Taking future climate change into account will be necessary to ensure the long-term viability and usefulness of these projects.

When describing project results, most of the case studies do not provide any evidence of how effective the activities have been in terms of mitigation (e.g. how much emissions reductions and removals have been made) or adaptation (e.g. how much flooding damage has been avoided). Such information would be a powerful tool for advocating the use of ecosystem-based approaches. However, the qualitative evidence and the associated benefits, including the livelihood and business potential and the overall positive impact on quality of life, which are part an evaluation of adaptation (Adger et al. 2005), provide a good case for ecosystem-based approaches. Further in connection with some of the case studies, information was found that hinted at or demonstrated the efficacy of ecosystem-based approaches. For example, there has been good research on the role of urban green space in cooling, and reducing surface runoff (Gill et al. 2007), the benefits of using mixed species in forestry (Ammer et al. 2008; Matthes & Ammer 2000), and on the role of vegetation in protecting the shoreline (Möller et al. 2009; Gedan et al. 2011) and against landslides (ProAct Network 2008).

The current lack of measures of effectiveness in EBA/EBM projects is likely to be due in part to the fact that many of these projects were originally set up to improve the environment and biodiversity of the area, only latterly being adopted as an adaptation measure. There is a need therefore for these and future EBA/EBM projects to measure and monitor effectiveness.

One clear observation from the compiled case studies is that ecosystem-based approaches to adaptation and mitigation bring a number of environmental, social and economic benefits in addition to adaptation or mitigation. Many of the EBA approaches also contribute to EBM and vice-versa. These approaches, for the most part, also contribute to biodiversity conservation. Moreover, they provide areas where recreation activities can take place, which can also provide income to local people; and can be a source of food and other materials for people. Finally, some of the studies suggest that these options can be more cost-effective than traditional adaptation or mitigation options.

[37] 23 projects from Ecologic Institute project

Despite these benefits, there are a number of barriers to adopting EBA and EBM approaches, which were highlighted in many of the case studies. The three main barriers are: the need for considerable land, opposition from communities and lack of funding. EBA and EBM approaches are often land hungry approaches. For example, managed realignment and many river restoration schemes require land to be ‗lost' as flood storage areas, though these can also be used for other functions, such as recreation. Some of the case studies made use of arable lands as flood storage areas. This does not necessarily have to mean loss of all the land if their drainage system is adapted. In so doing, it would also increase water conservation and directly benefit farmers in periods of drought. In terms of land use, making use of farmland in ecosystem-based approaches to adaptation is going to be necessary (and beneficial) given that approximately 70 % of Europe is farmland.

Nevertheless, in many of the case studies, areas of land had to be purchased, or people had to be given compensation for lost land. This problem, as well as scepticism of the effectiveness of these approaches in protecting people and property, often results in fierce opposition from the local community and other relevant stakeholders. For this reason, outreach and participatory decision-making are important tools to increase the acceptance and the engagement of the people concerned.

Finally, securing adequate funding is a common problem for many projects. Some of the case studies had funding for project set up or implementation, but no future funding for up-keep and management, which is highly problematic as it decreases the sustainability of the projects. However, investment in ecosystem-based approaches may reduce costs in the long-term and contributes to a resource efficient green economy.

Lessons learned from the case studies point to two key elements of success: Stakeholder engagement and communication, and monitoring and adaptive management. Involving stakeholders, getting their buy-in and maintaining communication and outreach are essential if a project is to be successful. Involving volunteers and the local community in project implementation is a great (though potentially unreliable) way to minimise project costs and engage in outreach. Many of the projects found that although community engagement can be a long and difficult process, the gain in terms of results is large.

Monitoring and adaptive management are project components which often do not take place; usually due to a lack of funding or poor project design. Nevertheless, these are essential components of good practice (see CMP 2007) and several of the projects indicated their importance. Long-term monitoring is necessary to indicate a) the responses of the ecosystem to changes (environmental/anthropogenic), b) the response to the ecosystem to any management in place and c) the success of the implementation. The results of the monitoring can then be used to adapt management plans and adaptation strategies (the essence of adaptive management). Furthermore, from a climate change perspective, where uncertainty of changes is high, adaptive management is the only way to ensure success.

Structural and other ‗grey' measures also require long-term upkeep, which can be more costly than the management of ‗green' measures (Campbell et al. 2009). Therefore, adaptation projects, including ecosystem-based ones, will contribute to long-term climate change adaptation if monitoring, management and maintanance is incorporated in the project design.

This study showed that numerous EBM and EBA projects are taking place in Europe, and highlighted elements of good practice, challenges and lessons learned. It is by no means a complete compilation of all the case studies that have or are taking place. The compilation process indicated that there may be more examples throughout Europe. For example, we found that there are a number of databases already in existence, e.g. APBmer, GRaBs, and ECRR, which provide further examples of EBM and EBA projects in Europe. Some of these databases record not only basic components of projects, but also identify the processes which have let to their successful implementation/failure. Such databases, including the database compiled for this study, will serve as valuable resources for practitioners wishing to learn from existing projects.

6. References

Adger, W.N., Arnell, N.W., Tompkins, E.L., 2005. Successful adaptation to climate change across scales. Global Environmental Change, 15, 77–86.

Ahern, J. (2007) Green infrastructure for cities: the spatial dimension. In: Cities of the Future: Towards Integrated Sustainable Water and Landscape Management. (Ed.V. B. P. Novotny.) IWA Publishing, London. pp. 267-283.

Ammer, C., Bickel, E. & Kölling, C. (2008) Converting Norway spruce stands with beech – a review of arguments and techniques. Austrian Journal of Forest Science, 125, 3-26.

Campbell, A., Kapos, V., Scharlemann, J., Bubb, P., Chenery, A., Coad, L., Dickson, B., Doswald, N., Khan, M.S.I., Kershaw, F. & Rashid, M. (2009) Review of the literature on the links between biodiversity and climate change: impacts, adaptation and mitigation. Secretariat of the Convention on Biological Diversity. Technical Series No.42, 124pp.

CBD (2009) Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change. Montreal, Technical Series No. 41, 126 pages.

CCBA (2008) Climate, Community & Biodiversity Project Design Standards Second Edition. CCBA, Arlington, VA. December, 2008. At: www.climate-standards.org

Cloos, I. (2009) A project celebrates its 25th birthday. The Landscape Programme including Nature Conservation for the City of Berlin.

Coastal Futures (n.d.) Humber Community Project: Lessons learned and best practice in community engagement on changing coasts. Produced by RSPB on behalf of the partnership. http://www.coastalfutures.org.uk/pdfs/community_engagement_report.pdf

COM (2009) White Paper: Adapting to climate change: Towards a European framework of action. Commission of the European Communities, Brussels.

CMP (2007) Open standards for the practice of conservation. Version 2.0. Conservation measures partnership. http://www.conservationmeasures.org/wp-content/uploads/2010/04/CMP_Open_Standards_Version_2.0.pdf

Costanza, R., Perez-Maqueo, O., Martinez, M. L., Sutton, P., Anderson, S. J. and Mulder,K. (2008) The value of coastal wetlands for hurricane protection. *Ambio,* 37, 241-248.

Cowan, C., Epple, C., Korn, H., Schliep, R., Stadler, J. (2009) Working with Nature to Tackle Climate Change. Report of the ENCA / BfN Workshop on"Developing ecosystem-based approaches to climate change- why, what and how". Cowen, C. and Shliep, R. International Academy for Nature Conservation and BfN, 22-25 June, Isle of Vim, Germany.

EEA (2006) The changing faces of Europe's coastal areas. EEA Report No 6/2006. European Environment Agency, Copenhagen.

EC (2007) Adaptation to Climate Change in the Agricultural Sector. AGRI-2006-G4-05, AEA Energy and Environment and Universidad de Politécnica de Madrid. http://ec.europa.eu/agriculture/analysis/external/climate/final_en.pdf

EEA (2010a) The European environment — state and outlook 2010: synthesis. European Environment Agency, Copenhagen.

EEA (2010b) The European environment — state and outlook 2010: adapting to climate change. European Environment Agency, Copenhagen.

EEA (2011) Global and European temperature (CSI 012/CLIM 001) - Assessment published May 2011 http://www.eea.europa.eu/data-and-maps/indicators/global-and-european-temperature/global-and-european-temperature-assessment-4; Accessed on 14/07/11

Gedan, K.B., Kirwan,M.L., Wolanski, E., Barbier,E.B., & Silliman, B.R. (2011) The present and future role of coastal wetland vegetation in protecting shorelines: an answering recent challenges to the paradigm. Climatic Change, 106, 7-29.

GEF, UNDP, Government of Belarus (2010) Renaturalization and sustainable management of peatlands in Belarus to combat land degradation, ensure conservation of globally valuable biodiversity, and mitigate climate change. 70pp.

Gill. S, Handley, J., Ennos, R. & Pauleit, S. (2007) Adapting cities for climate change: the role of the green infrastructure. Built Environment, 3, 115-133.

Nijland,H. & Menke, U. (Eds) (2005) Flood risk management and multi-functional land use in river catchements. Conference Proceedings. 17-19th October 2005, Mainz, Germany

Kazmierczak, A., Carter, J. (2010) Adaptation to climate change using green and blue infrastructure. A database of case studies. University of Manchester, Manchester. 1-172.

Prutsch, A., Grothmann, T., Schauser, I., Otto, S. & McCallum (2010) The guiding principles for adaptation to climate change in Europe. ETC/ACC Technical Paper 2010/6. European Topic Centre on Air and Climate Change, The Netherlands.

Möller I., Spencer T., French J. R., Leggett D. J. and Dixon M. (1999) Wave Transformation over Salt Marshes: A FieldNumerical Modelling Study from North Norfolk, England. Estuarine, Coastal and Shelf Science, 49, 411-426.

Matthes, U. & Ammer, U. (2000) Conversion of Norway spruce (*Picea abies* L.) stands into mixed stands with Norway spruce and Beech (*Fagus sylvatical* L.) – Effects on the stand structure in tow different test areas. In Kilmo, E., Hager, H. & Kulhavey (eds) Spruce Monocultures in Central Europe – Problems and Prospects. EFI Proceedings No. 33, pp. 71-79, European Forest Institute, Finland.

Montanarella, L., Jones,R.J.A., & Hiederer, R. (2006) The distribution of peatland in Europe. *Mires and Peat,* 1, 1 http://www.mires-and-peat.net/map01/map_1_1.pdf

ProAct Network (2008) The Role of Environmental Management and Eco-Engineering in Disaster Risk Reduction and Climate Change Adaptation.

Swart, R., Biesbroek, R., Binnerup, S., Carter, T.R., Cowan, C., Henrichs, T., Loquen, S., Mela, H., Morecroft, M., Reese, M. and Rey, D. (2009) Europe Adapts to Climate Change: Comparing National Adaptation Strategies. PEER Report No 1. Helsinki: Partnership for European Environmental Research.

Solomon, S., Qin, D., Manning, M., Marquis, M., Averyt, K., Tignor, M.M.B., Miller, H.L. Jr. & Zhenlin, C. (2007) Climate Change 2007: The Physical Science Basis. Contribution of Working group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, Cambridge University Press.

Tengo, M. & Belfrage, K. (2004) Local management practices for dealing with change and uncertainty: a cross-scale comparison of cases in Sweden and Tanzania. *Ecology and Society*, 9. http://www.ecologyandsociety.org/vol9/iss3/art4/

Tinch, R. & Ledoux, L. (2006) The economics of managed realignment in the UK. Final report to the Coastal Futures Project. Environmental Futures Limited report to RSPB.

Trumper, K., Bertzky, M., Dickson, B., van der Heijden, G., Jenkins, M., Manning, P. (2009) The Natural Fix? The role of ecosystems in climate change mitigation: A UNEP rapid response assessment. United Nations Environment Programme, UNEP-WCMC, Cambridge, UK.

van der Linden P., and J.F.B. Mitchell (eds.) (2009) ENSEMBLES: Climate Change and its Impacts: Summary of research and results from the ENSEMBLES project. Met Office Hadley Centre, FitzRoy Road, Exeter EX1 3PB, UK. 160pp.

ANNEX I: Questionnaire

Nature-based solutions to climate change: ecosystem-based adaptation and mitigation and adaptation for the natural environment – good practice examples and lessons learned in Europe

Climate change increases the need for a cross-European approach to nature conservation. With new approaches needing to be developed and tested, one aspect of this cooperative approach is the need to learn from experiences of existing adaptation projects from across the continent. Sharing information in this way could:

- help conservation practitioners learn from the experiences of colleagues dealing with similar conditions, issues, threats and opportunities in other parts of Europe,
- facilitate the wider practical application of scientific findings into conservation and communication of the outcomes
- provide examples of successful action that would help researchers and conservation practitioners communicate more persuasively with decision makers

For all these reasons, one of the conclusions that emerged from the recent BfN-ENCA international conference on biodiversity and climate change was that there is a need for a better set of examples of existing adaptation projects in the field of nature conservation, from across Europe. Addressing this would greatly help to improve our understanding of the sorts of adaptation action that could be taken in different parts of the continent.

The ENCA Climate Change Group aims to address this. We are looking for examples of projects in Europe that undertake nature conservation measures or manage ecosystem services for enhanced ecological and societal resilience to climate change, including to climate variability. We want to collect good examples of three different types of climate change action:

Ecosystem-based adaptation – the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. Adaptation is facilitated through both specific ecosystem management measures (e.g. managed realignment) and through increasing ecosystem resilience to climate change (e.g. watershed management, conserving agricultural species genetic diversity).

Ecosystem-based mitigation – the use of the carbon storage and sequestration service of ecosystems to aid climate change mitigation. Emission reductions are achieved through creation, restoration and management of natural systems (e.g. forest restoration, peat conservation).

Adaptation for wildlife and the natural environment – conservation action that increases the resilience of species and ecosystems to climate change and facilitates their adaptation (e.g. facilitating movement of species across the landscape to enable shifts in distributions, reducing other sources of harm known to interact with climate effects, conserving species genetic diversity to maximise chances of adaptation, creating or modifying habitat to reduce climate effects).

Case Study Template

Please note that the text boxes will expand as you write

Country:

Project title:

Brief project description (a paragraph giving an overall summary)**:**

Implementing agency:

Partner organisations:

Project start date: **Project finish date:**

Location of project site (e.g. Humber Estuary; Alps; Paris)**:**

Project area (km^2):

What are the major landscapes in the project area? (tick all appropriate boxes)

Coast	☐	River/floodplain	☐
Forest/woodland	☐	Grassland/heath	☐
Mountain	☐	Wetland	☐
Agricultural land	☐	Urban	☐
Other	☐ state:		

Primary aim(s) (tick all appropriate boxes)**:**

Mitigation ☐ Adaptation for people ☐ Adaptation for nature and wildlife ☐

Objectives and activities (tick all appropriate boxes in the section(s) below corresponding to the aims you have indicated above)**:**

Mitigation

What are the *objectives* of the project?

Biomass carbon conservation	☐	Biomass carbon sequestration	☐
Soil carbon conservation	☐	Soil carbon sequestration	☐
Sustainable renewable fuel	☐	Reduction of non-CO_2 gases	☐
Other	☐ state:		

What are the specific *activities* undertaken to achieve the objectives above?

Adaptation

What are the main climate change impacts of concern?

Temperature change ☐ Precipitation change ☐ Change in growing season ☐ Sea level rise ☐
Drought ☐ Flooding ☐ Extreme weather ☐ Air quality ☐ Water quality ☐ Fire ☐
Avalanches ☐ Other ☐

Adaptation for people:
What are the primary threats to and opportunities *for people*, arising from the impacts that you have indicated above, that the project is trying to address?
(Please provide concise but specific information; e.g. ‗damage to houses and disruption to transport' from heavy rainfall and flooding)

What are the *objectives* of the project?

Water management ☐ Reduced inland flooding ☐
Coastal protection ☐ Disaster risk reduction ☐
Urban cooling ☐ Food security ☐
Resource management ☐ Improved air quality ☐
Other ☐ state:

What are the specific *activities* undertaken to achieve the objectives above?

Adaptation for nature & wildlife:
What are the primary threats to and opportunities *for nature and wildlife*, arising from the impacts that you have indicated above, that the project is trying to address?
(Please provide concise but specific information; e.g. reduced amphibian populations from reduced water levels in wetlands)

What are the *objectives* of the project?

Enhanced resilience of species/ecosystems *in situ* ☐
Enhanced ecological connectivity ☐
Habitat creation/management for species turnover ☐
Ecosystem management facilitating projected changes ☐
Other ☐ state:

What are the specific *activities* undertaken to achieve the objectives above?

Project implementation:

Have the following been undertaken or planned?

Vulnerability assessment: yes ☐ no ☐ unknown ☐

[Have the adaption objectives/activities been decided based on a vulnerability assessment?]

Environmental impact assessment: yes ☐ no ☐ unknown ☐

[Have the environmental impacts been considered and minimised?]

Adaptive management: yes ☐ no ☐ unknown ☐
[Is there a management plan and does it include adaptive management?]

Community engagement: yes ☐ no ☐ unknown ☐

If yes, what kind?

Monitoring: yes ☐ no ☐ unknown ☐

If yes, what is monitored?

Project results in terms of what has been achieved so far in relation to the original objectives:

Other outcomes in terms of additional benefits that were not the aim of project (e.g. recreation, conservation, new economic opportunity):

Challenges including what obstacles and problems were encountered**:**

Lessons learned including success/failure factors, sustainability, etc.**:**

Contact details of lead officer:
Name: Email: Phone:

Web links:

Any further information that can be provided – please attach. (e.g. management/monitoring plans)

Would you be happy for us to contact you further on this? yes ☐ no ☐

Please send the filled in template and any further documentation to Dr Nathalie Doswald (nathalie.doswald@unep-wcmc.org)