Guiding principles for adaptation to climate change in Europe

ETC/ACC Technical Paper 2010/6
November 2010

Andrea Prutsch, Torsten Grothmann, Inke Schauser, Sonja Otto, Sabine McCallum

European Topic Centre on Air and Climate Change

The European Topic Centre on Air and Climate Change (ETC/ACC)
is a consortium of European institutes under contract of the European Environment Agency
PBL UBA-D UBA-V NILU AEAT AUTh CHMI MET.NO ÖKO TNO REC

Front page picture:
Astrid Felderer, Environment Agency Austria

Author affiliation:

Andrea Prutsch, Sabine McCallum: Environment Agency Austria (UBA-V)
Torsten Grothmann: Potsdam Institute for Climate Impact Research (PIK)
Inke Schauser, Sonja Otto: Environment Agency Germany (UBA-D)

DISCLAIMER

ETC/ACC Technical Paper 2010/6
European Topic Centre on Air and Climate Change
PO Box 303
3720 AH Bilthoven
The Netherlands
Phone +31 30 2748562
Fax +31 30 2744433
Email etcacc@pbl.nl
Website http://air-climate.eionet.europa.eu/

Preface

This report is the result of the work done in Task 2.1.3.2 of the Implementation Plan 2010 of the European Topic Center on Air and Climate Change (ETC/ACC): 'Guiding principles on adaptation'. This study was led by the Environment Agency Austria (UBA-V) in cooperation with the Potsdam Institute for Climate Impact Research (PIK) and the Environment Agency Germany (UBA-D) within the ETC/ACC. The work was coordinated by André Jol and Stéphane Isoard from the EEA.

The aim of the study is to provide a starting point for further work by EEA and/or other organizations on identifying success factors and case studies on how good adaptation could work in practice at various governance levels and in different sectors. In order to achieve this, the paper presents a set of guiding principles for good adaptation in Europe and therein identifies specific elements that support its successful implementation. Furthermore, it illustrates a few practical examples that are meant to highlight how certain aspects presented in the guiding principles can be put into practice.

The guiding principles presented in this paper build on a comprehensive literature review, a comparison of national adaptation strategies, expert judgements and good practice examples.

Table of Contents

Guiding principles for adaptation to climate change in Europe

Guiding principles for adaptation to climate change in Europe

I. The need for adaptation to climate change

The EU target is to stabilize the global mean temperature to 2 °C above pre-industrial levels. But according to science (e.g. IPCC, 2007; Copenhagen Diagnosis, 2009) even a global increase of 2°C can result in impacts to which adaptation will be needed on European to local scale. **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 (IPCC, 2007). In general, a broad range of adaptation options, including behavioral, technological, regulatory, institutional, or financial adaptation measures are possible.

II. Guiding adaptation action

Since several years, the EU and its Member States have undertaken proactive adaptation actions by developing strategies based on future climate change projections. A number of EU Member States have adopted national adaptation strategies or are in the process of doing so (see table 1). In addition, the European Commission published a White Paper on adaptation to climate change (EC, 2009a/b). It sets out a two-phase strategy that complements actions taken by Member States through an integrated and coordinated approach. In the first phase (until 2012) mainstreaming of climate change in key EU policies will start and by 2013 an EU climate change adaptation strategy will be developed.

Countries in which a national adaptation strategy has been adopted	Year	Link
Denmark	2008	http://www.kemin.dk/Documents/Klima-%20og%20Energipolitik/klimatilpasningsstrategi_UK_web.pdf
Finland	2005	http://www.mmm.fi/attachments/ymparisto/5kghLfz0d/MMMjulkaisu2005_1a.pdf
France	2007	http://www.developpement-durable.gouv.fr/IMG/ecologie/pdf/Strategie_Nationale_2.17_Mo-2.pdf (not available in English)
Germany	2008	http://www.bmu.de/files/english/pdf/application/pdf/das_gesamt_en_bf.pdf

Hungary	2008	http://klima.kvvm.hu/documents/14/nes_080219.pdf (not available in English)
The Netherlands	2008	https://www.maakruimtevoorklimaat.nl/english-summary.html
Norway	2008	http://www.regjeringen.no/upload/MD/Vedlegg/Klima/Klimatilpasning/Klimatilpasning_redegjorelse150508.pdf (not available in English)
Portugal	2010	http://dre.pt/pdf1sdip/2010/04/06400/0109001106.pdf (not available in English)
Sweden	2009	http://www.regeringen.se/content/1/c6/12/27/78/4ce86514.pdf (not available in English)
Spain	2006	http://www.mma.es/portal/secciones/cambio_climatico/areas_tematicas/impactos_cc/pnacc.htm (not available in English)
United Kingdom	2008	http://www.opsi.gov.uk/acts/acts2008/pdf/ukpga_20080027_en.pdf

Table 1: Countries with adaptation strategies in place
(Source: based on information from the EEA web site, http://www.eea.europa.eu/themes/climate/national-adaptation-strategies, accessed in August 2010)

Even though adaptation is still a relatively new concept, some methodological approaches for designing and implementing adaptation actions have been published (Willows & Connell 2003; Lim et al. 2004, Kropp & Scholze 2009; ICLEI 2008; UNECE Water 2009). The European Commission prepared guidelines on how to include climate change into river basin management plans (European Communities, 2009c) and performed a study for possible guidelines on developing regional adaptation strategies (Ribeiro et al. 2009). The European Centre for Disease Prevention and Control prepared guidance on climate change and communicable diseases (ECDC, 2010).

Nevertheless, for most countries in Europe and also at the EU level ***widely acknowledged guiding principles*** for all levels of decision making are still lacking. It should be noted however that some of the existing national adaptation plans (e.g. Germany) and regional/local plans (e.g. city of London) include principles of good practice in adaptation. In addition, the UK, as a front-runner in adaptation, has published Defra´s Climate Change Plan 2010, including key principles, that Central government as well as organisations in the wider public and private sectors shall take account of (HM Government, 2010):

- *Any adaptation needs to be **sustainable**. This means that our responses should not add to climate change, or limit the ability of other parts of the natural environment, society or*

business to carry out adaptation elsewhere. Our responses must avoid any detrimental impacts on other parts of society, the economy or the natural environment.

- *Actions should be **flexible**. Although there is still uncertainty over the future climate, we should consider options now and make decisions that maximise future flexibility – in many cases it is failure to take decisions that locks us into inflexible pathways.*
- *Action needs to be **evidence-based** – making full use of the latest research, data and practical experience so that decision-making is well-supported and informed.*
- *Our response to climate impacts should be **prioritized** – for example, by focusing more attention on policies, programmes and activities that are most affected by the weather and climate, those which have long-term lifetimes or implications, where significant investment is involved or high values are at stake, or where support for critical national infrastructure is involved.*
- *Adaptation measures need to be **effective** (reducing the risks from climate change without introducing perverse effects), **efficient** (the long-term benefits of adaptation actions should outweigh the costs), and **equitable** (the effects of the activity on different groups and where the costs should fall should be taken into account).*

These general aspects from the Defra´s Climate Change Plan 2010 can be taken as an overall framework in which any good/successful adaptation should take place.

Yet, there is no commonly agreed definition of "good" or "successful" adaptation. In the broadest term, one can speak of good/successful adaptation when the objectives of adaptation are reached without negative impacts for others (Adger et al. 2005). This definition clearly focuses on the outcome of adaptation activities. Most of other definitions for good/successful adaptation rather highlight key success factors for the adaptation process (Frankhauser et al. 1999, Smith & Lenhart 1996, Lemmen et al. 2008). One can expect though that taking these factors into account and tailor them to site-specific conditions will enhance the chance of reaching good adaptation outcomes.

Given the variety of definitions and approaches for good/successful adaptation, general support is needed on *how* adaptation action can be put into practice. The set of generic guiding principles for good adaptation presented in section IV of this document is intended to give direction on *how* the adaptation process should be carried out to be successful, both for planning and effectively implementing adaptation. It aims to support adaptation processes for a wide range of situations and actors (e.g. public authorities, businesses, NGOs) by offering a synthesis of key aspects to better structure the complexity inherent when dealing with adaptation to climate change. In addition, they can also serve as a framework for the identification of good practice examples in adaptation.

III. Identifying good practices examples

Up to now, only limited practical activities of adaptation to climate change exist in Europe and many adaptation activities are still in the planning phase. However, in many countries good practice examples are emerging. While several governments across Europe have taken their lead responsibility in setting up a framework for national adaptation, practical responses to climate change still need to be incorporated by a much wider range of people and organisations. Adaptation action shall bring benefits to those affected through appropriate and tailored responses by respecting general aspects for good adaptation.

The presentation of good practice examples supports knowledge transfer and allows learning from each other. Good practice examples show different approaches for responses to climate change impacts for various situations. They highlight courses of adaptation actions that are expected to be most efficient and effective by taking into account relevant factors of successful adaptation. Sharing existing information on good adaptation practices and experiences also aims to optimise individual resource and effort management and can thus advance adaptation on a larger scale. Besides, good practice examples help to raise awareness for the most relevant aspects in adaptation planning and play an important role in motivating decision makers, adaptation planners and further stakeholders.

To make existing examples of adaptation available to stakeholders and the general public, the European Commission (DG Climate Action) is currently preparing a Clearinghouse on Climate Change impacts, vulnerability and adaptation in Europe, which will include good practice examples of adaptation via an online platform. The selection of good practice shall be based on common principles that are expected to guide good/successful adaptation. The set of guiding principles presented in section IV represents a synthesis of key success factors for good adaptation processes. The guiding principles were developed based on literature review and analysis of practical examples and have been evaluated in an online survey by more than 250 adaptation experts across Europe. Feedback from this survey helped to further improve the guiding principles. More than 80 % of the experts agreed that the guiding principles integrate the most important aspects of adaptation, give good orientation in realizing adaptation and could be used as a common basis for cooperative adaptation activities of various actors in Europe. Developed in a bottom-up approach and supported by a wide range of adaptation practitioners, the guiding principles can be seen as key factors to support good adaptation processes.

Section V of this document illustrates three practical examples that address many of the relevant aspects of good adaptation involved in the guiding principles. The approach applied for presenting the good practice example describes each guiding principle applied in relation to its practical implementation. Using the guiding principles for identifying and presenting good practice examples in this technical paper can be seen as a starting point and extended later to

feed into a more comprehensive database on good practice examples that is envisioned within the European Clearinghouse.

IV. Guiding principles for good adaptation

The **guiding principles for good practices in adaptation** presented in this document are intended to support planners and decision makers **when dealing with the challenges of adapting** to climate change and provide a framework for identifying good practice examples in adaptation. Adaptation is a cross-level and cross-sectoral activity which brings together actors from different stakeholders including governments (EU, national, regional, local), businesses, environmental NGOs, scientists and citizens. The guiding principles are intended to support adaptation processes for a wide range of situations and actors. Thus, they are intended to be a common basis for cooperative adaptation activities for all sectors and decision-making levels from local to the European scale.

The guiding principles were compiled after a comprehensive **literature review** and represent the **experience of experts** across Europe. 100 different sources of literature on designing, implementing and evaluating adaptation were analysed and integrated to develop this set of overarching adaptation principles. A first draft of the guiding principles was evaluated in a survey by 252 experts and scientists with practical experience and/or planning responsibility in the field of adaptation. Based on these expert judgements, the set of guiding principles for adaptation to climate change has been revised and represents the final draft version in this document.

The following ten guiding principles are strongly interlinked and should be understood in an integrated way. Links between guiding principles (GPs) are additionally indicated in the text (e.g. "see GP 1"). The importance of each guiding principle depends on the context they are applied to, in particular regarding the stages in the adaptation process as indicated in Figure 1 below, the level of decision-making or the specific regional conditions.

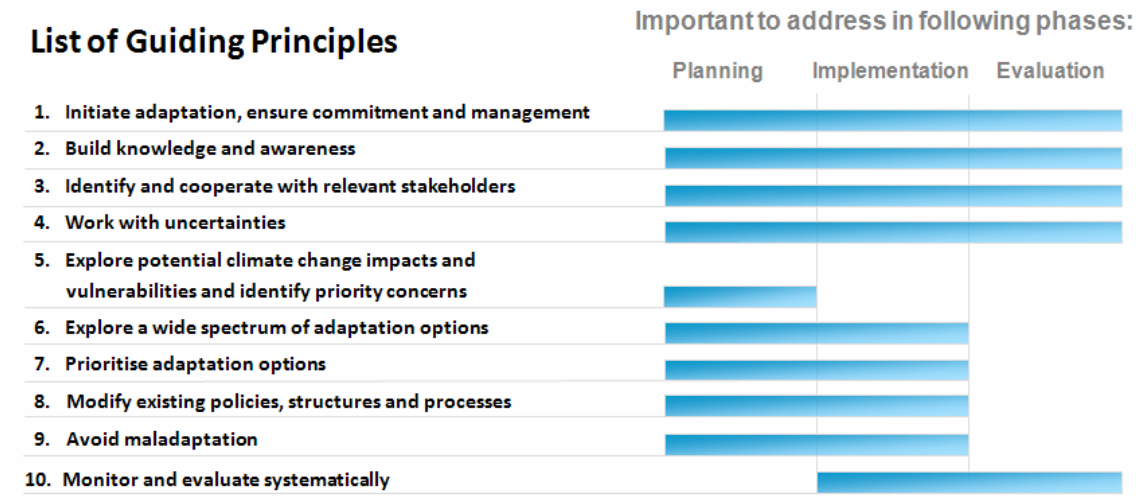

Figure 1: List of guiding principles in context with the stages of the adaptation process

1 Initiate adaptation, ensure commitment and management

Most processes of adaptation to climate change are initiated by motivated individuals. Since adaptation is given a low priority in many regions, sectors and organisations, the start of adaptation processes very much depends on single persons to act as triggers and drivers of such processes.

Impacts of climate change affect various domains of human societies. Because of its multi-thematic and multi-sectoral nature, adaptation to climate change impacts should happen as a joint effort of equitable stakeholders from civil society, business and government (see GP 3) – often referred as "governance", which allows for close interactions not only between the different levels of government but also with commercial and non commercial actors.

A clear commitment from decision makers (e.g. political leaders, business managers) to support the adaptation process is helpful for realizing adaptation in a region, sector or in an organization. To ensure commitment, it is often necessary to raise awareness for climate change impacts and adaptation needs among decision makers (see GP 2). Decision makers should be aware that climate change will very likely proceed for at least several decades. Thus, they should take responsibility for building long-term capacity for society and ecosystems to adapt to climate change.

To sustain an adaptation process a clear mandate for the management of the process should be given to an organization or an individual. Therefore the role of the managing unit is:

- to facilitate the process by motivating stakeholders to participate and
- to promote dialogue, understanding and coordination between different actors and stakeholders.

The power and responsibilities of the managing unit should be transparent and agreed upon for an effective working environment. As adaptation can be a resource intensive process, resources for the managing unit should be assured in the long term.

2 Build knowledge and awareness

Due to the complexity of climate change and its potential impacts, particular attention needs to be given to knowledge transfer and awareness raising. Decision makers, stakeholders and the larger public should have access to reliable information about potential climate change impacts, vulnerabilities, adaptation options and tools, good practice examples and advantages of adaptation, potential trade-offs, synergies and conflicts with mitigation and existing policies.

An adaptation strategy should include provisions for communication (and education), which:

- differentiate between different stakeholder groups that need different information and communication instruments,

- build a common knowledge base and a common language among stakeholders to support stakeholder cooperation,
- incorporate considerations for raising awareness in the general public (possibly also by integrating climate change and adaptation information in school education),
- formulate information as simple, understandable and usable as possible but also as complex as necessary,
- explicitly include ways to communicate gaps and uncertainties of climate change (impact) information (see GP 4),
- conceptualize communication as mutual dialogue and learning between scientific and stakeholder knowledge.

Personal consultations (e.g. public talks, small group discussions, etc.), build trust, allow to learn from each other and are effective in stimulating action. Internet communication and media are well suited for knowledge transfer and raising awareness by reaching the general public.

Researchers, policy makers and practitioners should jointly bundle information sources and improve access to understandable and usable information on potential impacts and adaptation and fill knowledge gaps by targeted assessments (see GP 5 and 6) especially for local levels.

3 Identify and cooperate with relevant stakeholders

Adaptation often requires cross-sectoral coordination and cooperation between different levels of government from local to international to ensure that adaptation actions make use of stakeholder knowledge, avoid or solve conflicts, identify synergies and compromises between various adaptation activities and have broad support and thus better potential for success. In some cases, also cross-boundary cooperation is required.

Relevant stakeholders from civil society, different business sectors and governmental decision levels should be invited to take part in the adaptation process.

One way to identify relevant stakeholders is by asking questions such as:

- Who will likely be affected by the impacts of climate change or the outcomes of the decisions related to adaptation?
- Who is responsible for realising the potential adaptation action?
- Who can increase the effectiveness of the potential adaptation action through their participation or decrease its effectiveness by their non-participation?

To address equity and social justice, particular attention should be given to also include groups that are often marginally represented in participatory processes, e.g. low-income groups.

A clear vision or goal to be set from the start is important to motivate stakeholders to participate. The extent of influence of the stakeholders on the adaptation process and its outcome should be clearly defined to avoid unrealistic expectations. The cooperative process needs to have a clear and efficient structure and should be well integrated in the larger decision

context to ensure policy relevance (see GP 1). Overall, a clear commitment and sufficient investment of time and resources are needed from all stakeholders involved.

4 Work with uncertainties

Uncertainties are an inherent part of all projections of climate change and its impacts. This is due to uncertainties in expected future amounts of greenhouse gas emissions and related economic development, incomplete scientific knowledge of the climate system, and insufficient long-term data at the regional scale. In order to handle uncertainties, climate impact scenarios aim to provide plausible descriptions of possible future impact ranges. However, even with further refinement of the scenarios, future impacts of climate change will remain uncertain.

Different principles and approaches are available to take adaptation decisions despite uncertainties (see also GP 7). The precautionary principle demands that the absence of full scientific certainty should not be used as an excuse to postpone adaptation when there is a potential of serious or irreversible harm. Adaptive management is a flexible step-by-step process of planning, implementing and revising adaptation activities on the basis of new research results, regular monitoring and evaluation (see GP 10). In some cases such an adaptive management approach has to go beyond improvements of existing socio-economic systems and has to modify the system itself (e.g. termination of ski tourism in some regions). Adaptive management to be used for reducing uncertainties through continuous monitoring is particularly suited for sectors with short-term planning horizons (e.g. agriculture) but difficult in sectors where long-term planning is required (e.g. forestry, where trees planted today have to be adapted to the climate in 50 to 100 years). In such cases the principles of maintaining or increasing robustness and resilience are useful. Robust systems continue to function under a wide range of potential future (climatic) conditions (e.g. wastewater systems effective in times of low and heavy precipitation), while resilient systems are flexible and can adapt to changed conditions (e.g. communities with diversified livelihoods).

Increasing robustness and resilience as well as readjusting pathways through an adaptive management approach usually come at a cost which increases with the degree of uncertainty.

5 Explore potential climate change impacts and vulnerabilities and identify priority concerns

It is necessary to analyse potential direct and indirect impacts of climate change in the short and long term for all regions. One approach, modified from Ribeiro et al. (2009), is to:

1 Identify ‘key systems’ (e.g. ecosystems, important economic sectors, critical infrastructure, vulnerable population groups)

2 Analyse the impacts of past weather events and recent climate trends on key systems

3 Assess potential likely future climate and socio-economic scenarios

4 Identify potential impacts of climate change including cost, magnitude, timing, persistence, reversibility, likelihood, and distributional aspects

5 Assess the vulnerability of key systems to current and potential future impacts

6 Rank potential impacts to be addressed by adaptation at first and later on

Exploration of potential impacts should also consider non-climatic factors and developments (e.g. demographic and socio-economic changes, habitat destruction by land use) as these will also influence climate change impacts (e.g. heat fatalities, biodiversity loss). Therefore, an interdisciplinary approach (considering also ecosystem services (with cross-sectional priority)) should be favoured. Stakeholder agreements on criteria for estimating the importance of the various impacts can help to rank potential impacts to identify priority adaptation needs (see GP 3).

6 Explore a wide spectrum of adaptation options

After prioritising the adaptation needs (see GP 5), a wide spectrum of adaptation options, including behavioural, technological, infrastructural, informational, organizational, ecosystem-based and socio-economic options at all levels, sectoral as well as cross-sectoral, should be investigated at the appropriate (temporal and spatial) scale. All possible adaptation options should be characterized in as much detail as feasible including information about:

- objectives,
- direct and indirect effects with emphasis on potential benefits
- duration and spatial scope,
- socio-economic and ecological context,
- interplay between options,
- cross-sectoral interactions,
- financial resources needed,
- responsible actors and opponents, etc.

This will help to determine how the adaptation actions can be best interconnected with existing structures and processes (see GP 8).

Past and current adaptation experiences and adaptation initiatives in regions, sectors or organizations can provide a valuable knowledge base when assessing adaptive capacities and adaptation options.

7 Prioritise adaptation options

From the wide spectrum of adaptation options, specific adaptation actions need to be selected based on adaptation objectives and criteria. Adaptation has to be tailored to spatial and temporal circumstances. In the majority of cases, different types of actions combined with learning elements (see GP 10) should be applied as there will hardly ever be one optimum or final solution. Stakeholder discussions and agreements (see GP 1) are very useful for a transparent decision making process on the main objectives, criteria and their weightings for the prioritisation of adaptation options.

Most often a multi-criteria analysis of adaptation options will be necessary. This analysis should include criteria such as importance, effectiveness, urgency, sustainability, co-benefits and side effects, reversibility, flexibility, resilience, robustness as well as political and cultural acceptability. Further, a comprehensive cost-benefit analysis considering also indirect costs and benefits, non-monetary values and externalities can be useful for prioritising adaptation options.

Many adaptation actions can be implemented at relatively low costs with high benefits, e.g. the use of habitat adapted crops and tree species in agriculture and forestry. However, the information currently available about adaptation costs (both market and non-market costs) is limited and it is often difficult (due to a lack of information and/or the complexity of the issues), especially in the long term, to quantify benefits.

Due to the broad range of potential future climate change impacts and the implicit uncertainties in prediction, multiple-benefits and no-regret adaptation options should be favoured. Multiple-benefits options provide synergies with other goals such as mitigation or sustainability (e.g. ecosystem based approaches). Examples include water saving devices in regions experiencing drought or insulation of buildings in regions exposed to heat waves. No-regret actions are beneficial in all plausible climate futures, such as early warning systems and insurance against floods. Actions which likely become costly (e.g. large and long-lived infrastructure projects), difficult to implement (e.g. spatial planning for nature conservation) or redundant (e.g. raising awareness) when postponed, should be undertaken immediately (due to long time spans before they take effect). In case of high danger of significant impacts in the near future, proactive adaptation interventions become especially urgent. In this regard it seems useful to put a timeframe for action against anticipated impacts to arrange responses according to their urgency.

8 Modify existing policies, structures and processes

Adaptation should not be performed decoupled from existing policies (e.g. legislation, funding systems), management structures (e.g. networks) and processes (e.g. in decision making). Relevant instruments in place should be reviewed and adapted to be able to deal with current

and future negative impacts of climate change. They should be modified in such a way to ensure that adaptation is truly apparent in a concrete decision.

Integrating adaptation through reviewing and modifying existing instruments shall not be restricted to the environmental sector or to the public authority; it also refers to economic sectors and private organisations such as businesses. Clearly assigned responsibilities (e.g. for coordination, information provision, taking actions), staff-training and a sufficient financial budget will enhance the success of integrating adaptation (see GP 1 and 2).

However, there may be cases where the modification of existing policies, structures and processes are insufficient to handle the adaptation needs and the development of new instruments is required.

9 Avoid maladaptation

Maladaptive actions and processes do not succeed in reducing vulnerability to climate change impacts but instead increase it and/or reduce the capacity to cope with the negative effects of climate change. Maladaptation may deliver short-term benefits (e.g. financial profit) but lead to harmful consequences in the medium and long-term perspective.

Different types of maladaptation should be avoided, including

- actions that conflict with mitigation (e.g. installation of energy intensive air conditioners),
- actions that use resources unsustainably (e.g. using ground water for irrigation in dry regions which causes a decreasing groundwater level),
- actions that distribute the benefits of adaptation unequally across society (e.g. prevention from climate change induced diseases only for affluent people).

Maladaptation may be avoided by a detailed assessment of different options (see GP 7) to clarify potential impacts of adaptation actions in the long term.

10 Monitor and evaluate systematically

Adaptation is an ongoing process for which systematic monitoring and periodic evaluation is vitally important. The main aim of monitoring and evaluation is to keep the adaptation process focused on prioritised impacts of climate change and to ensure that adaptation responds without delay to changes in the evidence base. A monitoring system supports the learning process (e.g. improving actions, avoiding maladaptation, finding new opportunities), while an evaluation scheme indicates the progress towards meeting the goals of adaptation. Monitoring and evaluation shall address impacts of climate change (e.g. flood damage before and after adaptation) as well as direct and indirect costs and benefits (see GP 7) of adaptation actions (e.g.

costs and benefits of dyke construction). They also underpin readjustments of decisions where needed.

Monitoring and evaluation schemes shall be developed along with designing adaptation options before implementation (e.g. to decide on evaluation criteria and consider data availability). Indicators can help to describe the performance of adaptation actions. Existing indicator systems (e.g. for sustainable development) can provide support in the establishment of monitoring and evaluation schemes for adaptation.

New scientific knowledge should regularly be reviewed and included in the monitoring and evaluation process. This is an important component of the adaptive management approach (see GP 4) which enables the decision makers to continuously adapt decisions and adaptation actions based on lessons learned and best knowledge available.

To guarantee objectivity, an independent organisation should conduct monitoring and evaluation and publish status reports on a regular basis to be shared with stakeholders and the public.

V. Good practice examples

This section provides three good practice examples of adaptation activities with the intention to highlight how certain aspects of good/successful adaptation presented in the guiding principles can be put into practice. It appears that applying certain aspects of the guiding principles unfold not only challenges but also possible opportunities of climate change. As such they may also support to overcome possible barriers of adaptation processes.

A set of key criteria have been chosen for the selection of good practice examples within this work (Box I).

BOX I – Criteria for the selection of good-practice examples

Adaptation activities selected to serve as good-practice examples:

- address as many guiding principles as possible
- have an applied focus
- are finished or in implementation phase
- can be transferred to other regions in Europe
- are well documented
- cover different horizontal levels (e.g. local to European)
- cover different vertical levels (e.g. businesses, governments)

From a comprehensive review of existing adaptation activities, the following three examples where chosen to be presented as good practice meeting all given criteria. They shall not claim to be representative for Europe but aim to exemplify the practical application of the guiding principles. Hence, each guiding principle applied is described in relation to its practical implementation in the presented examples. This approach for the identification and presentation of good practice examples can be seen as a starting point for a more comprehensive database on good practices to be included in the European Clearinghouse.

The chosen examples present three different approaches on how to deal efficiently with water related climate change impacts such as sea level rise, water availability and ground water level rise. For each example, four concrete guiding principles are presented to demonstrate the actual possibility to apply them.

The first example focuses on the protection of biodiversity against sea level rise. Its positive influence on human living conditions as surplus of the recreation of an ecosystem was the trigger to initiate the Wallasea Island Wild Coast Project in UK. In the second example, Dragør, a region in Denmark, focuses on the local protection of humans and their possessions against sea level- and ground water level rise. The urban region of Hamburg in Germany serves as a third example, comprehensively dealing with various economic and human related problems across all sectors with regard to sea level rise in a populated region.

I) Royal Society of the Protection of Birds – Wallasea Island Wild Coast Project, UK

The Wallasea Island Wild Coast project aims to restore the special landscape of the area for people and wildlife in the 21st century. Thus, helping adaptation to the challenges of climate change and sea level rise by providing space for nature and a place for relaxation and enjoyment. It will be an exciting landmark conservation and engineering project on a scale never before attempted in the UK, and the largest of its type in Europe.

(Duration 2009 – 2019; Sector and objective: biodiversity, sea level rise, habitat protection; Level: local scale).
Further information: http://www.rspb.org.uk/reserves/guide/w/wallaseaisland/index.asp)

Implementation of four exemplary guiding principles:

GP 1 Initiate adaptation, ensure commitment and management	The project is initiated and managed by the Royal Society on the Protection of Birds (RSPB). Prior to the implementation of activities it was important to build a public understanding that (climate) change is coming and to persuade people of an immediate action to prevent future damage from rising sea levels to the area. The main challenge has been countering the general opinion to better delay taking action. With strong commitment, the RSPB succeeded to adopt a planned and managed approach to coastal change adaptation. The adoption of GP 2 (Build knowledge and awareness) thus was a prerequisite for this success.
GP 3 Identify and cooperate with relevant stakeholders	The project has been developed through a broad partnership with extensive consultation to a variety of stakeholders and interest groups to guarantee that adjacent interests are not adversely affected. Groups work closely together to ensure that all interests are being developed in the project. Particularly good practice here was to not only have dialogues with powerful institutions to assure official permits for projects (e.g. the harbour authority) but also to weaker parties such as recreational sailing interest groups, commercial fisheries and agricultural interest groups. Extra stakeholders included local councils, parish councils, local land owners/businesses, local residents, walkers, birdwatchers and cyclists. The dialogue has been a major part of the project.
GP 5 Explore potential climate change impacts and vulnerabilities and identify priority concerns	The rate of loss (of e.g. mudflats and saltmarshes) is recognised to accelerate with climate change as rising sea levels and more storminess steadily erode the precious transition zone between land and sea. Prior to the implementation of actions, RSPB carried out detailed studies, such as a range of hydrodynamic modelling techniques combined with a 2-year desk top study reviewing all other relevant information, to help assess the impacts of their managing proposal.
GP 10 Monitor and evaluate	Monitoring will focus on 1) impact verification, 2) ecological functioning verification and 3) mitigation habitat success verification. Monitoring will be divided into two

systematically	sections: (a) The effects on the adjacent estuary – this will cover the affects of the scheme on flow speeds, sedimentation and tide heights. The monitoring will continue for 25 years from the first breach or 10 years from the last breach; (b) the development of the site – sedimentation rates, development of habitats and their use by fauna and flora.

II) Regional adaptation in Dragør, Denmark

The municipality of Dragør is very low-lying and therefore vulnerable to sea and groundwater level increases, extreme precipitation and storm surge events. The people of Dragør have been well aware of this for generations. They have learned to live with the fact that sometimes there is too much water, both in the city and in the open countryside. Therefore, the people of Dragør have built dykes around the cities and established large delay basins along the coast. Now Dragør has moved away from an 'insensitive' coastal defence policy. Instead, the municipality has chosen nature's own technology for the new challenge of adaptation to the climate of the future.

(Duration 2007, ongoing; Sector and objective: water, sea level and groundwater increase; Level: regional scale)
Further information: http://klimatilpasning.dk/en-US/Service/Cases/Sider/Dykesalonearenotenough.aspx)

Implementation of four exemplary guiding principles:

GP 4 Work with uncertainties	Underpinned by the future scenarios from the IPCC (Intergovernmental Panel on Climate Change), climate change reached the top of Dragør's agenda. It is aware of the complexity to coordinate a great number of different factors and considerations in future planning efforts. An example is to be aware of the fact that watercourses in the municipality will be small in drought situations and large on high precipitation events. In extreme situations, fields, which have been taken out of operation, will serve as relief as wet meadows for the water to accumulate. The municipality seeks for legislative environmental targets for the condition and quality of the watercourses in any condition.
GP 7 Prioritise adaptation options	The municipality decided to turn the problems associated with climate change into something positive, i.e. as an opportunity to incorporate the increased rainfall amounts and water levels, nature, history and culture into an entirely new vision for the landscape of southern Amager. Dragør concluded the rich nature and recreational areas to be the unifying force in the planning of adaptation actions. Instead of introducing only technical regulations, Dragør works with the considerations encapsulated in Natura 2000. The municipality takes the chance for creating natural physical coherence between coastal areas, forests and meadows, involving great opportunities for entirely new recreational areas. The possibility of coastal defences can accommodate beach meadow biotopes dependant on occasional flooding.

The great idea behind the municipality's green blue plan and local climate strategy (see GP 8) is to avoid an 'insensitive' coastal defence policy and instead to employ nature's own technology and to some extent allow nature to adapt to altered climate conditions on its own.

GP 8
Modify existing policies, structures and processes

The municipality's "Planstrategi 2007" (spatial planning strategy 2007) contains a special section on climate change. In December 2008 the strategy was followed up by a "Grøn blå plan" (green blue plan), which summarises the most important topics on the open countryside. In June 2009, the municipality published its own local climate strategy. There exists active and close collaboration of the governance of Dragør with the spatial planning and building sector and the technical and environmental administration in the region. This ensures effective working conditions and allows a broad preparation of activities with expert knowledge and legislative commitment.

GP 9
Avoid maladaptation

The great idea behind the municipality's "green blue plan" and local climate strategy is to avoid an 'insensitive' coastal defence policy and instead to employ nature's own technology and to some extent allow nature to adapt to altered climate conditions on its own. This ecosystem based approach is taken as an overarching principle into all activities, thus serving nature and human living conditions on a broad scale.

III) KLIMZUG Nord – Integrated urban- und spatial development in Hamburg, Germany

The main focus of the project is on the development of technical solutions and methods to mitigate climate change impacts and to adapt society and economy on the increased risks of climate change. The interdisciplinary approach includes a variety of sectors and institutions and allows for a range of core areas to prepare the large European metropolis Hamburg for the threads of climate change. .The target entails a coordinated action plan up to the year 2050.

(Duration 2009 – 2014; Sector and objective: various sectors – including spatial planning, economy, water, ecology; Level: Municipality, Metropolis region) Further information: http://klimzug-nord.de

Implementation of four exemplary guiding principles:

GP 2
Build knowledge and awareness

Information for the public and educational concepts are an important outcome of the project. An intensified dialogue with decision makers, stakeholders and the general public helps to raise their enthusiasm to implement and adopt technical solutions and planning options. Public awareness is raised periodically via press releases, publications, conferences and workshops and public education programmes to involve every citizen in the prevention and adaptation to climate changes and to ensure the implementation of recommended strategies and procedures thoroughly.

GP 5

Actual global and regional climate models were consulted and possible scenarios

Explore potential climate change impacts and vulnerabilities and identify priority concerns	(following IPCC suggestions) of a future development on global and municipality scale determined. Additionally, assessments of urban and rural water supply and an analysis of oceanographic, hydrographical and hydrological data on the coast of Hamburg were a prerequisite for the planning of possible adaptation options. Specifically assessed were impacts on flora and fauna in estuary areas, coastal eroding due to tidal amplifications, ground- and waste-water implications of extreme weather events to name only some. Visible impacts of climate change such as increasing tidal mud and sand deposits have already become a serious problem in several smaller Elbe streams as well as some harbours and their accesses.
GP 6 Explore a wide spectrum of adaptation options	The comprehensive approach of the project allows covering a wide range of possible adaptation options. A focus is given on the adaptation to temperature, relative moisture, precipitation, wind and radiation impacts. Different sectors with options for action (i.e. the building sector, flood protection, coastal protection, biodiversity and natural protection, agriculture, forestry, economic issues, insurances, industry and business, spatial planning, policy and education) work hand in hand and are involved in the planning of suitable measurements. The implementation of adaptation measures includes nature recreation on the coast, sustainability options in agriculture, technical solutions e.g. in the building sector and behavioural changes in the population. Experiments (in labs and outdoor) and models have been set-up and will provide results within project time.
GP 7 Prioritise adaptation options	Core areas of the project are in estuary management, integrated spatial development and sustainable cultural landscapes. Cross-cutting tasks stress urban nature conservation and economics. This comprehensive approach allows covering the most vulnerable spots in an urban and adjacent rural environment. As examples, the management of sea level rise, surplus rain water and urban flooding, strategies in urban- and rural development, adopting innovations in the building sector to scope with climate change and the insurance of nature conversation in urbane regions are highlighted.

VI. Recommended reading on adaptation to climate change

Smith, J.B., Vogel, J.M. & J.E. Cromwell II (2009): An architecture for government action on adaptation to climate change. An editorial comment. In: Climatic Change 95:53-61.

Swart, R., Biesbroek, R., Binnerup, S., Carter, T.R., Cowan, C., Henrichs, T., Loquen S., Mela, H., Morecroft, M., Reese, M. & D. Rey (2009): Europe adapts to climate change: Comparing national adaptation strategies. PEER Report No. 1, Helsinki. (http://www.peer.eu/fileadmin/user_upload/publications/PEER_Report1.pdf)

Kropp, J. & M. Scholze (2009): Climate Change Information for Effective Adaptation. A Practitioner‘s Manual. Germany. (http://www.pik-potsdam.de/research/research-domains/climate-impacts-and-vulnerabilities/research/research-field-2-1/nsp/pubs/pik-gtz-adaptation-manual)

ADAM Compendium (http://adam-digital-compendium.pik-potsdam.de/)

Climate Change Adaptation (http://www.klimatilpasning.dk/en-us/Sider/ClimateChangeAdaptation.aspx)

FINADAPT (http://www.ymparisto.fi/default.asp?contentid=56105&lan=EN)

Lim, B. & E. Spanger-Siegfried (eds.) (2004): Adaptation Policy Frameworks for Climate Change. Developing Strategies, Policies and Measures. UNDP, Cambridge University Press (http://www.undp.org/climatechange/adapt/apf.html)

Dessai, S., Hulme, M., Lempert, R., Pielke, R. (2008): Climate prediction: a limit to adaptation? In: Adger., N., Lorenzoni, I., O`Brien: Living with climate change: are there limits to adaptation? Cambridge University Press, Cambridge. (http://sciencepolicy.colorado.edu/admin/publication_files/resource-2626-2009.01.pdf)

Willows, R. & R. Connell (2003): Climate adaptation. Risk, uncertainty and decision-making. UKCIP Technical Report. (http://www.ukcip.org.uk/images/stories/Pub_pdfs/Risk.pdf)

Ribeiro, M. , Losenno, C., Dworak, T., Massey, E., Swart, R., Benzie, M. & C. Laaser (2009): Design of guidelines for the elaboration of Regional Climate Change Adaptations Strategies. Study for European Commission – DG Environment - Tender DG ENV. G.1/ETU/2008/0093r. Ecologic Institute, Vienna. (http://ec.europa.eu/environment/climat/adaptation/pdf/RAS%20Final%20Report.pdf)

Ciscar J.C. (editor)(2009): Climate change impacts in Europe. Final report of the PESETA research project. European Communities, Luxembourg. (http://ftp.jrc.es/EURdoc/JRC55391.pdf)

Commission of the European Community (2009): Commission staff working document accompanying the White Paper. Adapting to climate change: Towards a European framework for action. Impact Assessment, pp. 134.
(http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2009:0387:FIN:EN:PDF)

UK Climate Impacts Programme (2005): Identifying adaptation options. UK, (http://www.ukcip.org.uk/images/stories/Tools_pdfs/ID_Adapt_options.pdf)

v. Ierland, E.C., De Bruin, K., Dellink, R.B. & A. Ruijs (2007): A qualitative assessment of climate change adaptation options and some estimates of adaptation costs. Wageningen. (http://www.enr.wur.nl/UK/Routeplanner+Report/)

Hallegatte, S. (2009): Strategies to adapt to an uncertain climate change. Global Environmental Change, 19, p. 240 - 247.

NO REGRET Project (http://www.noregret.info/), UKCIP 2005

Mickwitz, P, Aix, F., Beck, S., Carss, D., Ferrand, N., Görg, C., Jensen, A., Kivimaa,P., Kuhlicke, C., Kuindersma, W., Máñez, M., Melanen, M., Monni, S., Pedersen, A., B., Reinert, H. & S. van Bommel (2009): *Climate Policy Integration, Coherence and Governance.* PEER Report No 2. Helsinki: Partnership for European Environmental Research. (http://www.peer.eu/fileadmin/user_upload/publications/PEER_Report2.pdf)

Bizikova, L., Neale, T. & I. Burton (2008): Canadian community's guidebook for adaptation to climate change. Including an approach to generate mitigation co-benefits in the context of sustainable development. Environment Canada. (http://www.forestry.ubc.ca/LinkClick.aspx?fileticket=xsexCSatHjo%3D&tabid=2455&mid=5415&language=en-US)

Swart, R. & F. Raes (2007): Making integration of adaptation and mitigation work: mainstreaming into sustainable development policies? In: Climate Policy 7: 288-303. (http://www.earthscanjournals.com/cp/007/0271/0070271.pdf)

Lim, B. & E. Spanger-Siegfried (eds.) (2004): Adaptation Policy Frameworks for Climate Change. Developing Strategies, Policies and Measures. UNDP, Cambridge University Press. (http://www.undp.org/climatechange/adapt/apf.html)

VII. List of references analysed for the guiding principles

Aaheim, A. & M. Aasen (2008): What do we know about the economics of adaptation? CEPS Policy Brief No.150, ADAM Series. http://shop.ceps.eu/BookDetail.php?item_id=1594

Aaheim, A., Berkhout, F., McEvoy, D., Mechler, R., Neufeldt, H., Patt, A., Watkiss, R., Wreford, A., Kundzewicz, Z., Lavalla, C. & C. Egenhofer (2008): Adaptation to Climate change: Why is it needed and how can it be implemented? CEPS Policy brief, No. 161.

Adger, N.W., Arnell, N.W. & E.L. Tompkins (2005): Successful adaptation to climate change across scales. In: Global Environmental Change 15: 77-86

Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit & K. Takahashi: Adaptation practices, options, constraints and capacity. In: M.L. Parry, J.P. Palutikof, P.J. van der Linden & C.E. Handon (eds.) (2007): Climate Change 2007: Impacts, Adaptation and Vulnerabilty. Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, 717-743.

Adger, W.N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D.R., Naess, L.O., Wolf, J. & A. Wreford (2009): Are there social limits to adaptation to climate change? Climatic Change 93, 335-354.

Adger, W.N. & K. Vincent (2005): Uncertainty in adaptive capacity. In: External Geophysics, Climate and Environment 399-410

AEA, SEI & Metroeconomica (2005): Objective Setting for Climate Change Adaptation Policy. p183.

Agrawala, S. & S. Frankhauser (eds.) (2008): Economic Aspects of Adaptation to Climate Change. Costs, Benefits and Policy Instruments. OECD, Paris, p138.

AIACC (2007): Climate Change Vulnerability and Adaptation in developing country regions. DRAFT final report.

Arnold, M. & A. Kreimer (2004): The Socio-economic Costs of Disasters In: A. Mathur, I. Burton, M. van Aalst (Eds.): An Adaptation Mosaic. A SAMPLE OF THE EMERGING WORLD BANK WORK IN CLIMATE CHANGE ADAPTATION. World Bank Global Climate Change Team, pp 6-14. http://siteresources.worldbank.org/INTCC/817372-1110879250911/20551573/AnAdaptationMosaicCCteam2004part1.pdf

Aribigbola, A. (2009): Funding climate change adaptation and mitigation in urban areas of Nigeria: the case of Ondo State in South Western Nigeria, Earth and Environmental Science 6 (2009), IOP Conf. Series.

Awuor, C.B., Orindi V.A. & A. Ochieng Adwera (2009): Climate Change and Coastal Cities: The Case of Mombasa, Kenya. In: Bicknell, J., Dodman, D., and D. Satterthwaite (ed.) (2009): Adapting Cities to Climate Change - Understanding and Addressing the Developent Challenges, London/UK: p. 77 - 92.

Berkhout, F., Hertin, J. & D.M. Gann (2006): Learning to adapt: Organisational Adaptation to Climate Change Impacts. In: Climatic Change 78, 135-156.

Bizikova, L., Neale, T. & I. Burton (2008): Canadian communities guidebook for adaptation to climate change. Including an approach to generate mitigation co-benefits in the context of sustainable development. Environment Canada.

BRANCH (2007): Planning for biodiversity in a changing climate. Final report, UK.

Brunnengräber, A., Dietz, K., Hirschl, B., Walk, H. & M. Weber (2008): Das Klima neu denken - Eine sozial- ökologische Perspektive auf die lokale, nationale und internationale Klimapolitik, 1. Auflage, p. 256, Münster: Westfälisches Dampfboot.

Burton, I., Smith, J.B. & S. Lenhart (1998): Adaptation to Climate Change: Theory and Assessment. In: Feenstra, J.F., I. Burton, J.B. Smith, and R.S.J. Tol (eds.) 1998: Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies. United Nations Environment Programme and Institute for Environmental Studies, Free University of Amsterdam, Amsterdam. http://dare.ubvu.vu.nl/bitstream/1871/10440/1/f1.pdf

Christoplos, I., Anderson, S., Arnold, M., Galaz, V., Hedger, M., Klein, R.J.T. & K. Le Goulven (2009): The human dimension of climate adaptation: the importance of local and institutional issues. Commission on climate change and development report, Stockholm

Copenhagen Diagnosis (2009): Updating the world on the Latest Climate Science. I. Allison, N. L. Bindoff, R.A. Bindschadler, P.M. Cox, N. de Noblet, M.H. England, J.E. Francis, N. Gruber, A.M. Haywood, D.J. Karoly, G. Kaser, C. Le Quéré, T.M. Lenton, M.E. Mann, B.I. McNeil, A.J. Pitman, S. Rahmstorf, E. Rignot, H.J. Schellnhuber, S.H. Schneider, S.C. Sherwood, R.C.J. Somerville, K.Steffen, E.J. Steig, M. Visbeck, A.J. Weaver. The University of New South Wales Climate Change Research Centre (CCRC), Sydney, Australia, 60pp.

De Bruin, K., Dellink, R.B., Ruijs, A., Bolwidt, L., Buuren, v.A., Graveland, J., Groot, d.R.S., Kuikman, P.J., Reinhard, S., Roetter, R.P., Tassone, V.C., Verhagen, A. & E.C. v. Ierland (2009): Adapting to climate change in The Netherlands: an inventory of climate adaptation options and ranking of alternatives. In: Climate change 95:23-45.

DEFRA - Department for Environment, Food and Rural Affairs (2008): Adapting to climate change in England. A Framework for Action. pp.55. http://www.defra.gov.uk/environment/climatechange/adapt/pdf/adapting-to-climate-change.pdf

Dessai, S., Hulme, M., Lempert, R. & R. Pielke (2008): Climate prediction: a limit to adaptation? In: Adger., N., Lorenzoni, I., O`Brien: Living with climate change: are there limits to adaptation? Cambridge University Press, Cambridge. 13

Dessai, S., Adger, W.N., Hulme, M., Turnpenny, J., Köhler, J. & R. Warren (2004): Defining and experiencing dangerous climate change. In: Climatic Change 64: 11-25.

Deutsche Bundesregierung (2008): DAS - Deutsche Anpassungsstrategie an den Klimawandel.

DG Mare (2009): The economics of climate change adaptation in EU coastal areas. Linking climate change adaptation and disaster risk management for sustainable poverty reduction; EU Framework Contract AMS/451 Lot No 6, Reference code: DRR10367

Dossou, K. M.R. & Bernadette Gléhouenou-Dossou (2009): The Vulnerability to Climate Change of Cotonou (Benin): The Rise in Sea Level. In: Bicknell, J., Dodman, D., & D. Satterthwaite (ed.) (2009): Adapting Cities to Climate Change - Understanding and Addressing the Development Challenges, London/UK: p. 111 - 128.

Douglas, I., Kurshid, A., Maghenda M.A., Mc Donnell, Y., McLean, L. & J. Campbell (2009): Unjust Waters: Climate Change, Flooding and the Urban Poor in Africa. In: Bicknell, J., Dodman, D. & D. Satterthwaite (ed.) (2009): Adapting Cities to Climate Change - Understanding and Addressing the Development Challenges, London/UK: p. 201 - 224.

Downing, T. & P. Watkiss (2005): Adaptation: Policy Perspectives. Presentation at the launch of the European Climate Change Programme (ECCP) II launch. Brussels, 24th October, 2005.

Dyszynski, J. (2009): The Economics of Adaptation. WeAdapt Briefing Note. http://www.weadapt.org/downloads/The_Economics_of_Adaptation.pdf

Economic of climate change adaptation working group (McKinsey)(2009): Shaping climate-resilient development. A framework for decision-making.

EC — European Commission (2009a): Adapting to climate change: Towards a European framework for action - White paper. COM (2009), 147/4 final, Brussels.

EC — European Commission (2009b): Working document accompanying the White paper - Adapting to climate change: towards a European framework for action - Impact assessment. COM (2009), 147 final, Brussels.

EC – European Commission (200c): Common implementation strategy for the water framework directive (2000/60/EC). River basin management in a changing climate. Guidance document No. 24, Brussels.

ECDC - European Centre for Disease Prevention and Control (2010): Climate change and communicable diseases in the EU Member States. Handbook for national vulnerability, impact and adaptation assessments. http://www.ecdc.europa.eu/en/publications/Publications/1003_TED_handbook_climatechange.pdf

EEA (2005): Vulnerability and adaptation to climate change in Europe. EEA Technical Report, Copenhagen, p79.

EEA (2007): Climate Change - the cost of inaction and the cost of adaptation. EEA Technical Report, Copenhagen, p67.

EEA (2009): Regional climate change and adaptation. The Alps facing the challenge of changing water resources. Technical Report, Copenhagen, p143.

ESPACE – Planning in a Changing Climate http://www.espace-project.org/part1/part1_strategy.htm

EU Ad Hoc Expert Working Group on Biodiversity and Climate Change (2009): DRAFT Strategy Paper on Biodiversity and Ecosystems, Ecosystem Services and Climate Change.

Feenstra, J.F., Burton, I., Smith, J.B. & R.S.J. Tol (eds.) (1998): Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies. UNEP, p464.

Few, R., Brown, K. & E.L. Tompkins (2006): Public participation and climate change adaptation. Tyndall Centre Working paper 95

Füssel, H.M. & R.J.T. Klein (2002): Assessing vulnerability and adaptation to climate change. An evaluation of conceptual thinking. Presented at: UNDP Expert meeting on “Integrating disaster reduction and adaptation to climate change”, Havana, Cuba, 17-19 June 2002.

Füssel, H.M. (2007): Adaptation planning for climate change: concepts, assessment approaches, and key lessons. Sustainability Science 2:265-275.

Füssel, H.M. (2009): Ranking of national-level adaptation options. An editorial comment. In: Climate change 95:47-51.

Frankel-Reed, J. & N. Brooks (2008): Proposed Framework for Monitoring Adaptation to climate Change.draft version. UNDP, p28.

Frankhauser, S., Smith, J.B. & R.S.J. Tol (1999): Weathering climate change: some simple rules to guide adaptation decisions. In: Ecological Economics 30: 67-78. 22

Frankhauser, S. (2009): A perspective paper on adaptation as a response to climate change. Copenhagen Consensus Centre, Denmark. p15

Greather London Authority (2005): Adapting to climate change: a checklist for development. Guidance on designing developments in a changing climate, p60.

Grothmann, T., Nenz, D. & Pütz, M. (2009): Adaptation in vulnerable alpine regions — lessons learnt from regional case studies. In: European Environment Agency (Ed.), Vulnerability to climate change and adaptation to water resources problems in the European Alps - A regional perspective. EEA Report No. 8/2009.

Hallegatte, S. (2009): Strategies to adapt to an uncertain climate change. In: Global Environmental Change, 19:240-247

Harley, M., Horrocks, L., Hodgson, N. & J.v. Minnen (2008): Climate change vulnerability and adaptation indicators. ETC/ACC Technical paper

HM Government (2010): Climate change: Taking action. Delivering the Low Carbon Transition Plan and preparing for a changing climate. Crown Copyright, UK.

Horstmann, B. (2008): Framing Adaptation to climate change - a challenge for building institutions. Discussion paper 23, Deutsches Insitut für Entwicklungspolitik

Hulme, M., Adger, W.N., Dessai, S., Goulden, M., Lorenzoni, I., Nelson, D., Naess, L.O., Wolf, J. & A. Wreford (2007): Limits and barriers to adaptation: four propositions. In: Tyndall Briefing Note No. 20

Hulme, M., Neufeldt, H. & H. Colyer (eds.) (2009): Adaptation and Mitigation Strategies: Supporting European climate Policy. The Final report from the ADAM Project. Tyndall Centre for Climate Change Research, University of East Anglia, Norwich, UK.

Hunt & P. Watkiss (2007): Literature Review on climate change impacts on urban city centres: Initial findings, Working Party on Global and Structural Policies, OECD Paper.

ICLEI Oceania (2008): Local government climate change adaptation toolkit. Australia, 68p

IIED (2008): Taking steps: mainstreaming national adaptation. IIED briefing, p4.

IFOK-Report (2009): Floating Houses and Mosquito Nets: Emerging Climate Change Adaptation Strategies Around the World - Case Studies from Selected Countries.

Ingham, A., Ma, J. & U. Alistar (2006): Theory and practice of economic analysis of adaptation. Tyndall Centre for Climate Change Research. Technical Report 55.

v. Ierland, E.C., De Bruin, K., Dellink, R.B. & A. Ruijs (2007): A qualitative assessment of climate change adaptation options and some estimates of adaptation costs. Wageningen.

IPCC — Intergovernmental Panel on Climate Change (2007): Summary for policymakers'. In: Solomon, S.; Qin, D. and Manning, M. (Eds): 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 University Press, Cambridge, United Kingdom and New York, NY, USA.

Kivimaa, P. & P. Mickwitz (2009): Making the climate count. Climate Policy Integration and Coherence in Finland. The Finnish Environment 3/2009.

Klein, R. J. T., Nicholls, R. J. & F. Thomalla (2003): The Resilience of Coastal Megacities to Weather-Related Hazards. In: Kreimer, A., Arnold M. and Anne Carlin (ed.): Building Safer Cities - The Future of Disaster Risk, The World Bank, Disaster Management Facility, p. 101 - 120.

Koch, I.C., Vogel, C. & Z. Patel (2007): Institutional dynamics and climate change adaptation in South Africa. In: Mitigation and Adaptation Strategies for Global Change 12:1323–1339.

Kristensen, P., Bräuer, I., Laaser, C., Roo, C.d. & R. Vidaurre (2009): DRAFT How to adapt to climate change with regard to water issues and EU water legislation. Chap. EEA activity: 4.2.1 ETC/Water task: Task 1.5.4

Kropp, J. & M. Scholze (2009): Climate Change Information for Effective Adaptation. A practitioner`s Manual. Germany, p58

Laaser, C., Leipprand, A., Roo, C.d. & R. Vidaurre (2009): DRAFT Report on good practice measures for climate change adaptation in river basin management plans.
ETC/Water Task: 1.5.4 Water and climate change; Subtask: 1.5.4.2 Measures for climate change adaptation

Larsen K. & U. Gunnarsson-Östling (2008): Climate change scenarios and citizen-participation: Mitigation and adaptation perspectives in constructing sustainable futures. In: Habitat International 33: 260–266.

Laukkonen, J., Blanco, P. K., Lenhart, J., Keiner, M., Cavric, B. & C. Kinuthia-Njenga (2009): Combining climate change adaptation and mitigation measures at the local level. In: Habitat International, 33 (2009) p. 287 – 292.

Leary, N.A. (1999): A framework for benefit-cost analysis of adaptation to climate change and climate variability. Mitigation and Adaptation Strategies for Global Change, 4, 307-318.

Lemmen, D.S., Warren, F.J., Lacroix, J. & E. Bush (eds.)(2008): From Impacts to Adaptation: Canada in a Changing Climate 2007; Government of Canada, Ottawa, 448p.

Lim, B. & E. Spanger-Siegfried (eds.) (2004): Adaptation Policy Frameworks for Climate Change. Developing Strategies, Policies and Measures. UNDP, Cambridge University Press, p255.

Lorenzoni, I. Nicolson-Cole, S. & L. Whitmarsh (2007): Barriers perceived to engaging with cc among the UK public and their policy implications. In: Global Environmental Change 17: 445-459

Mani, M., Markandya, A. & V. Ipe (2008): Climate change. Adaptation and mitigation in development programs. A practical guide. World Bank, New York, 98p.

Margulius et al. (2008) The economics of adaptation to climate change: Methodology report. World Bank.

Mechler, R., Hochrainer, S., Aaheim, A., & Z. Kundzewicz (2009): A Risk Management Approach for Assessing Adaptation to Changing Flood and Drought Risks in Europe. ADAM BOOK CHAPTER 8.

Mendelsohn, R. (2000): Efficient adaptation to climate change. In: Climate Change 45: 583-600

Millner, A., Ciampaglio, G., Aravamudan, N. & J. Foster (2008): The cost of strategic adaptation in a simple conceptual model of climate change. Santa Fe Institute Working Paper, p13.

Ministry of Environment (2008): Wise Adaptation to Climate Change. Report by the committee on Climate Change Impacts and Adaptation Research. Japan, p70.

Mickwitz, P., Aix, F., Beck, S., Carss, D., Ferrand, N., Görg, C., Jensen, A. Kivimaa, P., Kuhlicke, C., Kuindersma, W., Máñez, M., Melanen, M., Monni, S., Branth Pedersen, A., Reinert, H. & v.Bommel, S. (2009): Climate Policy Integration, Coherence and Governance. PEER Report No2, Partnership for European Environmental Research, Helsinki, p91.

Mukheibir, P. & G. Ziervogel (2009): Developing a Municipal Adaptation Plan (MA) for Climate Change: The City of Cape Town. In: Bicknell, J., Dodman, D., and D. Satterthwaite (ed.) (2009): Adapting Cities to Climate Change - Understanding and Addressing the Development Challenges, London/UK: p. 270 - 289.

NeWater - New Approaches to Adaptive Water Management under Uncertainty. SP9: Guidebook
http://www.newater.info/index.php?pid=1052

NeWater - New Approaches to Adaptive Water Management under Uncertainty. SP 6: Cross-Comparison of Climate Change Adaptation Strategies across Regions - Summary of Results
http://www.newater.info/index.php?pid=1137

Nicholls R. J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., Château, J. & R. Muir-Wood (2008): Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes: Exposure Estimates. OECD Environment Working Papers, No. 1, OECD publishing, doi:10.1787/011766488208.

Paavola, J. & W.N. Adger (2006): Fair adaptation to climate change. In: Ecological Economics, 56, 594-609.

Patt, A., Reckien, D., Klein, R.J.T., v.Vuuren, D., Wrobel, M., Bauer, N., Eskeland, G.S. & T. Downing (2009, in press): What can social science tell us about meeting the challenge of climate change: five insights from five years that might make a difference. In: Hulme, M. & H. Neufeld (eds.): Making climagte change work for us. Cambridge University press.

Prasat, Neeraj, Ranghieri, F., Shah, F., Trohanis, Z., Kessler E. & R. Sinha (2009): Climate Resilient Cities - A Primer on Reducing Vulnerabilities to Disasters. The International Bank for Reconstruction and Development/World Bank, p. 186.

Parry, M., Arnell, N., Berry, P., Dodman, D., Fankhauser, S., Hope, C., Kovats, S., Nicholls, R., Satterthwaite, D., Tiffin, D. & T. Wheeler (2009): Assessing the Costs of Adaptation to Climate Change: Review of the UNFCCC and Other Recent Estimates. International Institute for Environment and Development and Grantham Institute for Climate Change, London.
http://www.iied.org/pubs/pdfs/11501IIED.pdf

Preston, B.L., Westaway, R., Dessai, S. & T.F. Smith (2009): Are we adapting to climate change? Research and methods for evaluating progress.

Roberts, D. (2009): Thinking Globally, Acting Locally: Institutionalizing Climate Change at the Local Government Level in Durban, South Africa. In: Bicknell, J., Dodman, D., and D. Satterthwaite (ed.) (2009): Adapting Cities to Climate Change - Understanding and Addressing the Developent Challenges, London/UK: p. 253 - 270.

Ribeiro, M.M., Losenno, C., Dworak, T., Massey, E. Swart, R., Benzie, M. & C. Laaser (2009): Design of guidelines for the elaboration of regional cliamte change adaptation strategies. Final Report. Tender DG ENV.

Ruth, M. & D. Coelho (2007): Understanding and managing the complexity of urban systems under climate change. In: Climate Policy 7: 317-336

Scheraga, J.D. & A.E. Grambsch (1998): Risks, opportunities, and adaptation to climate change. Climate Research, 10, 85-95.

Schools, R. J. (2006): Impacts and Adaptation to CC in the Biodiversity sector in southern Africa. Project part von AIACC.

Scientific Expert Group Report on Climate change and sustainable development (2007): Confronting climate change: Avoiding the unmanageable and managing the unavoidable. Report prepared for hat UN Commission on Sustainable Development. Washington, p144.

Shaw, R., Colley, M., & R. Connell (2007): Climate change adaptation by design: a guide for sustainable communities. TCPA, London, 49p.

R. J. Smithers; C. Cowan; M. Harley; J. J. Hopkins; H. Pontier & O. Watts (2008): DEFRA: England Biodiversity Strategy - Climate Change Adaptation Principles. Conserving biodiversity in a changing climate.

Smith, J.B. & S. Lenhart (1996): Climate change adaptation policy options. In: Climate Research, Vol. 6:193-201.

Smith, J.B., Vogel, J.M. & J.E. Cromwell II (2009): An architecture for government action on adaptation to climate change. An editorial comment. In: Climatic Change 95:53-61.

Smit, B., Burton, I., Klein, R.J.T. & J. Wandel (2000): An Anatomy of Adaptation to Climate Change and Variability. Climate Change, 45, 223-251.

Stern, N. (2006): The Economics of Climate Change. Cambridge University Press. Executive Summary.

Swart, R. & F. Raes (2007): Making integration of adaptation and mitigation work: mainstreaming into sustainable development policies? In: Climate Policy 7: 288-303.

Swart, R.J., Biesbroek, G.R., Binnerup, S., Carter, T., Cowan, C., Henrichs, T., Loquen, S., Mela, H., Morecroft, M., Reese, M. & D. Rey (2009): Europe adapts to climate change. Comparing National Adaptation Strategies in Europe. Partnership for European Environmental Research (PEER), printed at the Finnish Environment Institute, Helsinki.

Tearfund - Linking climate change adaptation and disaster risk reduction
THE ECONOMICS OF ADAPTATION TO CLIMATE CHANGE. METHODOLOGY REPORT, pp 18
http://siteresources.worldbank.org/INTCC/Resources/MethodologyReport0209.pdf

UKCIP (2005): Identifying adaptation options. http://www.ukcip.org.uk/images/stories/Tools_pdfs/ID_Adapt_options.pdf

UNDP (2008): Proposed Framework for Monitoring Adaptation to Climate Change. p28.

UNECE Water (2009): Guidance on water and adaptation to climate change. New York and Geneva, 130p

UNFCCC (2008): Compendium on methods and tools to evaluate impacts of , and vulnerability and adaptation to, climate change.

van Aalst, M. & S. Bettencourt (2004): Vulnerability and Adaptation in Pacific Island Countries. In: A. Mathur, I. Burton, M. van Aalst(Eds.): An Adaptation Mosaic. A sample of the emerging World Bank in climate change adaptation. World Bank Global Climate Change Team, pp. 14-31. http://siteresources.worldbank.org/INTCC/817372-1110879250911/20551573/AnAdaptationMosaicCCteam2004part1.pdf

Marttila, V., Granholm, H., Laanikari, J., Yrjölä, T., Aalto, A., Heikinheimo, P., Honkatuki, J., Järvinen, H., Liski, J., Merivirta, R. & M. Paunio (2005): Finland's National Strategy for Adaptation to Climate Change, Ministry of Agriculture and Forestry, pp 288 http://www.mmm.fi/attachments/ymparisto/5kghLfz0d/MMMjulkaisu2005_1a.pdf

Wilby, R., Wright, J., Forrow, D. & T. Davy (2009): DRAFT River basin management in a changing climate. Chapter 4 – analysis steps of river basin management.

Wilby, R.L. & S. Dessai (2009): Robust adaptation to climate change. In: Weather. In preparation.

Willows, R. & R. Connell (2003): Climate adaptation. Risk, uncertainty and decision-making. UKCIP Technical Report, p154.