BASE

BOTTOM-UP CLIMATE
ADAPTATION STRATEGIES
TOWARDS A SUSTAINABLE EUROPE

Implementation of climate change adaptation: Barriers and Opportunities to adaptation in case studies

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BASE report

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1 Summary

In the field of climate change adaptation the implementation of political and administrative decisions is heavily influenced by various political, social, legal, cultural and economic framework conditions, the actors involved and their "translation" processes. The drivers and barriers to adaptation are dynamic and, therefore, their impacts change in the course of the adaptation process. Research efforts should be geared to provide causal explanations of the occurrence of barriers for unique and sets of case studies, analyse how barriers change over time and how they have been overcome, among others. This deliverable aims to assess the implementation of adaptation measures and strategies through the study of their key barriers and drivers. This implementation analysis was conducted in the 23 BASE case studies in five sector clusters: city, coast, agriculture, health and biodiversity. The climate change impacts covered include flooding, sea level rise, drought, water scarcity, extreme weather events, heat island effect or extreme temperature, erosion, and UV radiation. The drivers and barriers to adaptation were categorised for each case study across temporal stages of adaptation progress, and we studied how barriers have been overcome and searched for patterns to provide recommendations. The findings identified the main factors influencing adaptation (actor-related aspects, resources, knowledge on climate change, and the institutional context) across case studies, clusters and climate change impact. Further, barriers and drivers are quite varied through time, but there some visible trends per clusters and as adaptation progresses in time. Regarding policy, all levels (EU, national and local) were found to be drivers of adaptation, particularly local non-climatic ones. Mainly cases which are more advanced in adaptation, overcame barriers successfully, particularly through participatory approaches or stakeholder engagement; learning from pilot projects, government schemes, studies and BASE research, institutional changes or re-arrangements and networks/cooperations. Finally, future climate change adaptation prospects of cases are more positive for advanced cases compared to those in the early stages of adaptation.

2 Introduction

2.1 Aims and objectives

According to the project's Description of Work (DOW), deliverable 5.4 focuses on "Methodologies and tools for adaptation planning and implementing adaptation in cases: Implementation analysis and execution of case studies in accordance to the Standard Operating Procedures (SOPs)". The specific aim of Task/deliverable 5.4 is to establish what the key obstacles and opportunities are of the implementation of adaptation measures in the context of case studies. In participatory cases, the implementation analysis makes use of different techniques, such as workshops, to identify the strengths, weaknesses, opportunities and threats for the implementation of developed adaptation strategies and measures, and to identify best practices with regards to decision-making processes that promote acceptance and empower bottom-up initiatives and involvement of stakeholders in the planning process. The key changes or reforms that would best foster adaptation in the case study contexts will also be identified. Comparisons of the methodological strategies applied in the case studies will also be made in order to feed into Task/deliverable 5.5.

This deliverable contributes to BASE objective 3 "Identify conflicts and synergies of adaptation policies at different levels of policy making with other policies (including climate mitigation) within and between sectors". This entails analysis of specific policies mentioned for the case studies and the environmental, social and economic effects of adaptation responses at the local level and the identification of strategies that improve policy coherence and effectiveness.

2.2 Implementation of climate change adaptation

In the last decade awareness grew that even ambitious mitigation actions cannot avert climate change and its related impacts. Hence, decision-makers at various spatial scales and politico-administrative levels started making provisions to adapt to these changes. Meanwhile, this societal challenge has been widely recognised and adaptation is no longer dealt with only at a strategic level. Increasingly adaptation strategies are being implemented. In the field of climate change adaptation as in all policy areas the implementation of political and administrative decisions is heavily influenced by various political, social, legal, cultural and economic framework conditions, the actors involved and their "translation" processes.

Since the 1970's the analysis of policy implementation has been viewed as an essential part of the policy making process. As Anderson (1975:98) observes, "policy is being made as it is being administered and administered as it is being made". In other words, the distinction between policy making a policy implementation are not necessarily discrete; decisions, interpretations, actions and behaviours of implementing actors and their interactions with policy makers and client groups shape the substance of policy.

Much of the earlier work on policy implementation tended to be highly normative and somewhat prescriptive. Models of implementation developed in the 1970's conceptualised implementation as a top down or hierarchical rational process. Seminal among this work was Pressmen's and Wildavsky's (1973) study of implementation economic development policy in Oakland, USA, in which they portrayed implementation as "a process of interaction between the setting of goals and the actions geared to achieve them" (p.xv). Sabatier (1986) for example states that successful implementation requires: clear and consistent objectives; adequate causal theory; implementation mechanisms that are legally structured; committed and skilful implementers; support of interest groups and sovereigns; and that any resulting changes in socio-economic conditions should not undermine the support of groups or sovereigns nor the original causal theory.

Evidence suggests that implementers' thoughts about policy extend beyond simply deciding whether to implement or not and prominently include a judgment about what the policy means in the first place. This is compounded according to Hill by the fact that implementers have incomplete information, weak guidance, and incomplete or inaccurate perceptions of the implications of policy in relation to their working practice.

To deliver policy, local implementers must interact with non-state actors at the 'street-level' such as professional organizations, businesses, third sector organisations, sectors of society, academic scholars, trade journalists, interest groups, etc. How policy is implemented is therefore likely to be shaped by these interactions as it is ultimately the behaviour of such groups that will dictate whether and how a policy works. When considering this interaction between implementers and their client groups, Hill (2003) highlights the importance of learning in this relationship, which significantly influences how policy goals are interpreted and delivered.

Institutional analysis (March and Olsen 1989) suggests that 'street-level' bureaucrats and their client groups implement policy on the basis of it being 'appropriate' to the professional identity and/or organisational culture rather than a rationalistic logic associated with top-down models (see for example Dunlop and Russel 2012).

Institutions' interpretations of policy goals are thus argued to shape implementers' own understandings of policy and ultimately their actions (Hill 2003). While the discretion at the street level may aid implementation through making it more sensitive to local contexts, professional identities and organisation cultures, critics question whether it is it right for street level bureaucrats to have discretion on how to implement the policies of democratically elected authorities (Parsons 1996).

So many of the factors influencing the implementation of climate change adaptation-related activities are not adaptation-specific. Challenges such as how to deal with different types of uncertainty, how to institutionally embed activities, how to raise awareness of political decision-makers and the general public or how to secure resources to act are prominent in many policy fields. Nevertheless, some scholars claim that there are several factors, which are particularly relevant for climate change adaptation (Termeer, Dewulf, Breeman 2012, Arvai et al. 2006). These include the existence of conflicting timescales, i.e. the need for short-term action to mitigate (often) future climate change-related effects; the relevance of various types of uncertainty, i.e. regarding future climate change, its impacts and people's ability to mitigate these effects; and the necessity for mutual action across organisational boundaries and spatial levels as adaptation is a typical multi-level governance issue.

A substantial number of empirical studies exist, which analyse a great variety of general as well as adaptation-specific aspects influencing policy implementation. Most of these studies produce inventories of barriers (and drivers) of climate change adaptation, which can be found in different policy contexts (see e.g. Arnell, Delaney 2006, Berkhout et al. 2006, Eisenack, Stecker 2012, Inderberg 2011, Koch et al. 2007, Næss et al. 2005, Steinhäuser et al. 2012, Amundsen et al. 2010, Burch 2010a, b, Crabbé, Robin 2006, Measham et al. 2011, Runhaar et al. 2012). They unveil that the effect of a particular factor, i.e. whether and to what extent it promotes or impedes adaptation, always depends on the specific context and on the perspective of the actor, who judges its impact.

The current state of the debate on the drivers and barriers of climate change adaptation is summarized by Eisenack et al. (2014, 2015). They present and discuss the most prominent conceptualisations of barriers of adaptation by the IPCC (Klein et al. 2014) as well as by Moser and Ekstrom (2010) and propose the following definition: "A 'barrier to adaptation' is (1) an impediment (2) to specified adaptations (3) for specified actors in their given context that (4) arise from a condition or set of conditions. A barrier can be (5) valued differently by different actors, and (6) can, in principle, be reduced or overcome. In this definition, conditions are the attributes of adaptations, actors, and their context (Eisenack et al. 2014:868)." As we understand drivers and barriers as two sides of the same coin, we defined drivers in the same way by replacing "impediment" by "promoter" and leaving out definition criterion 6.

Eisenack et al. (2014) give an overview about commonly reported barriers. They emphasize that often these are very context and actor-specific and scientific analysis tackling them is rather descriptive. The results of the studies, which try to offer some insights on the causes of the barriers identified, are mixed. This means that similar barriers are traced back to different underlying reasons. Vice versa it can be seen that similar context conditions might lead to very different adaptation results. This observation highlights the relevance of the interplay of different influencing factors. These drivers and barriers are dynamic and, therefore, their impacts change in the course of the adaptation process. Eisenack et al. (2014) stress that the research efforts

on how adaptation obstacles have been or are to be overcome need to be intensified. The fact that there are very few studies available so far can be considered a symptom of the currently still limited state of knowledge regarding the causes of adaptation failure. Nevertheless, this branch of adaptation research is seen to be "highly policy and practice relevant".

Biesbroek et al. (2015) point to the fact that, even though, the consideration of feedback, causal interdependencies and agency aspects improves the investigation of adaptation-related decision-making processes, analysis should not rest on a functionalist understanding of these processes. This means that it shouldn't be assumed that if certain preconditions are met the expected adaptation output will follow or that, seen the other way around, the gap of expected to actual output can be explained by ex-ante identified barriers. Prima facie this remark opposes Eisenack et al. by critising their barrier-oriented research perspective. On closer inspection this comment is rather underpinning the research agenda proposed by Eisenack et al. requesting the consideration of complementary investigations from the field of public policy research and political science, which provide interesting insights e.g. regarding the role of rules, norms and beliefs.

It can be concluded that research efforts should be geared to (1) provide causal explanations of the occurrence of barriers not only for unique cases but (2) for sets of case studies, which allows for generalization, (3) investigate the interrelationship of barriers, (4) analyse how barriers change over time and (5) how they have been overcome, (6) focus on mainstreaming of climate change adaptation into existing policies and the windows of opportunity to start adaptation action, (7) search for entry points and (8) enabling context- and actor-related conditions to initiate or intensify climate change adaptation and (9) study the role of individuals for promoting or hindering adaptation processes at various stages of the decision-making and/or implementation process (Eisenack et al. 2014).

2.3 Factors used for implementation analysis in BASE case studies

For the empirical analysis of drivers and barriers of climate change adaptation-related activities in BASE case studies the following factors have been identified based on a literature review.

Knowledge and information about climate adaptation

Decision-makers at different spatial levels require proper information about the regional or local climate change effects. Ideally these are known as changes of climate change-related vulnerability understood as a function of exposure, sensitivity and adaptive capacity (see Füssel, Klein 2006, Füssel 2007a). Empirical evidence shows that frequently actors have to consider information addressing single vulnerability aspects such as exposure, e.g. projected changes of selected climate parameters. Beyond information about changing climate conditions and their potential impacts actors also need to know about viable adaptation options as well as their costs and benefits for planning and implementing adaptation activities (Füssel 2007b, Füssel, Klein 2004).

Actor-related aspects

Actors have specific perceptions, preferences, experiences and knowledge, which guide their decisions and behaviour (Reser, Swim 2011). Several psychological barriers have been identified, which might hinder action towards adaptation e.g. such as limited cognition, ideologies, comparing oneself with others, sunk costs, discredence, perceived risks and limited behaviour (Gifford 2011). Mental models determine how individuals interpret and value information (Eisenack, Stecker 2012, Moser, Ekstrom 2010). These models are not only determined by psychological aspects but also by actors' interactions with natural and socio-economic framework conditions, e.g. personal experiences with climate change-related events and the institutional environment, such as prevailing social values and norms (Lehmann et al. 2015). Adger et al. (2009) emphasise that actors' preferences and concerns, their risk attitudes and their perceptions of self-efficacy and controllability of the adaptation problems have an influence on their adaptation actions. The interplay of these aspects and actors' abilities, e.g. communication and facilitation skills, and actors' characteristics, e.g. pioneer spirit, creativity and willingness to take responsibility, determines whether they are able to put adaptation on the (political) agenda and acquire the resources needed to take action. Empirical evidence shows that especially at an early stage, i.e. when adaptation concerns are not yet institutionalized, a clear mandate is still missing or public demand for adaptation is low, leadership plays an important role to kick-start adaptation action and keep the momentum going (Measham et al. 2011, Moser, Ekstrom 2010).

Local and regional context

Natural and socio-economic conditions, i.e. non-institutional aspects, influence the need to act action or the ability of local actors to do so. Regional and local climate change effects are very location-specific, i.e. the actual impact of changes of the general climate conditions is strongly influenced by factors such as the natural setting and orographic patterns such as altitude. A socio-economic system is characterised by specific demographic patterns and level of political, cultural, economic and technological development. These factors have an influence on the availability of technologies for climate change adaptation, the need and the means to employ them as well as the way adaptation action is planned and implemented.

The complex and variable framework conditions at the regional and local level, especially in urban areas, impede reliable impact projections (Wilbanks et al. 2007, Hunt, Watkiss 2011). A region's or city's exposure and sensitivity to climate change strongly influences citizens' motivation to demand adaptation action and political decision-makers' determination to take action. If this requires the coordination of multiple actors across different scales, as it is often the case at the local or regional level, substantial resources and efforts might be needed to take action (Moser, Ekstrom 2010). Empirical evidence shows that the availability of resources for adaptation planning and implementation is usually a function of the socio-economic context, in particular of the level of economic development.

Institutional context

In general institutions are defined as formal, i.e. laws and regulations, and informal rules, i.e. (organizational) routines, cultural and societal values and beliefs, which guide interactions of actors and organizations (North 1990, Eisenack, Stecker 2012, Moser, Ekstrom 2010, Berkhout et al. 2006, Adger et al. 2009). Institutions strongly influence the information exchange within and across organisations, the coordination of collective action and allocation of responsibilities and resources (Ostrom 1990). Successful adaptation planning and implementation depends on the vertical and horizontal integration of adaptation concerns into the (existing) institutional framework. Mainstreaming adaptation into administrative structures, strategies and decision-making processes is the most prominent form of horizontal integration. Another form of horizontal integration

is participation, which addresses the interactions of the organizational unit being responsible for climate change adaptation at a particular politico-spatial level and the general public. Vertical integration aims for coordination of adaptation across different scales, i.e. the local (i.e. urban), regional and national decision-making levels, and is often referred to as multi-level governance (Corfee-Morlot et al. 2011).

Resources

Planning and implementing adaptation measures requires resources, i.e. financial means, technologies, personnel, staff expertise and time (Moser, Ekstrom 2010). Due to their wide range of responsibilities local and regional governments often suffer resource constrains. In many cases this leads to reactive management patterns focusing on short-term technical fixes rather than long-term strategies to address climate change adaptation (Crabbé, Robin 2006, Measham et al. 2011). Nevertheless, empirical evidence shows that often it is not a general lack of resources, which constraints adaptation, but rather the fact that adaptation concerns are not considered to be as important as competing policy areas such as the labour market, economic development or innovation.

European, national, regional and local regulatory framework

The relevance of sound vertical integration of adaptation concerns into the existing institutional framework implies that adaptation planning and implementation at the local or regional level is influenced by regulations and decisions taken at the national or European level. Therefore, the existing patterns of multi-level governance have a substantial impact on the level adaptation action (Corfee-Morlot et al. 2011). Laws, regulations and political practices might establish incentives for local decision-makers, which can lead to maladaptation (Amundsen et al. 2010, Corfee-Morlot et al. 2011, Eisenack, Stecker 2012). Prominent examples, which discourage local adaptation, are national schemes, which cover climate-related damages, or hesitating amendments of relevant regulations such as the national building codes. But multi-level governance can also drive adaptation e.g. by stimulating local action through timely revision of the regulatory framework or assignments of strong adaptation mandates. This is particularly important as empirical evidence shows that the lack of such mandates is often an important barrier to adaptation action Amundsen et al. 2010, Betsill 2001, Bulkeley, Kern 2006, Burch 2010b, Corfee-Morlot et al. 2011, Koch et al. 2007, Measham et al. 2011, Næss et al. 2005). The regulatory framework is also fundamental for making adaptation policies consistent with other policy objectives (Yohe 2001).

Framing of climate change adaptation

As climate change adaptation is a crosscutting concern rather than an issue addressing a single policy area is it not surprising that in various spatial contexts actors from different policy fields take the lead for initiating adaptation planning and action. Often adaptation is advanced by actors, who work in the field of environmental protection or spatial planning. In some cases decision-makers from the health sector or in charge of disaster risk management put adaptation on the agenda. It can be assumed that the way adaptation is framed in a particular context, i.e. e.g. as sustainability concern, (urban) planning, environmental or disaster risk reduction issue, will have an impact on its implementation. Empirical evidence shows that especially at the very early stages of the adaptation process it is beneficial if climate change adaptation is linked to a well-established and institutionalized (political) discourse. The same applies, if the responsibility for adaptation is assigned to an institutional actor with a strong position at the respective politico-administrative level.

Nature of adaptation measures

Adaptation measures can be characterized by a multitude of criteria, which have an impact on whether and to what extent these measures are implemented. In general cost- and benefit-related criteria are distinguished. For that matter costs typically include (re-)investments as well as operational and maintenance costs. Sometimes transaction costs, i.e. e.g. costs incurred in the course of contract negotiations or conflict solving costs, are considered. In addition, it is possible to also take adverse side effects of adaptation measures into consideration, such as negative environmental and social effects being a consequence of the implementation. The beneficial effects of adaptation measures are very context-specific and include such diverse effects as damage reduction, improvement of the values of goods or land as well as safeguarding biodiversity and ecosystem services.

Further criteria for characterizing adaptation measures are their lifetime; their robustness, i.e. effectiveness under different climate scenarios and different socio-economic scenarios; their flexibility, i.e. the possibility to adjust the measures to changing conditions; their benefits in the absence of climate change or climate variability (no regret, low regret, regret option); their synergies or conflicts with other measures; their co-benefits, i.e. their positive impact on the achievement of (environmental, social, economic etc.) goals in other policy areas as well as their public and/or political acceptance.

3 Methodology

3.1 Deliverable methodology

The implementation analysis conducted in the 23 BASE case studies draws on the requests formulated in the current academic debate about the new frontiers of adaptation barriers and drivers research (see above). A common methodological framework is applied to a substantial number of cases across Europe. As a first step an inventory of different types of drivers and barriers to climate change adaptation is produced. Then the relative importance of particular driving or hindering factors are analysed based on the assessments of relevant stakeholders at case study level (see sections 5.1 - 5.3). Furthermore, it is analysed how obstacles encountered in the implementation of adaptation action in the various contexts have been overcome (see sections 5.4 and Appendix 5). On the basis of the empirical data common patterns are searched for, recommendations are provided (see section 6) and conclusions are drawn (see section 7).

3.2 Case studies' methodology

The 23 case studies analysed in this document are divided in five sector clusters. Although some cases are relevant to more than one sector, for the purposes of the analyses they are ascribed to only one sector. The city cluster includes seven case studies: Cascais (Portugal), Copenhagen (Denmark), Jena (Germany), Leeds (UK), Prague (Czech Republic), Rotterdam (The Netherlands) and Venice (Italy). The Agriculture cluster includes seven case studies: Alentejo (Portugal), Doñana (Spain), Holstebro (Denmark), Ijsselmeer (The Netherlands), Kalajoki (Finland), South Moravia and Usti (Czech Republic). The Coastal cluster has four cases: Ílhavo and Vagos coast (Portugal), Kalundborg (Denmark), South Devon (UK), and Timmendorfer Strand (Germany). The Health cluster includes three case studies: Madrid (Spain), Cornwall and England (UK). Finally, the Biodiversity cluster has two case studies: Dartmoor (UK) and Green Roof (also known as Šumava National Park, Czech Republic). Other sectors covered by the case studies include education, rural areas, water resources and tourism.

The number of climate change impacts covered per case study range from 1-4. The following impacts are addressed: flooding (17 case studies), sea level rise (8), drought (6), water scarcity (5), extreme weather events (6), heat island effect or extreme temperature (6), erosion (2), and UV radiation (2). The number of climate change adaptation measures studied in each case study ranged from 1-3 and varied widely. The spread across adaptation measure types is well balanced, with 12 grey measures (e.g. sand nourishment operations, flood defenses and irrigation systems), 11 green measures (e.g. water retention landscape, sustainable drainage and bog restoration), and 12 soft measures (e.g. information-awareness campaigns, improve flood preparedness, and heat warning systems).

The case studies also varied regarding their temporal perspectives. Twelve case studies analysed implementation of adaptation measures or strategies retrospectively (i.e. Alentejo, Cascais, Copenhagen, Dartmoor, Holstebro, Ijsselmeer, Jena, Kalundborg, Prague, South Devon, Timmendorfer Strand, Venice). Seven case studies focused on on-going adaptation activities (i.e. Cascais, Dartmoor, Holstebro, Jena, Kalajoki, Rotterdam, South Devon). Thirteen case studies had a future prospective view on potential

adaptation (i.e. Ílhavo and Vagos coast, Cascais, Cornwall, Dartmoor, Doñana, Green Roof, Holstebro, Leeds, Madrid, South Devon, South Moravia, England, Usti). These categories were not mutually exclusive as some case studies analysed past, current and/or future adaptation activities

Each case study holder provided the required information for each case study. Although an initial effort was made to encourage data compilation via interviews or workshops, the final data sources varied widely across case studies. Case study holders used between one and six different (direct or indirect) sources of information to report on case study implementation. Case study data sources were distributed as follows: document or literature review (19 cases), interviews (15), surveys or questionnaires (7), researchers' expertise (7), workshops/meetings (5), informal communications (5), data generated during BASE research (3), action research methods (2), public event participation (2), and validation of information by a local contact and online databases (1), respectively. For more detailed information on the general characteristics of the case studies, see Appendix 1.

4 Current state of case studies

The case studies all vary in the level of adaptation progress they have reached, influenced by different political, social, economic and geographical contexts. Details on the current state of adaptation in each of the 23 case studies and the research done through the BASE project can be found in Appendix 2. In this study, the Adaptation Support Tool from Climate-ADAPT inspired the determination of stages of adaptation progress for each case study. These stages refer to the official status of the case study locality, not the country. Although some case studies have a focus on, for instance, flood risk or water management, these sectorial measures and strategies are considered here as adaptation if they advance adaptation. Note that any activities carried out as part of the BASE project should have been officialised or incorporated by local authorities in order for them to count towards this classification.

a) *Stage 1: Preparing the ground for adaptation*

This stage includes case studies that have introduced key elements that are the basis for a successful adaptation process. These include high level support, set up of adequate coordination mechanisms, exploration of funding opportunities, and the development of climate change awareness and understanding.

b) *Stage 2: Assessing risks and vulnerability to climate change*

This stage includes case studies that have analysed how past weather events have affected the area, assessed the future threats and opportunities, addressed knowledge gaps and dealing with uncertainties, and determined some strategic direction.

c) *Stage 3: Identifying adaptation options*

This stage includes case studies that have compiled detailed information of adaptation options that accommodate the main concerns identified in stage two, and explored good practices and the pros and cons of existing measures.

d) *Stage 4: Assessing adaptation options*

This stage includes case studies that have assessed possible adaptation options (i.e. in terms of time, cost, benefits and efforts), and their trade-offs, prioritised adaptation options and selected preferred ones, and elaborated an (optional) adaptation strategic document.

e) *Stage 5: Implementation*

This stage includes case studies that have elaborated an (optional) action plan, are implementing adaptation actions, have modified existing instruments or created new ones to mainstream adaptation, set up collaborations and agreements, appointed roles and responsibilities, and estimated resources needed.

f) *Stage 6: Monitoring & Evaluation (M&E)*

This stage includes case studies that have arrangements for monitoring and evaluating adaptation and (optional) performance indicators have been developed.

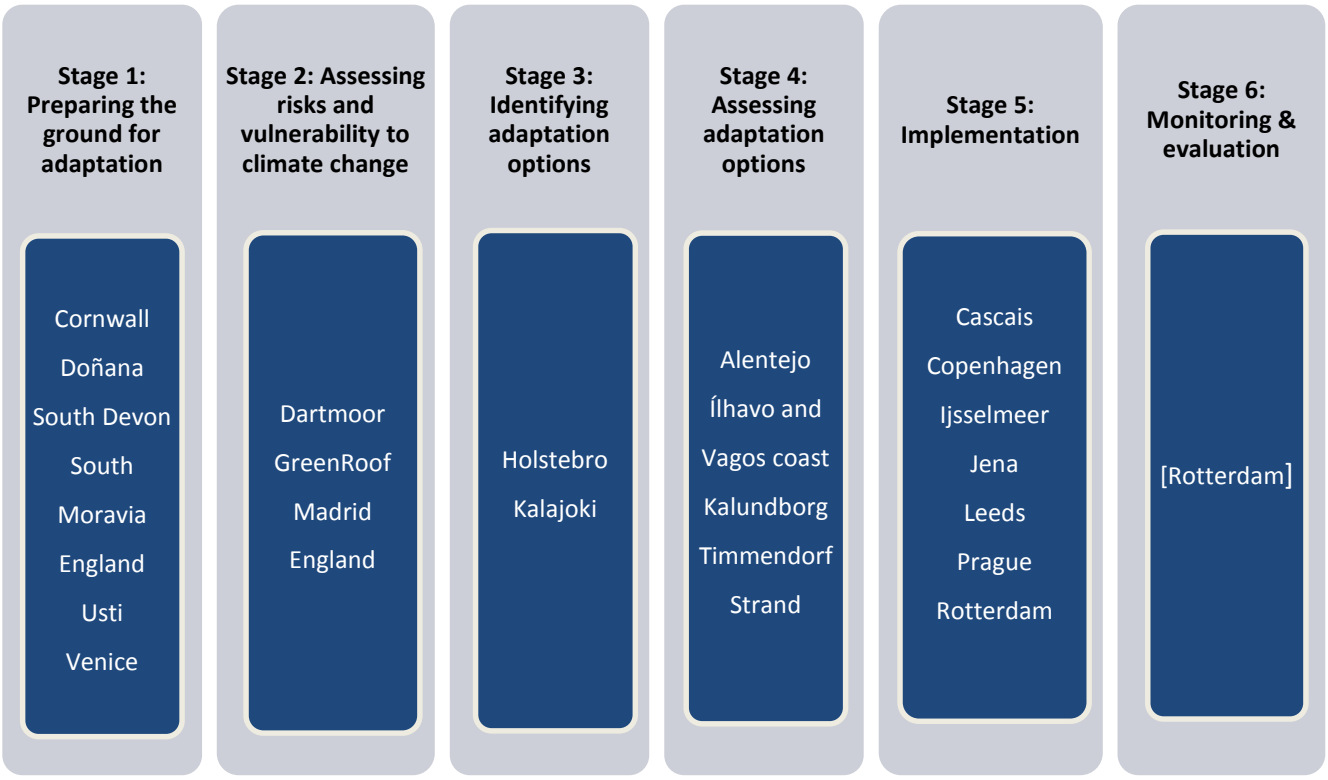

Figure 1. Case studies classified according to their stage of adaptation advancement.

All case studies are located in countries with an approved National Adaptation Strategy, Italy and the Czech Republic approved theirs in 2015. On the other hand, very few case studies have an adaptation plan or strategy for their locality. There are eight cases that do: Cascais, Copenhagen, Dartmoor, Holstebro, Ijsselmeer, Jena, Kalundborg, and Rotterdam. As the England case study is a national case study it is not considered here.

It was reported by six case studies that BASE research advanced adaptation at their locality. These are the three Portuguese cases (Alentejo, Ílhavo and Vagos coast, and Cascais), Jena, Green Roof, and Kalajoki. Furthermore, autonomous adaptation was highlighted as taking place in fourteen cases: Alentejo, Ílhavo and Vagos coast, Copenhagen, Dartmoor, Doñana, Ijsselmeer, Jena, Kalundborg, Leeds, Prague, Rotterdam, South Moravia, Usti, and Venice. See Appendix 3 for further information on the background and context of the case studies.

5 Analysis: Drivers of and barriers to climate change adaptation

5.1 Ranking of Key Factors

Case study holders were asked to rank the eight factor categories that affect climate change adaptation by their importance. The average ranking of factors across all case studies is highest for actor-related aspects, followed by resources, knowledge and institutional context (Figure 2).

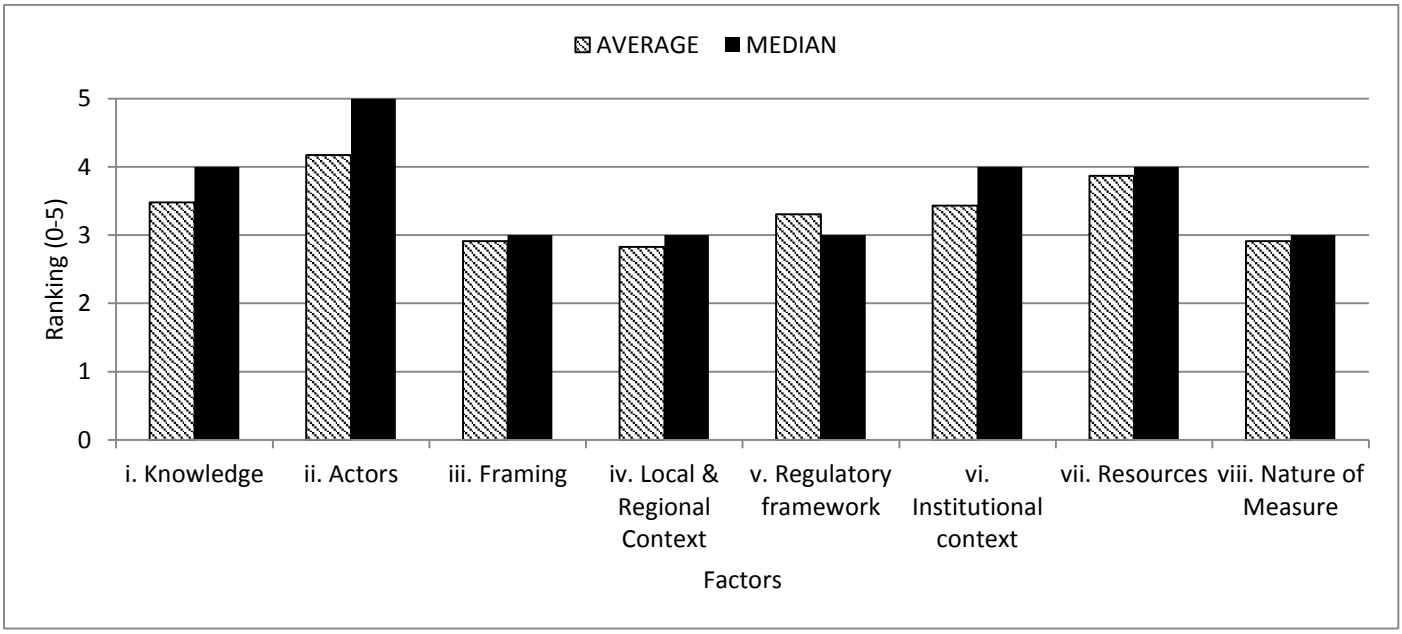

Figure 2. Average and median rank values of factors affecting climate change adaptation at all case studies.

The most important factors across case study main sectors are actors, knowledge on climate change adaptation, and resources (Figure 3). More specifically, for agriculture case studies the most important factors are knowledge, actors, and resources; for city case studies it is actors, knowledge and institutional context; for coastal case studies it is actors, resources and institutional context; for biodiversity case studies it is actors, resources and regulatory framework; for health cases it is knowledge and resources; and for water resources case studies it is knowledge and regulatory framework. Framing of adaptation, local and regional context, and the nature of the measure were never top-ranked by the cases. Specifically, the least important for agriculture is framing, for cities its nature of measure, for coastal and biodiversity its knowledge, for health it's framing of adaptation and local and regional context, and for water resources it's equally framing, resources and nature of measure. Both the agriculture and the city cluster have the most balanced spread of mid-value factor rankings, indicating a similar importance across factors. While the other four clusters evidence a more disparate distribution of factor rankings, with actors, resources and the regulatory framework proving to be key to these case studies. See appendix 4 for a similar graph considering all sectors relevant to each case study.

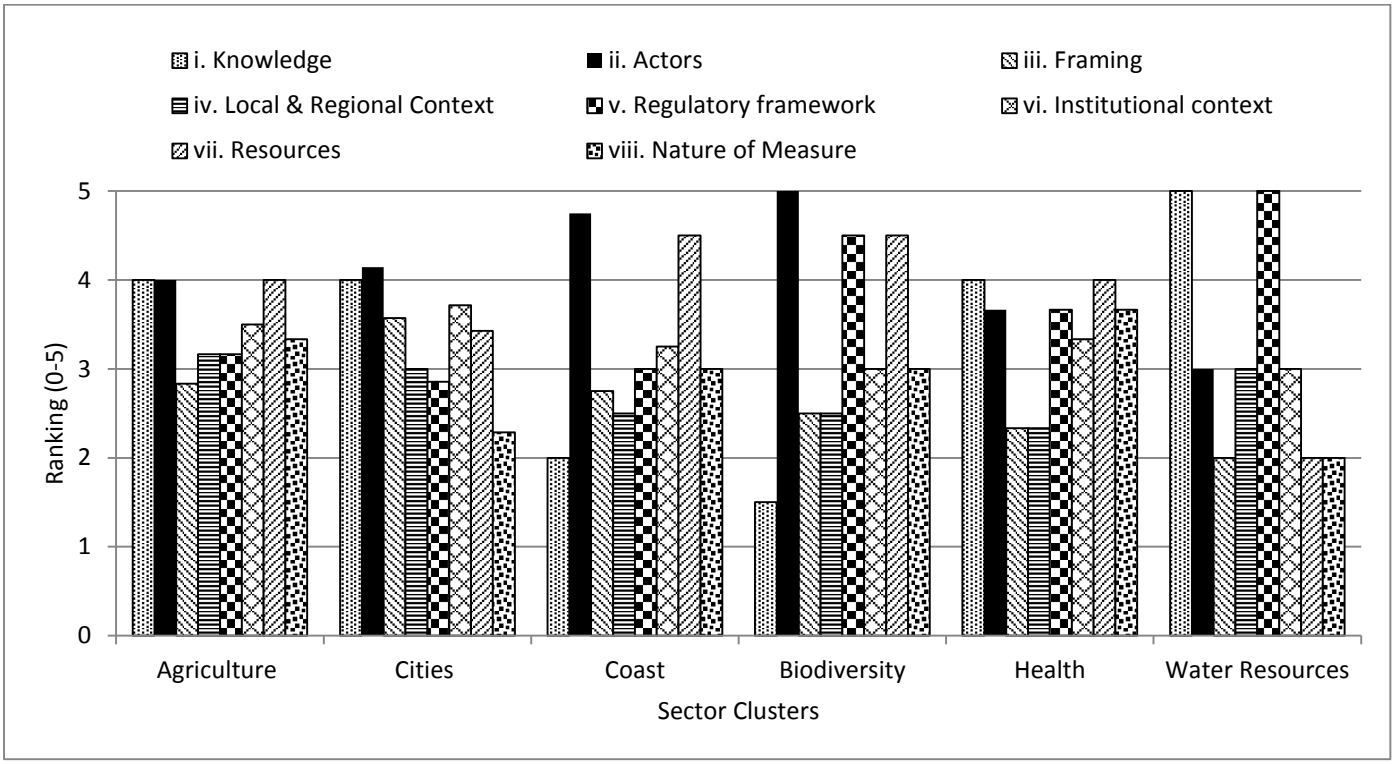

Figure 3. Average rank values of factors affecting climate change adaptation for each main sector cluster for each case study.

The most important factor(s) for case studies studying flooding are actors, resources, and knowledge; for sea level rise case studies they are actors, resources and local-regional context; for drought case studies they are actors, resources, knowledge and institutional context; for extreme weather event case studies they are resources, regulatory framework and institutional context; for heat stress case studies they are actors, knowledge (probably due to less information available on this impact), institutional context and resources; for water scarcity cases they are institutional context, actors, knowledge, regulatory framework and resources; for erosion they are actors, resources and regulatory framework; and for UV cases it is resources, regulatory framework and nature of measure (Figure 4). As above, framing of adaptation was never top-ranked by the cases, and the local and regional context and the nature of the measure were only mentioned once. Specifically, the least important for flooding, extreme weather events, heat stress, and water scarcity is local-regional context, for sea level rise it's nature of measure, for drought it's framing, for erosion it's knowledge and for UV it's equally framing and local-regional context.

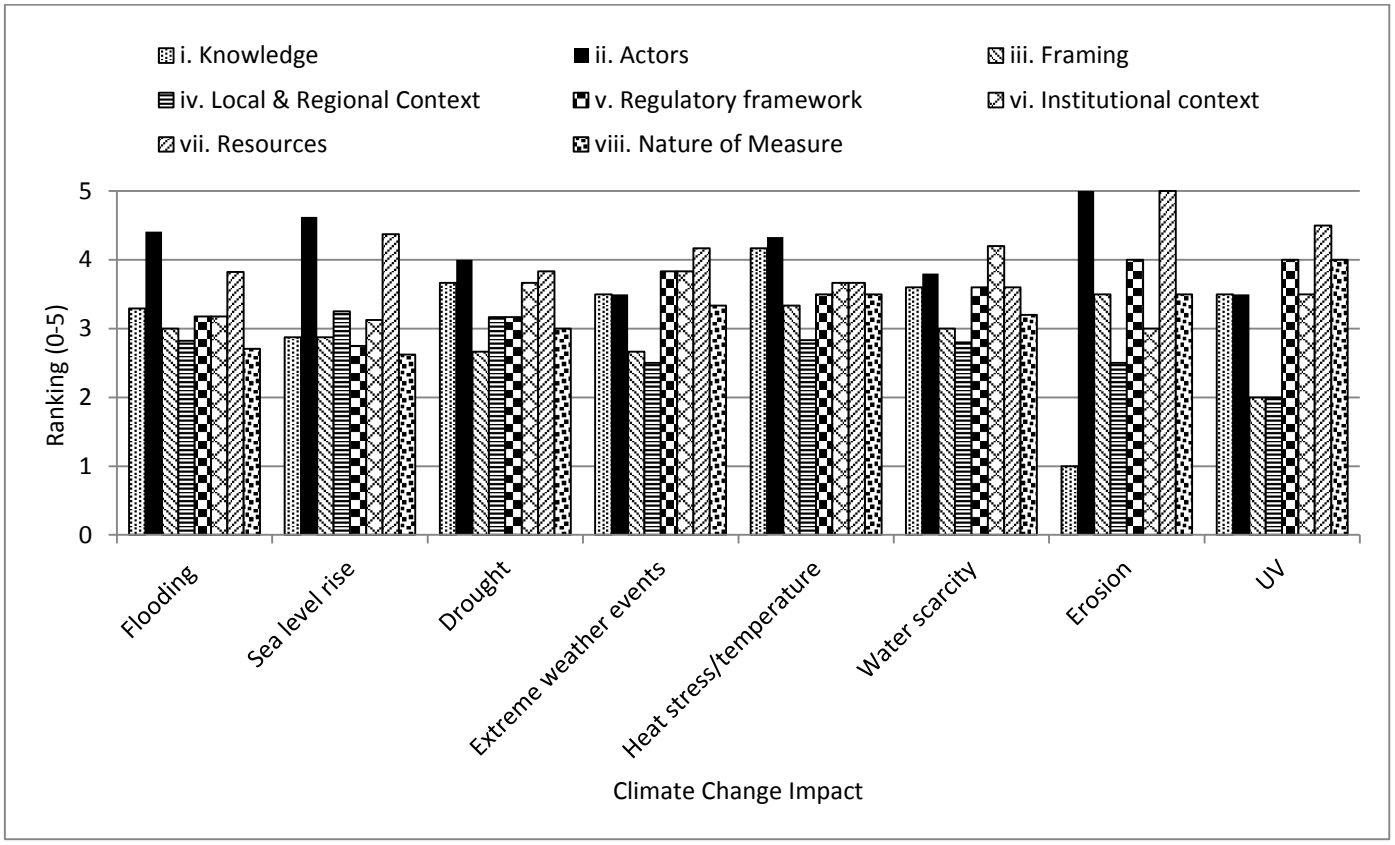

Figure 4. Average rank values of factors affecting climate change adaptation according to the climate change impact addressed by each case study.

5.2 Barriers to climate change adaptation

a) Barriers to climate change adaptation by cluster

City Cluster

The City cluster includes seven case studies: Cascais, Copenhagen, Jena, Leeds, Prague, Rotterdam and Venice. Most of these case studies mentioned barriers in the areas of knowledge, actor-related aspects and institutional context, but these cases include a varied, complex array of barriers. Knowledge barriers existed on adaptation measures available and their effectiveness (5 instances), followed by lack of information on adaptation costs, benefits and co-benefits (3), climate change (2), climate change impacts (2), water or weather system (2), climate change adaptation (1) and climate in general (1). This lack of or limited knowledge was ascribed to the local authorities (i.e. municipality) and citizens.

Actor-related barriers are quite widespread in nature and involve an array of actors. Unaware or non-sustainable views and ways of thinking (3 instances), conflicts within and between institutions (3), lack of interest of households and limited interest of businesses (2), low willingness of stakeholders to engage and participate (2), climate change scepticism by stakeholders and politicians (2), strong misperceptions of the

effectiveness or benefits of adaptation measures (2), insurance companies and other key actors don't feel accountable for their actions (2), and other one-off barriers.

Institutional context barriers mainly related to governance issues (9) including the lack of structure to accommodate adaptation, changes in the institutional structure that impacted on adaptation actions, rigid hierarchical system, and priority given to other issues, e.g. economic growth, above adaptation. Other institutional barriers include the lack of or inefficient internal and external communication among stakeholders (3), short-term planning (2), lack of definition of financial and implementation roles (2) and other one-off barriers. Only two case studies mentioned regulatory framework barriers, Leeds highlighted the absence of regulation of green infrastructure measures at all levels and Prague found the multiple regulations for building in the historic city as a barrier to adaptation.

A lack of or limited funding is a commonly mentioned resource barrier as well as the challenges in accessing the funding, e.g. providing sufficient evidence (8 instances). Another important resource barrier is a lack of or limited (trained/experienced) personnel in local authorities. The nature of adaptation measures can also be a barrier, mainly due to potential negative side effects (4), such as property right conflicts or safety, and requirements of the measure (4), such as space or data. Local context barriers were few, including moderate climate change impacts (compared to other cities), city spatial demands and layout, and valuable historic buildings. Framing of adaptation was mentioned as a barrier by Jena, as the strong engagement of the urban planners for developing a local adaptation strategy made it appear to be primarily an urban planning issue, which might have discouraged some stakeholders and decision makers from other policy fields to also make adaptation one of their top priorities.[1]

Agriculture Cluster

The Agriculture cluster includes six case studies: Alentejo, Doñana, Holstebro, Ijsselmeer, Kalajoki, South Moravia and Usti. Most of these case studies mentioned barriers in the areas of knowledge, actor-related aspects and regulatory framework. Farmers encounter different knowledge barriers regarding the effectiveness of adaptation measures and their implementation (5 instances), followed by lack of information on adaptation costs and benefits (2), and climate change impacts (1). Actor-related barriers include interest issues (2 instances), including contradictory interests across authorities at different levels and limited interest in adaptation by politicians and citizens. Other barriers include farmers' perceiving negative side effects from implementing adaptation measures (2), conflict of interests between water users (1), and farmer's non-willingness to participate due to existing problems (1).

Regulatory framework barriers relate to national and EU legislation that present too many requirements for or impede adaptation (4 cases). The two Czech cases highlighted too many requirements of the national agricultural policy linked to integrated production and the agri-environment schemes. Similarly, adaptation measures at the Alentejo case study were taken forward illegally and had to pay fines, due to rigid and demanding national regulations. The Alentejo case study also evidenced the inflexibility of the EU Common

[1] The are other cases described in literature, where strong individual leadership had a negative impact on the development of mutual ownership among administrative entities (see e.g. Storbjörk, Hedrén 2011).

Agricultural Policy and Doñana mentioned how existing subsidies distort the local setting and hinder adaptation actions.

The institutional context barriers were quite varied across case studies. Both Alentejo and Holstebro found a lack of interest as a barrier, disparate interests of farmers, environmentalists and administration and low political interest at the local level, respectively. Other barriers include a (lengthy) bureaucracy associated with land management (Alentejo), disarticulated actor groups (e.g. downstream and upstream) and between local-regional-national levels of governance (Donana), and a lack of prioritisation of adaptation at the local level (Holstebro).

Resource barriers were mainly financial, with three instances of a lack of or limited funding for adaptation, and one instance of time constraints that have hindered dialogue between stakeholders. The nature of the adaptation measure(s) was also a barrier in some cases, with three instances of perceived negative side effects (e.g. safety, loss of local identity) and an instance of challenging requirements.

Coast Cluster

The Coast cluster includes four case studies: Ílhavo and Vagos coast, Kalundborg, South Devon and Timmendorfer Strand. Most of these case studies mentioned barriers in the areas of actor-related aspects, institutional context and resources. Actor-related barriers include two instances of scepticism, by politicians (Ílhavo and Vagos coast) and by tourism-relevant stakeholders (Timmendorfer Strand). The Ílhavo and Vagos coast case study also found stakeholders' distrust and disappointment with the authorities due to past experiences (of inaction), which generates a frustrated and blaming attitude. A key barrier in the South Devon case study is a lack of leadership to take adaptation action

Health Cluster

The Health cluster includes three case studies: Cornwall, Madrid, and England. All case studies mentioned the lack of funding as a barrier. Particularly, the Cornwall case study suffered reduced funding due to the move of public health responsibilities from the National Health System (NHS) to the local councils, and the England case study highlighted the inflexibility of funding available in the health system.

Biodiversity Cluster

The Biodiversity cluster includes two case studies: Dartmoor and Green Roof. Both case studies mentioned barriers in the areas of actor-related aspects and resources. Regarding actor-related aspects at Dartmoor, initiators of the Bog project communicated insufficiently in advance with the local farmers (showing lack of sensitivity, arrogance) and, hence, protests developed. At Green Roof there was a lack of interest by political representatives (also an institutional context barrier) and by the population at large, as well as conflict among stakeholder groups, probably due to ambiguous climate change projections (a knowledge barrier). Dartmoor highlighted a lack of funding to implement the park's climate change adaptation strategy and Green roof

mentioned limited resources for all environmental issues. Dartmoor found that the nature of two adaptation measures being considered was a barrier, as they were perceived to have potential negative side effects. The initiators of the DFF project (i.e. the commoners) at Dartmoor had some difficulties negotiating their proposal into the existing agri-environmental policy, as it proved to be a regulatory framework barrier, and it is uncertain whether it will continue to be financed under the new 2016 agri-environmental policy.

b) Barriers to climate change adaptation by temporal stage

The results of an analysis of case studies per stage of adaptation reveal that barriers are quite varied through time. However, there seems to be a trend showing that as case studies advance in adaptation, they are less likely to find the regulatory framework to be a barrier and more likely to find the institutional setting to be a barrier. This result is important as it seems to indicate a lag between the uptake of new regulations for adaptation and their integration into institutional procedures, values and beliefs.

5.3 Drivers of climate change adaptation

a) Drivers to climate change adaptation by cluster

City Cluster

Most of the seven city case studies mentioned drivers in the areas of actor-related aspects and local-regional context. Six referred to actor-related aspects that ranged from key driving actors to leadership and attitudes. In Cascais the municipality took the lead in some iconic measures (e.g. the Dunes natural protection in Guincho) and supported others in implementing adaptation measures. There is a strongly committed, active, knowledgeable person at the municipality who is a key promoter of the adaptation agenda. In Copenhagen the municipality drives adaptation through its strategic approach to climate adaptation including participation. In Jena the personal commitment of the administrative head of the Department of Urban Development and City Planning (DUDCP), who by professional background and personal experience was sensitised to climate change-related risks, was an important driver of the strategic adaptation efforts. Scientists, as part of the local interdepartmental climate change adaptation working group, support the adaptation efforts of the municipality by disseminating relevant up-to-date knowledge. Within the DUDCP an adaptation handbook as well as various decision-support tools, facilitate the mainstreaming of adaptation into urban planning. A pioneering spirit of the city officials and the population for discussing early on new topics as well as the incorporation of adaptation into professional training of some relevant stakeholder groups (e.g. foresters, farmers) are other drivers mentioned. Actor-related drivers at Leeds include the past leadership by DEFRA's adaptation people and some community flood groups that are temporarily active in tackling flood issues. In Rotterdam for the implementation of adaptation measures the municipality of Rotterdam and the water boards are both responsible and the main driving actors. In Venice, adaptation has been carried out primarily by private individual actors, i.e. households and businesses.

The local-regional context was mentioned as a driving force in six of the seven case studies. In Jena past extreme weather-related events (i.e. heat stress and floods due to specific geographic location), future

projected climate change impacts, the important role of the academic sector and links between academia and city administration, all promoted adaptation. In Rotterdam the long history of flooding compounded with the urban planning challenges of being one of the top ten largest ports in the world (maintaining attractiveness of port for economic activities, managing a high cultural urban diversity, and need to redevelop old urban and port areas) have been key drivers to adaptation. In Prague the main driver of the implementation process was the past occurrence of destructive flood events and the increasing risk in the city (cultural and historical context) and also across the whole country. In Venice, periodic flooding in the historic centre and the islands of the lagoons (e.g. *Acqua Alta* flood of the 4th of November 1966) is slowly leading to work on adaptation. In Leeds it is generally agreed that the main driver of flood risk adaptation is flooding events and their associated damages. Cascais is a comparatively rich municipality with several assets that positively reinforce adaptation.

The regulatory framework at different governance levels is important for driving adaptation at four case studies. In Rotterdam the local, national and EU regulations are relevant. The EU Water Framework Directive prompted the new national memorandum for water and under the Dutch water law (Waterwet) provinces are obliged to include adaptation measures into their spatial plans (structuurplannen), which provide a more integrated spatial vision and future oriented perspective. Also, the involvement of mayors and municipalities in the 'bestuurlijke tafels' within the Deltaprogramme RIjnmond-Drechtsteden led to streamlining sustainability and adaptation plans of municipalities with the strategies and measures proposed in the Deltaprogramme (i.e. Rotterdam municipal adaptation strategy). In Jena only national and local regulations proved to be drivers. The adoption of the local climate change adaptation strategy as an informal urban planning principle by the City Council was a pivotal pre-requisite for the consideration of adaptation aspects in urban planning routines. Also, the amendment of the national building code strengthened climate change adaptation in urban planning. In Copenhagen the mandatory reporting required by the national government of all local governments to submit a climate adaptation plan was a driver. Adaptation at Leeds is being driven by the national policy approach requiring a cost-benefit analysis for all projects, including flood risk spending, and more specifically, by the penalties to the water industry for internal flooding, this has encouraged long-term planning.

Certain aspects of the institutional context have been seen to drive adaptation at three case studies. In Copenhagen the re-organisation of the Technical and Environmental Administration into cross-area centres, changes in waste water treatment responsibilities between the public authorities and private companies, adjustments to the local government organisation, training of local government employees in adaptive knowledge and actions for the assistance of citizens, and development of a range of different governance measures to manage climate change impacts by City of Copenhagen and their integration into city planning, are all driving adaptation. In Jena a local interdepartmental working group is steering adaptation-related activities. Professional trainings of administrative staff partially led to a change in personal attitude towards climate change issues. In Leeds DEFRA requires that all city councils report on adaptation practices every 4 - 5 years.

The Jena and Leeds case studies mentioned several types of knowledge from different sources as drivers to adaptation. At Jena the development of the local adaptation strategy JenKAS was driven by local climate change impacts knowledge produced in the context of a 6-months preparatory project and through knowledge

exchange with other pilot cities under a national research programme. The implementation of JenKAS was driven in part by this preparatory work and further knowledge exchange with scientists in the context of various adaptation-related research projects. At Leeds knowledge has come from evidence-based research, predominantly funded by DEFRA, on natural measures to reduce flood risk, from pioneering projects which use innovative ways of flood management, from spatial studies carried out on catchment-level flooding, and from sharing across sectors including the authorities and the third sector. Adaptation has also been driven by being framed as specific sector actions and initiatives in four cases. At Leeds and Rotterdam it is being promoted as flood risk management. In Jena it is being framed as urban planning, and in Venice it is a combination of ex-post justification as adaptation and disaster risk reduction.

The availability of funding for adaptation was mentioned as a driver at four case studies. In Copenhagen it was public and private funding from clean technology development projects. In Prague there was access to funds at municipal, national and European level (European structural funds). Venice counted on financial resources from public subsidies for building renovation for private households. The development of JenKAS in Jena accessed financial resources through the participation in a national research programme and the implementation of JenKAS through local public budgets and external funds acquired through cooperation with scientists. Jena is the only case study mentioning personnel resources as driving adaptation, that is, access to personnel and (scientific) networks through participation in a national research programme, and two staff members of the DUDCP, who spend 20% of their working time supporting the implementation of JenKAS. Finally, at Cascais the nature of certain adaptation measures (i.e. green and soft) was a driver due to being easier, quicker and cheaper to implement, and can be led by NGOs.

Agriculture Cluster

The six Agriculture case studies mentioned mainly drivers in the areas of actor-related aspects, framing of adaptation and local-regional context. Some actors were key drivers, at South Moravia and Doñana adaptation measures are mainly farmers' initiative (bottom-up) and they are quite active/ organised. At Alentejo the adaptation process was driven by the leadership of the community (civil disobedience & illegal grassroots action) and an expert's ability to convey to the (already interested) community the benefits of the measure. Kalajoki was also driven by experts from the regional water management authorities (ELY-centre) and the flood risk management group (i.e. regional authorities, related municipalities and the regional emergency services). In Holstebro the network that developed the idea for the ‘the farmer as water manager’ project grew out of the EU-interreg-funded project Acquarius. At Ijsselmeer, and beyond in The Netherlands, the Delta Programme was initiated by the Dutch Parliament.

The framing of adaptation is a driver, which is linked to the local-regional context (see below). For Doñana, South Moravia and Usti drought management is the main framing for adaptation. At Holstebro and Kalajoki it is flood risk management and for Alentejo its sustainable agriculture. Regarding the local-regional context, the Alentejo, South Moravia and Usti case studies mention the current dry and drought-prone weather (and its associated water scarcity) as a driver for adaptation actions. Holstebro has experienced several significant flooding events (past extreme weather event) and might experience such events in the future, too, which has contributed to adaptation. Similarly, the identification of Kalajoki as a significant flood risk area has also

prompted actions. In contrast, it is the ecological value (i.e. migratory birds from Africa) at Doñana that is a driver for environmentalists (WWF, local NGOs, some citizens) to indirectly push adaptation.

The access to and generation of specific knowledge was also an important driver to adaptation in the agriculture sector. At Alentejo an expert consultant knowledgeable on the adaptation measures was key for the adoption of Water Retention Landscapes. At Doñana knowledge generated by BASE researchers on potential new measures, including management measures such as water re-allocation from industry and policy measures such as decreasing rice plantation area, have been useful. At Kalajoki the elaboration of detailed flood risk maps for the area and BASE research have both contributed to develop knowledge relevant to adaptation. At Holstebro, historical data and the criteria in Directive 2007/60/EC highlighted it as an area, which might experience climate change-related extreme weather events in the future.

Regarding the regulatory framework, three case studies mentioned different non-climatic EU policies as drivers of adaptation. In Alentejo the Common Agricultural Policy (CAP) offers subsidies for irrigation lakes (adapting to future water scarcity), in Holstebro the municipality's climate adaptation plan was developed partly in response to the EU Floods Directive, and in Kalajoki the implementation of the Floods Directive and the Water Framework Directive are the main drivers (integrating adaptation into River Basin Management Plans for the European Commission). At the national level, in Ijsselmeer the Delta Programme generated a management contract driving the local authorities to implement the strategy and in Kalajoki the National Adaptation Strategy has been taken into national land use guidelines. At the local level, in Holstebro an agreement between Local Government Denmark and the Danish Government, all Danish municipalities were obliged to develop local climate adaptation plans and in Ijsselmeer there is a drive to implement a flexible water level strategy.

The institutional context was mentioned as a driver in two cases. At Doñana the Guadiana Hydrographic Confederation that regulates all the catchment (regionally) and at Holstebro the network cooperation of the Knowledge Centre for Agriculture (now SEGES), municipalities in selected areas of Jutland and agricultural organizations (generators of the 'farmer as water manager' project) drives adaptation. The nature of the adaptation measure(s) has been a driver in two cases. At Alentejo the measures are no-regret with positive side effects and at Kalajoki they are flexible and require small investments. The Holstebro case study found that funding available from a Danish government program, The Green Development and Demonstration Program has driven adaptation.

Coast Cluster

The four Coast case studies mainly mentioned drivers in the areas of actor-related aspects, framing of adaptation and local-regional context. Actor-related drivers include the BASE participatory research demonstrated to local practitioners that a more collaborative and participatory decision-making process supports the development of a common action-plan for the future. Three aspects of the local-regional context of the Ílhavo and Vagos coast case study drove adaptation. First, past extreme weather events, particularly damages by winter storms in 2014, which prompted the Portuguese Minister of the Environment, Spatial Planning and Energy to form an adaptation measures assessment group. Second, there is a need to protect

the dunes and stop beach erosion to maintain a sandy beach for tourism activities. Third, there is a strong attachment and value for the conservation of the coast's natural beauty. There are a number of future disaster risk concerns in the Kalundborg municipality, which drive adaptation. The Timmendorfer Strand community is a well-established touristic destination for beach tourism at the Baltic Sea with high value infrastructure (economic context), which stimulates adaptation actions. Furthermore, framing of adaptation as coastal erosion management (Ílhavo and Vagos coast) or flood risk management (Timmendorfer Strand), as well as dealing with a single extreme weather event (South Devon) have also been reported as adaptation drivers.

Two case studies mentioned participatory processes (institutional context) and either the national (The Action plan for a climate-proof Denmark led to the Kalundborg adaptation policy) or the federal state-level regulatory framework (Framework for coastal defense at the state level - Timmendorfer Strand) as drivers. At the Ílhavo and Vagos coast case study the cost-benefit analysis of different adaptation measures carried out in the BASE project was a knowledge-related driver. Adaptation action at Timmendorfer Strand was driven by municipal, state and EU cohesion policy funding.

Health Cluster

The three Health cluster mentioned actor-related aspect drivers. At the Cornwall case study the only drivers reported were research carried out by the University Exeter Medical School as well as its close links with the local council. The England case study highlighted three drivers: the role of the National Health Service (NHS) Sustainable Development Unit (SDU), which has been pushing the consideration of climate change in Joint Strategic Needs Assessments, the National Institute for Health Research funded a Health Protection Research Unit (HPRU) on Environmental Change and Health bringing together key actors (actor-related), and the national concern for sustainability (framing of adaptation). The Madrid case study mentioned several drivers for heat stress adaptation, including the drive created by past heatwaves (local-regional context) and highlighting key actors. Furthermore, the knowledge on heat stress generated by the *Instituto de Salud Carlos III*, the impacts of climate change and the framing of adaptation actions as health concerns (i.e. heat warning system) have been drivers. The Community of Madrid (metropolitan authority) and Madrid City Council have been committed leaders, and there is a high level of multiscalar institutional engagement (institutional context). Regarding the regulatory framework, the local "*Program of Vigilance on Environmental Risks with Health Effects*" required the elaboration of both a "*Plan for Heatwave Warnings*" and an "*Alert and Prevention Plan for the Effects of Heatwaves on Health*".

Biodiversity Cluster

The two Biodiversity cluster case studies mentioned drivers in the areas of framing of adaptation, actor-related aspects and regulatory framework. Both case studies mentioned the framing of adaptation as nature conservation management. Dartmoor also mentioned that adaptation is also framing as framed as sustainable agriculture and at Green Roof adaptation was framed as disaster risk reduction. Both projects carried out in the Dartmoor case were bottom-up initiatives by farmers and other local stakeholders. Regarding the regulatory framework, Dartmoor mentions how the English National Park Authorities and its national policy programme for National Parks, in turn stimulated by the UK Climate Change Act 2008, probably drove the elaboration of the park's Climate Change Adaptation Strategy (CCAS). At Green Roof the

adaptation process (nationally) was mainly driven by the European Adaptation Strategy and the need to comply with it.

b) *Drivers to climate change adaptation by temporal stage*

The results of an analysis of case studies per stage of adaptation reveal that drivers are quite varied through time. However, there seems to be a trend showing that as case studies advance in adaptation, they are less likely to be driven by the framing of climate change of adaptation and (slightly) more likely to driven by the institutional context, the nature of the adaptation measure, actor-related aspects, and availability of resources. This result is important as it indicates that as case studies progress they no longer are driven under the heading of another sector (e.g. flood risk management, conservation, or sustainable agriculture) but specifically as adaptation. The findings also highlight that as adaptation advances, case studies are driven by a wide arrange of factors as enabling conditions develop.

c) *Regulatory Framework Driving Adaptation*

Table 1 presents a summary of all the European, national and local policies that have been mentioned as drivers of adaptation at the case studies. The European Union (EU) climate change adaptation legislation is only mentioned once, but other sectorial EU policies are referred to. Despite all case studies being located in countries with a national adaptation strategy, only 3 cases mention this policy as driving adaptation. At the national and local level several climate and non-climatic policies are highlighted. Interestingly, the most mentioned driving policies (8 cases) were local non-climatic ones. All case studies identified at least one driving policy except for the Prague, South Devon, Usti, and Venice cases.

Table 1. European, national and local policies mentioned as drivers of adaptation in the case studies.

EU Policy	**Case Studies**
Agri-environmental schemes	Dartmoor, South Moravia
Common Agricultural Policy (CAP)	Alentejo, Doñana
Flood Directive	Holstebro, Kalajoki
Water Framework Directive	Doñana, Kalajoki, Rotterdam
Cohesion Policy	Timmendorfer Strand
Climate Change Adaptation Strategy	Green Roof
National Policy	**Case Studies**
National Adaptation Strategy	Copenhagen, Kalajoki, England
Other national climate law/strategy	Dartmoor, Kalundborg
Other non-climate law/strategy	Dartmoor, Ijsselmeer, Jena, Leeds, Rotterdam
Local Policy	**Case Studies**
Local Adaptation Plan/Strategy	Copenhagen, Holstebro, Jena, Kalundborg, Rotterdam
Other climate plans/strategies	Copenhagen, Doñana, Rotterdam
Non-climate plans/strategies	Ílhavo and Vagos coast, Cascais, Cornwall, Ijsselmeer, Kalajoki, Madrid, Rotterdam, Timmendorfer Strand

5.4 Success Stories: Barriers Overcome

Fourteen case studies mentioned one to eleven barriers each that have been overcome and these were mainly in stages 3-5 of adaptation development. A total of 45 barriers were overcome in the following categories: actor-related aspects (17 barriers); knowledge on climate change and adaptation (12); institutional context (7); resources (7) and regulatory framework (2). Barriers were overcome by one to four solutions out of 14 types, the most frequently mentioned include participatory approaches or stakeholder engagement/involvement (14 instances); learning from pilot projects, government schemes, studies and BASE research (10); institutional changes or re-arrangements (9); and networks or cooperations (5). See Appendix 5 for details on barriers overcome at the case studies.

Although there is no correlation between type of barrier and type of solution, there are some patterns arising from the data overall. Lack of knowledge or uncertainty on climate change and adaptation was overcome by learning from pilot projects, government schemes, studies or BASE research 7 out of 12 times. Implementing participatory approaches or engagement/involvement of actors was the solution to overcoming reactive stakeholders or with little interest 3 out of 6 times; overcoming conflicts, resistance or opposition by stakeholders 4 out of 9 times; and scepticism 2 out of 5 times. The lack of funding was overcome by the formation of networks or cooperations 3 out of 8 times.

A look at case studies by cluster doesn't show any patterns for biodiversity (1 case study) or agriculture (4 cases) but there are some findings for the city (6 cases) and coast (3 cases) clusters. Four city cases (for a total of 7 barriers) had barriers overcome on lack of knowledge or uncertainty on climate change adaptation. Three cases (6 barriers) overcame funding issues, and three cases (4 barriers) overcame disinterest or scepticism, and conflict, respectively. City cases always overcame conflict barriers via participation processes or institutional changes, and four cases solved different barriers by collaborations or networks. Of the coast cases, two cases overcame barriers on scepticism, lack of information, and conflict, respectively. All three coast cases solved at least one barrier through participatory processes.

Case studies in early stages of adaptation (stages 1 – 3) didn't show any evidence of patterns in overcoming barriers. However, out of four stage 4 cases, which were mainly coastal cases, three of them overcame a total of 7 barriers through participatory processes. Out of six stage 5 cases, which were mainly city cases, five overcame a total of eight barriers on lack of knowledge or uncertainty and three overcame a total of four barriers on conflict or opposition. Four cases solved different barriers through collaborations, and three by the action of key actors. Three cases overcame barriers on disinterest or conflict through participation, and three overcame lack of knowledge or uncertainty by means of projects or studies. Although there are no clear cut patterns, data shows potential emerging trends, as well as the most frequent solutions to barriers.

Nine case studies didn't report any barriers, which have been overcome during the BASE project research: the two Spanish cases (Doñana and Madrid), three UK cases (Cornwall, South Devon, and England) and the four Czech cases (Green Roof, Prague, South Moravia, and Usti). All of these nine case studies are at the early stages, 1 or 2, of adaptation development (except Prague), which might explain the lack of barriers overcome so far.

6 Future Prospects and key messages from the case studies

Case study holders were asked about the future prospects of climate change adaptation at their localities and the key messages of the BASE research. Just over half of the case studies mentioned both positive and negative future views (14 cases), while five expressed solely positive views and four negative views only. Those with negative views only (Cornwall, South Devon, England, and Venice) are all at early stages of adaptation development and those with solely positive views (Cascais, Copenhagen, Ijsselmeer, Jena, Rotterdam) are more advanced in their adaptation efforts. See Appendix 6 for the description of future adaptation prospects for each case study. Following are the key messages on climate change adaptation implementation from each case study.

6.1 City Cluster

Cascais:

- Personal relationships matter.
- Stakeholder engagement is crucial for adaptation.
- Communication is key for an efficient and effective allocation of resources.
- Going from an analysis of needs to an asset-based development enables creative processes with new links, perspectives and shared sense of responsibility.
- Stable and real political support at all levels is a crucial factor for implementation.

Copenhagen:

- Aspects promoting adaptation include building capacity, leadership, timely action, Climate Policy Initiative (CPI; consideration in urban development – a priority area; green growth strategy; co-benefits; urban spaces 'adaptive actions must enhance city and city space'); multi-actor; collaborative networks with local governments upstream; and using the platform for action created by weather events – but only possible due to existing governing capacity.
- Aspects hindering adaptation are branding overshadows real effects – publicity may hamper innovative solutions with uncertain outcomes; funding difficulties when involving private businesses (the private water company that manages the sewage system); to maintain public and political attention and support when time has passed since implementing costly events; to centre on have experimental planning and institutional learning makes the strategy vulnerable – if the 'experiments' fail, support may decrease; and institutional learning is an ongoing process

Jena:

- Potential conflicts of adaption and mitigation efforts can be solved or at least mitigated by explicitly addressing these issues at an early stage of strategy and project development and searching for synergic solutions.
- The exchange between representatives of different administrative bodies and scientists should be institutionalised and take place on a regular basis to promote knowledge transfer.
- Outreach activities do not only raise awareness but also ensure the support of the general public.

- The momentum created by the initial adoption of a local adaptation strategy can be maintained through projects that continuously update and expand the existing knowledge base.
- In-house trainings are essential to improve the ability of the municipal staff to use data and tools available for supporting adaptation. But although making information digitally available offers many advantages, e.g. more detailed explanation, options for customising or updating information, the provision of information should be adapted to the existing routines. In Jena primarily very young professionals used the decision support software whereas most of the planners preferred to use the hard copy of the handbook.
- The public commitment of political decision-makers to support local adaptation activities is pivotal, e.g., the adoption of an adaptation strategy by the city council.
- Due to high initial costs financial support is needed (especially by small municipalities) to kick-off adaptation activities.
- External appreciation of local adaptation activities fosters “internal” recognition by administrative and political decision-makers
- Any climate change related activity, e.g. COPs, best practice examples in public media etc., helps making climate change mitigation and adaptation a mainstream topic, which in turn support local climate change-related initiatives.

Leeds:

- A combination of soft, grey and green measures (a holistic approach) is needed to achieve maximum flood risk reduction, as well as multiple other benefits, and efforts should not be limited to one approach.
- In addition, the ability to quantify the benefits of green adaptation measures has a substantial bearing on their cost effectiveness and is required by stakeholders.
- Most, if not all, flood adaptation actions (including community participation) have generated from actual flood events as a ‘reaction’ and this needs to change to a proactive focus instead.
- It has been found that although local efforts are vital, it is also crucial to count with the support and political will of the central government for regulations, funding, research, among others (for example for Sustainable Urban Drainage Systems - SuDS).
- Adaptation efforts are enhanced when key stakeholders come together to work on an initiative (better communication, knowledge sharing), which also leads to a greater internalisation of concepts and goals in the stakeholders’ organisations.
- The private sector (businesses and insurance companies) need to be actively involved in all aspects of flood risk adaptation (planning, funding, incentives, etc.).
- A case study can benefit substantially from other neighbouring innovative case studies (evidence based research) especially if they are transferable.
- New sources of funding, such as from businesses, need to be explored as government funding will always be scarce, and incentive schemes seem to work in the UK.

Prague:

- There needs to be a greater emphasis on the involvement of stakeholders and on non-structural adaptation measures.
- The ongoing adaptation process is focused more on grey infrastructure and does not consider alternative measures. Even though in the case of Prague an implementation of grey infrastructure including flood barriers was essential in order to effectively protect the city and based on the analysis proved to be a very efficient, there is still a window of opportunity to adopt green and blue measures, which are usually cheaper and versatile. These could supplement the existing and forthcoming grey infrastructure and improve the overall resilience of the city not only in terms of flood risk but also other phenomena connected with climate change.
- Regarding the planning and decision making process, even though city officials declare that there are stakeholders involved, there is probably a problem rather with their selection than with their number. The group of stakeholders involved in the adaptation process comprised mostly members of various city hall departments. Stakeholders in terms of receivers of the protection measures were scantily represented. Besides that, there are also a plenty of opportunities how to involve citizens in the adaptation process, especially when it comes to adaptation of households and information dissemination.

Rotterdam:

- The importance of including simultaneously different government levels and stakeholders. This increased the validity of the current strategy and possibly also the implementation of the measures. The Rijnmond-Drechtsteden case shows that it is possible to bring together, and work together on strategizing for climate change adaptation, at least in the domain of water management. However, consensus about measures and their implementation demands collaboration of all stakeholders and groups in society. There is still some resistance due to the lack of innovation in the Rijnmond-Drechtsteden strategy, especially a highly visible group of engineers scrutinizes the necessity to close of the Rijnmond estuary although they are discarded by the Delta commissioner based on cost-benefit analysis of their proposed solutions. This could become pivotal in the further implementation of the strategy.
- The underestimated role of landscape, which was put on the agenda in the Rijnmond-Drechtsteden case. Consideration of the landscape is an essential part of creating policy for climate change adaptation. The attempts to include the quality of the living environment and search for creative solutions by means of design charrettes provide tools that could be used in other cases as well. As demonstrated in the Rijnmond Drechtsteden area, a landscape approach can strengthen the integration of different solutions and provide insight in the larger social costs and benefits of (in) action and is an explicit contribution of the Delta programmes activities in Rotterdam adaptation for both policy studies and practice.

Venice:

- The analysis of the economic performance of measures suggests that the prevention of physical damage is not the only rationale used for investment decisions in households; probably the psychological effect of being protected plays a major role that has not been quantified.

6.2 Agriculture Cluster

Alentejo:

- Implementing innovative solutions of climate change adaptation for the first time has to deal with a regulatory framework that does not incorporate the need to act different from usual. Despite the need to regulate and protect public space and the landscape privately funded innovative activities constitute an opportunity for learning and evaluation of climate adaptation efforts. Innovation should therefore not be penalised when its added value for research or local development is recognized. Furthermore, farmers mention that innovations that worked should be disseminated to other farmers and not only made available through companies the eventually sell them to farmers with products. Finally, innovation in adaptation should be rewarded/funded.
- Farmers that do not operate with tourism and education like the ecovillage of Tamera do not have the opportunity to obtain private funding and donors to finance their adaptation measures and innovation. Recognized solutions should be supported by public funding but also innovation is required in farming adaptation meaning that some degree of support for innovative farming solutions must dedicated from public funding.
- When prices are driven by supermarket chains, which source their supplies from the European or global market, adaptation can hardly be promoted since farmers cannot consider their full adaptation costs when calculating the prices they have to charge. This increases the need of public compensation to farmers and loss of public state income increasing the complexity of managing adaptation in the agriculture sector.
- Some farmers complained about impacts that they suffer from some legal forestry and agricultural practices that deploy the water and soil resources diminishing their adaptive capacity. They recommend that these large scale practices should require environmental impact assessments and/or are banned. For example, large regions of many km^2 of monocultures of eucalyptus intensively make use of the groundwater. On the other hand, to accompany the innovation and adaptation needs the regulatory framework should create mechanisms for regular update on environmental and societal needs and change.
- Farmers recommend that research must become more practical and applied in order to give support to farmers and adaptation in agriculture. They complaint that universities develop very theoretical studies and also that plenty of knowledge is already existing but it is not integrated and combined into innovation partnerships and on the ground applied action research.

Doñana:

- There are no perfect solutions with so many actors with contradictory views, it is a complex setting and a compromise needs to be reached to satisfy all sectors (particularly agriculture and environment).
- Profound participation of all relevant stakeholders is needed.
- All the actors and experts emphasized the important role that improved institutional governance could play and the need of encouraging the farmers' long-term views by climate change advisement and capacity building.

Holstebro:

- The farmer as water manager measure has a potential to be copied in the agricultural sector of other countries, because it is a way of using farmland for multiple functions and increases the flexibility of the land. However, for a voluntary measure like this, certain conditions need to be met. First and foremost the regulatory framework (vertically (EU-level, national level, local level) and horizontally (between different sectors)) must not put up obstacles for the measure. In particular, there are some obstacles in EU's Common Agricultural Policy, which probably need to be removed to make the farmers have the will to be water managers.
- Secondly, needless to say, financial resources are a prerequisite. If the farmers don't get a satisfactory compensation, there will be no adaptation measure. Finally, in the end, the success of the measure is dependent on the ability and will of the farmers (and will and ability are varying). Creating the right incentives (both financial and other types of incentives) is the be-all and end-all of this type of measure. In influencing the ability and will of the farmers to participate, bottom-up initiatives like the 'farmer as water manager network' might prove very important.

Ijsselmeer:

- Flexibility is allowed with regard to the water level in the lake, which is new. Flexibility enables the water authorities to anticipate high river discharges and droughts by reducing respectively increasing the water level. In the future this flexibility may even be extended, although there is still a lot of study required and clear rules. Key message is that since the Delta-Programme had a participatory design from the onset, people from the various organisations have come to know each other and gained understanding of the perspective and stakes of the others. Therefore, most parties were engaged with the process and contributed to the development of the adaptation strategy and felt ownership. The Delta Programme thus stimulated co-operation by providing the platform for inter-organisational communication.

Kalajoki:

- Policy integration is most effective if achieved at level of legislation and regulations. Policy integration is the key to successful implementation. Some policies have by virtue of their legal base direct relevance for local activities (in our case the legal acts concerning flood risks and the responsibilities for the consequences of floods). These will dominate activities and will determine concrete action in terms of resilience and adaptive capacity. If the National Adaptation Strategy (NAS) is successful in influencing these regulations it will fulfil its purposes. If the NAS tries to influence local activities directly, without a proper legal base, it is more likely to fail, because it lacks the relevant implementation mechanisms.
- Pay attention to policy coherence. If the "strong" policies at the local level give contradictory signals with respect to adaptation to climate change (concerning responsibilities, risk taking, standards for protection etc.) the awareness of the need for adaptation will develop slowly, even if the NAS itself would be "excellent". In our case, the national action plans were in line with set of possible measures considered in flood risk planning process.
- Utilize participatory process to improve implementation performance. Stakeholder participation is essential because implementation of adaptation measures in most cases is a direct concern or responsibility of the public and private stakeholders. A contingent evaluation study gives information about the attitudes and willingness to participate of the locals. If made visual interesting and informative, it can also improve awareness.

- Use modifications of multi-criteria decision analysis (MCDA) approach. Participatory processes need to be contextualised in such a way that local actors can relate to the question in a meaningful way. Multi-criteria approaches are useful in providing a platform for a discussion on multidimensional issues. The MCDA tools can be tailored to the local context including criteria considering relevant climate aspects.
- Find the reasonable level of uncertainty. Information about climate change, mitigation measures and their impacts and cost are essential to adaptive planning process. Using limited time and resources for detailed information or performing comprehensive cost-benefit analysis (CBA) in not always necessary to set up an adaption plan. In our case, the climate change information and calculations helped to consider options. Detailed CBA was not needed because after expert and stakeholder workshops there were not actual competing options left.

South Moravia:

- There is a need for broader political support to assist farmers with the implementation of suitable adaptation measures. Awareness raising and knowledge sharing is important at all levels.
- Agricultural practices are climate-dependent and yields vary over years depending on short-term weather patterns, farmers are to some extent used to these changes. But with the current and future expected impacts of climate change, the agricultural sector is particularly exposed to climatic change and increasing vulnerability, which needs to be taken into account.
- In the case of integrated vine production, new agro-envi-climate measures (AEKO) are currently in place, but these measures focus rather on sustainable pest management and marginally on land use management than on particular measures to increase water retention in the landscape that were identified by 93% of the respondents as the most important measures. Based on current trend, adaptation measures against drought, increasing landscape water retention are of major importance.

Usti:

- There is a need for broader political support to assist farmers with the implementation of suitable adaptation measures. Awareness raising and knowledge sharing is important at all levels.
- Agricultural practices are climate-dependent and yields vary over years depending on short-term weather patterns, farmers are to some extent used to these changes. But with the current and future expected impacts of climate change, the agricultural sector is particularly exposed to climatic change and increasing vulnerability.

6.3 Coast Cluster

Ílhavo and Vagos coast:

- In a context where various institutions are involved in decision-making and participation has not been embedded in local culture and policymaking practices, it is important to establish a forum for collective dialogue and decision-making by using participatory approaches. This forum should be informal and encourage consensus, dialogue and mutual understanding among the different stakeholders involved.
- Political actors and all those responsible for implementing the plan need to be involved from the beginning, but also all those who can substantiate the plan, both by providing local lay knowledge and expert knowledge. Choosing which actors should be involved is fundamental for implementation. In this case different stakeholder groups were important, but political actors were a must.

- Creating an action group that will be able to lead the adaptation process to its next stages is essential. This can only be achieved by a genuine engagement process.
- The participatory experiences should be well-facilitated and a rewarding experience for those involved. This can be attained by carefully choosing methods and conveying as much as possible baseline information on impacts and measures. The more stakeholders are prepared for the discussions, the better are the chances to reach consensus.
- It is also important to simplify complex decision through clear, easy to use yet, robust scientific tools such as the Adaptation Pathways.
- Methods and tools should be able to integrate different systems of knowledge – both scientific and local knowledge. If the final adaptation plan is something that all can agree too, and a determined action group is created, integrating policymakers and those responsible for implementation, then it is more likely that the project will progress.

Kalundborg:

- In the process of devising the local adaptation strategy, the Kalundborg municipality incorporated local knowledge, needs and suggestions into their short and long term adaptation planning. Not only did this provide them with valuable knowledge of where the adaptation needs were most pressing and other local comprehension, but it also enabled them to educate or inform the public about possible future consequences of climate change.
- The acknowledgement and incorporation of local views in Kalundborg, through the participatory processes, provided the city council with a mandate to make long-term planning (beyond 4-year political terms) and make some tough choices. However, none of this has manifested itself into action, yet.
- Participation and involvement is inherent and embedded in Danish municipal planning. Although open to local interpretation, the Danish democratic and associative tradition prescribes an anticipated involvement of affected citizens and stakeholders in planning and policy efforts. This is often the case with long-term planning involving a high degree of uncertainty or risk, as with climate adaptation. Since the regulatory system dictates that political processes are the primary focus of involvement, there are pitfalls for participation, concerning climate change adaptation planning. Climate change adaptation planning is often political, although, it may seem only technical in nature to those involved.

South Devon:

- Adaptive capacity may hugely depend on the institutional context. In a setting with privatised, decentralised and fragmented responsibilities and tasks, decision making and funding of adaptation may be very difficult (almost impossible). Climate change adaptation requires a long term collective perspective and willingness to anticipate uncertainties.

Timmendorfer Strand:

- Involve the key stakeholders from the very beginning: The mayor of the town was a key person. With his support for the project, it was possible to get other stakeholder involved in the discussion process.
- Understand the needs of the stakeholders: It is very important to understand the viewpoint of the different stakeholders and why they might not be willing to cooperate or not support the adaptation measure. In this case, the stakeholder had to be ‘convinced’ that a coastal defence measure is a reasonable investment.

- Have financial support: To implement the ‘extra’ measure (e.g. glazed retention wall and finishing and landscaping project) that ensured the support of the stakeholder, the financial back-up from the municipality had to be guaranteed. This is not always guaranteed but in Timmendorf it helped very much.
- Use results of damage cost analysis, CBAs as argument: Arguments based on costs and benefits helped to ‘convince’ the stakeholder. In the case of Timmendorfer Strand the results of a damage potential analysis showed that the values damaged by coastal flooding could be very high. This helped to raise awareness and was one important part in change the local stakeholders’ attitude towards coastal protection.
- Take your time: The whole process took over 10 years from its start to the implementation. It is important to have time for such a process. On the other hand, this long period also might become an obstacle when responsibilities change or the stakeholder and/or public lose interest in that topic.

6.4 Health Cluster

Cornwall:

- In Cornwall the benefits of public health interventions addressing skin cancer like prevention campaigns may significantly outweigh their costs. Furthermore, they are likely to be “no-regret” options – they would lead to benefits with or without climate change (and the benefits are likely increased still further in the case of climate change).
- Public health intervention campaigns may provide one measure to adapt to increased risk. The costs for public health intervention campaigns are not necessarily that high, but evidence on their effectiveness is limited.
- Barriers such as the limited financing of public health and human resource losses in terms of staff turnover may restrict effective adaptation.

Madrid:

- The increasing complexity of cities and the multiple spheres that play a role in urban areas make planning for adaptation to climate change a sophisticated challenge. Not only the high level of interconnection among urban elements make planning a tough task, but also the cross-sectorial nature of climate change impacts which result in adaptation options contemplating synergies and trade-offs in those different sectors. Thus, urban adaptation to climate change requires a high degree of knowledge and a high degree of consensus and common goals given the multiple interests that often meet in cities. Building strategies for urban climate adaptation requires achieving a comprehensive understanding of how the urban system works. This facilitates the identification of the most efficient and/or effective ways to achieve climate adaptation goals while implementing mitigation measures where negative impacts are foreseen.
- The implementation of green infrastructure strategies to adapt to climate change is a promising adaptation strategy as it would present several co-benefits. Green infrastructure consists of various elements such as trees, parks, green roofs, green wall, type of pavement, etc. and each of these is differs on its effectiveness with regard to heat stress reduction. We learnt that the effectiveness of the delivery of different services is subject to large uncertainty or even still unknown.

England:

- In terms of mental health in England, the results suggest that overall mental health may be positively impacted by changes in mean conditions. This may enable the reallocation of resources to other health conditions or to services targeted towards the mental health risks of extreme events (heatwaves or floods). However, this finding is based on a rather limited data set. The results are likely not transferable to different climatic zones – the variation in the dataset in terms of the temperature range considered is limited. The positive impacts of climate change should not be ignored in terms of adaptation – there may be need for action to fully realise such benefits.

6.5 Biodiversity Cluster

Dartmoor:

- Only assigning National Park Authorities to develop the CCA strategy is not enough. To enable implementation, it needs to be accompanied by allocating the necessary resources.
- In the Management Plan there may be measures, which address climate change, although they are listed under another heading. To monitor and evaluate progress in climate change adaptation, resources and a wider scope to identify measures are needed.
- For the Bog restoration project communication and deliberation are key factors. Although they may seem obvious, one can see that they are (still) not obviously applied in practice.
- In relation to the DFF project local bottom-up initiatives can work quite well. But when they depend on a national policy for their funding, and that policy changes, the initiative may be threatened.

Green Roof:

- A successful implementation of adaptation measures in case of low interest in this issue among the public and political representation requires awareness-raising and knowledge sharing on all governance levels. It is important to communicate with both local stakeholders and regional/national authorities and draw their attention to various environmental and socio-economic issues connected to climate change. In the context of the Czech Republic, it proved to be useful to relate the discussion with stakeholders and authorities to issues, which they perceived to be important (e.g. local conflicts linked to nature conservation, regional water management and flooding) and to elucidate their connection with climate change subsequently.

7 Conclusions

7.1 General

1. Overall, actor-related aspects, followed by resources, knowledge on climate change, and the institutional context were the highest ranked factors influencing climate change adaptation. These findings were consistent with the most important factors per cluster and per climate change impact.
2. Both the agriculture and the cities clusters have the most balanced spread of mid-value factor rankings, indicating a similar importance across factors. While the other four clusters evidence a more disparate distribution of factor ranking.
3. On the other hand, framing of climate change adaptation, local-regional context, and the nature of the measure were hardly ever top-ranked by cases overall, per sector or per impact.

7.2 Barriers

4. The City cluster exhibits one of the most varied and complex array of barriers to climate change adaptation, with knowledge – particularly on measures available and their effectiveness and their costs, benefits and co-benefits –, actor-related aspects and institutional context – mainly governance structure or change issues – as top-ranked factors.
5. The Agriculture cluster is characterised by knowledge – mainly for farmers regarding the effectiveness of measures and their implementation –, actor-related aspects and the regulatory framework – relating to national and EU legislation that present too many requirements for or impede adaptation – as top-ranked barrier factors.
6. The Coast cluster was marked by barriers in the areas of actor-related aspects, institutional context and resources; the Biodiversity cluster by actor-related aspects and resources; and the Health cluster by the lack of funding. However, these reduced findings are probably linked to the fewer number of case studies in these two clusters.
7. Barriers are quite varied through time, but there seems to be a trend showing that as cases move forward with adaptation, they are less likely to find the regulatory framework to be a barrier and more likely to find the institutional setting to be a barrier. This result is indicates a lag between the uptake of new regulations for adaptation and their integration into institutional procedures.

7.3 Drivers

8. Most city cases mentioned drivers in the areas of actor-related aspects – ranging from key actors to leadership and stakeholder attitudes – and the local-regional context – such as past weather events, projected climate change and economic assets.
9. The agriculture cases mentioned drivers mainly in the areas of actor-related aspects – key persons, institutions or networks, framing of adaptation – as flood risk or drought management, and conservation, and local-regional context.
10. The coastal cases mentioned drivers mainly in the areas of actor-related aspects, framing of adaptation and local-regional context.

11. The Health cluster mentioned actor-related aspects as the main drivers, probably linked to health adaptation being an area, which is not yet so well studied.
12. The two Biodiversity cluster case studies mentioned drivers in the areas of framing of adaptation – particularly as nature conservation management, actor-related aspects and regulatory framework.
13. Drivers are quite varied across time, but there seems to be a trend that as adaptation progresses, it is no longer driven under the heading of another sector or discourse but explicitly as adaptation. The findings also highlight that as adaptation advances, cases are driven by a wide range of factors as enabling conditions develop.
14. All policy levels (EU, national and local) were found to be drivers of climate change adaptation. However, EU adaptation legislation is only mentioned once, and many national and local level climate and non-climatic policies are highlighted, particular enabling policies are local non-climatic ones.

7.4 Overcoming Barriers

15. Overcoming barriers clearly only occurs in advanced cases of adaptation as all cases at early stages of the adaptation process didn't report overcoming any barriers.
16. Advanced cases mentioned instances in which barriers were overcome successfully, particularly with regard to actor-related aspects and knowledge on climate change adaptation. The most often mentioned solutions to the barriers were participatory approaches or stakeholder engagement/involvement; learning from pilot projects, government schemes, studies and BASE research, institutional changes or re-arrangements and networks/cooperations.
17. Participatory processes particularly, were found to have added value for overcoming common adaptation barriers. For example, all city cases reported that conflicts were overcome through participation processes or institutional changes.
18. Key solutions for overcoming barriers include learning from pilot projects, government schemes, studies or BASE research to overcome lack of knowledge or uncertainty on climate change; implementing participatory approaches or engagement/involvement of actors to overcome reactive or disinterested stakeholders, conflicts and scepticism; and forming networks/cooperations to overcome the lack of funding.
19. Options for overcoming barriers were evident in cases at latter stages of adaptation development. Stage 4 cases, which mainly belonged to the Coast cluster, mostly overcame barriers through participatory processes and stage 5 cases, which were mainly urban, overcame them through establishing collaborations, the commitment of key actors, participation, or learning from other projects.
20. Future climate change adaptation prospects of cases were linked to the stage of adaptation progress, with advanced cases reporting positive outlooks and cases in the early stages of adaptation having negative views.

8 Key Conclusions

1. In line with the deliverable aim, the BASE project was able to ascertain that economically attractive adaptation measures can be implemented, albeit subject to substantial barriers and driving factors.
2. In line with BASE objective 3, individual case studies showed that there are policy conflicts across EU, national and local levels; but also many national and local level climate and non-climatic policies interact synergistically to drive adaptation.
3. Barriers and drivers to climate adaptation vary widely across Europe, irrespective of sector and climate change impact, however the stage of adaptation advancement provides some indication into certain trends; e.g. regarding the delay in the uptake of new regulations and the positive change in discourse from other sectors to climate adaptation.
4. The key solutions to overcoming barriers to climate adaptation in advanced cases were participatory approaches or stakeholder engagement, institutional changes, networks or cooperations, and learning from pilot projects, government schemes, studies and BASE research.

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10 Appendixes

Appendix 1: Table of general characteristics of the case studies, including sector, impact, temporal perspective and data source

No.	Case Study	Main Sector Cluster	All Relevant Sector Clusters	Climate Change Impact	Temporal Perspective	Data Source(s)
1	Alentejo	Agriculture	Agriculture, Tourism, Education	Drought, Water Scarcity	Retrospective	CBA, Participatory CBA, interviews, work meetings, contribution validated by local authority
2	Ílhavo and Vagos coast	Coastal Zones	Coastal Zones	Sea Level Rise, Extreme Weather Events, Flooding	Prospective	Participatory action-research approach, literature review, initial conversations, meetings, Scenario Workshop method, MCA, Adaptation Pathways and Tipping-Points method, CBA
3	Cascais	Cities	Cities, Human Health, Tourism	Flooding	Retrospective, on-going, prospective	Expert interviews, questionnaires, workshops, literature review
4	Copenhagen	Cities	Cities, Coastal Zones	Flooding, Sea Level Rise, Health	Retrospective	Document analysis, interviews, informal consultations, participation in events
5	Cornwall	Human Health	Human Health	UV radiation, Health	Prospective	Literature review, informal conversations, researcher expertise
6	Dartmoor	Biodiversity and Ecosystem Services	Agriculture, Biodiversity and Ecosystem Services	Extreme Weather Events, Flooding	Retrospective, on-going, prospective	Interviews, literature review
7	Doñana	Agriculture	Agriculture, Biodiversity and Ecosystem Services, Water Resources	Health, Water Scarcity, Flooding, Drought	Prospective	WAPA model impacts, stakeholder survey, literature review
8	Green Roof	Biodiversity and Ecosystem Services	Biodiversity and Ecosystem Services, Tourism	Water Scarcity, Drought, Extreme Weather Events	Prospective	Participative workshops, general knowledge gained during BASE
9	Holstebro	Agriculture	Agriculture, Cities	Flooding	Retrospective, on-going, prospective	Literature review, qualitative interviews,

						quantitative questionnaires
10	Ijsselmeer	Agriculture	Agriculture, Cities	Drought, Flooding, Sea Level Rise	Retrospective	Interviews, documentation on the process
11	Jena	Cities	Cities	Health, Flooding	Retrospective, on-going	Stakeholder interviews using BASE questionnaire, document analysis
12	Kalajoki	Water Resources	Agriculture, Water Resources	Flooding, Extreme Weather Events	On-going	Interviews of administrators, researchers observations and experiences, policy papers
13	Kalundborg	Coastal Zones	Agriculture, Coastal Zones	Flooding, Sea Level Rise	Retrospective	Interviews, researchers experience
14	Leeds	Cities	Cities	Flooding	Prospective	Stakeholder workshop
15	Madrid	Human Health	Cities, Human Health	Health	Prospective	Stakeholder interviews, literature review, online database, CMCC data, researchers experience
16	Prague	Cities	Cities	Flooding	Retrospective	Survey, interviews, literature review
17	Rotterdam	Cities	Cities, Rural	Flooding, Sea Level Rise	On-going	Literature
18	South Devon	Coastal Zones	Coastal Zones, Infrastructure	Flooding, Sea Level Rise, Erosion	Retrospective, on-going, prospective	Interviews, public events, literature review
19	South Moravia	Agriculture	Agriculture	Water Scarcity, Drought, Extreme Weather Events	Prospective	Survey, interviews, literature review
20	Timmendorfer Strand	Coastal Zones	Cities, Coastal Zones, Tourism	Flooding, E, Sea Level Rise	Retrospective	Literature, informal interviews, researchers' expertise
21	England	Human Health	Human Health	Health, Flooding, UV radiation	Prospective	Literature review, informal conversations, researcher expertise
22	Usti	Agriculture	Agriculture	Water Scarcity, Drought, Extreme Weather Events	Prospective	Survey, interviews, literature review
23	Venice	Cities	Cities, Coastal Zones	Flooding, Sea Level Rise	Retrospective	Literature review, interviews

Appendix 2: Current state of adaptation of each case study and BASE activities

a) Alentejo

The Alentejo case study is divided into the Tamera subcase on the implementation of the water retention landscapes in an ecovillage, the Amoreiras subcase on participatory analysis in a rural development project that promoted adaptive capacity in a village, and the farms subcase on farmers' knowledge and perception on adaptation measures. The Alentejo study consisted of a participatory state of the art and review of the climate adaptation impacts and adaptation measures in the region with several stakeholders, including government and academia. Furthermore, it consisted of a participatory multi-criteria analysis of the agriculture adaptation measures based on the experience of a different group stakeholders, also government and academia, but mostly composed of farmers and associations. The subcases include autonomous adaptation.

There is a national strategy in Portugal for the different sectors and an institution responsible for it, the national agency for environment (APA). The regional and national stakeholder promotes and develops different seminars and reflections on related themes such as combat to desertification. There is a national interest in the adaptation theme since some European, regional development and EEA grants funds, for example, promote it. Presently there are several municipalities in the regional and national level developing adaptation strategies. The public company responsible for the Alqueva Dam (the biggest artificial lake in Europe, located in Alentejo) is mobilizing efforts to create an adaptation strategy and plan.

b) Ílhavo and Vagos coast

The study included a participatory action-research approach and represented the first attempt to produce an inter-municipal adaptation plan with local stakeholders. Stakeholders are well aware of the coastal vulnerability, but local municipalities have still not implemented any long-term action plan to address the problem collectively. According to local experts, there has been a halt in constructions of the coastal first line. To develop an action plan, the Scenario Workshop method was used and the required adaptation options were fairly consensual, but there were doubts concerning the different technical options (e.g. sand nourishment operations, submerged detached breakwater, sand dike). To address these doubts a multi-criteria analysis of the different technical options was done. The use of Adaptation Pathways and Tipping-Points method produced a set of dynamic adaptation pathways agreed by all. These pathways were then the analysed further through a cost-benefit analysis and to address technical uncertainty, a second multi-criteria analysis was done. The MCA provided important comparative data on the efficacy of the different options, possible secondary effects and uncertainty regarding the claimed efficacy. In the final workshop, fears that the research outcomes would not be implemented were expressed due to mistrust of central administrators.

To date, only sand nourishment operations have been implemented periodically over the past 10 years by the Aveiro Harbour Administration, although not in the context of climate change adaptation or as part of an action-plan or policy guideline. Sand was retrieved in dredging operations North of the Aveiro Harbour and placed on a longitudinal drift current, to the South of the Aveiro Harbour Southern groynes. The goal was to increase beach sand, which every winter is steadily depleted. Nevertheless, placing sand on this coastal stretch as part of a concerted action-plan for the long term requires a much higher quantity of sand than the one retrieved from the Aveiro Harbour dredging operations. Other possible options include dredging sand offshore or using sand from inland forest areas.

c) *Cascais*

Cascais Municipality has a Strategic Plan for Adaptation to Climate Change since 2010 (PECAC). During BASE this document was discussed with the Municipality in several meetings, analysed and reviewed with local stakeholders in many participatory workshops, updated with new data and improved mainly by including an Action Plan for the new Top Adaptation Measures. The new PECAC 2.0 recommendations, strategies and actions were also mainstreamed by considering them in the revision process of the Municipality Urban Plan in 2014. During BASE several new stakeholders were invited and actively participated in the reviewing process enlarging significantly the scope and complexity as well as adding the critical elements of multidisciplinarity into the PECAC 2.0. A survey of Cascais Municipality population also allowed not only to raise awareness on climate change but also to capture citizen's perceptions on opportunities and obstacles regarding implementation actions for climate adaptation. This valuable input also promoted even stronger advancements in the political process of mainstreaming adaptation and aligning the adaptation agenda with the political agenda fostering even more public events and trainings were climate change is becoming more a more a regular discussion topic. An important advancement towards the implementation of adaptations actions in Cascais was the natural and spontaneous creation of a climate change informal group with members of different departments of the municipality.

d) *Copenhagen*

After hosting the 15th Conference of the Parties under the UNFCCC (COP15) in 2009, the municipality of Copenhagen developed its climate plan. The Copenhagen 2025 Climate Plan was finally approved by the city council in 2012. For the plan, a screening of future climate change consequences was done and it became clear that mitigation was not enough to protect the city from the effects of heavy rains and rising sea levels. The two large cloudbursts in 2010 and 2011 causing massive flooding of the city, the latter causing damages of about 6 billion DKK in insurance payments, prompted the approval of the Cloudburst Management Plan in 2012. A mapping of water catchment areas followed, with a prioritization based on an economic risk assessment, implementation severity, and the potential for synergy with other plans. Prioritization of the water catchment areas determines investment efforts as it is not possible to carry out the whole plan at once. In 2013, Rambøll (an external private consultant bureau) advised the Municipality of Copenhagen on solutions based on the "service target level/accepted risk" set by the Cloudburst Management Plan. Citizens were then involved in choosing which solutions should be implemented.

The Copenhagen stormsurge management planning has begun and the Municipality of Copenhagen started looking into different possibilities for securing the coasts of Copenhagen based on impact assessments and cost-benefit calculations from the private consultant company, COWI, on stormsurge adaptation measures. The goal is to find solutions that secure the coasts from storm surge and contribute to the future development of the city by adding more recreational elements for citizens' enjoyment. There haven't been any final political decisions yet, but several adaptation solutions have been considered. However, there are many challenges in regards to storm surge adaptation planning, which need to be resolved. Thus, as part of BASE research, a 'stakeholder involving process' to facilitate the discussion about unclear questions such as: financial and legal questions, and allocation of responsibilities in adapting CPH to storm surges now and in the future, was done.

e) *Cornwall*

In this case study, the costs and benefits of a public health intervention on skin cancer were assessed. A number of different options exist, including urban design (including shade, albedo of the ground), but focus was placed on the potential option of continuing with a SunSmart type campaign.

Specific adaptation measures for human health are few at national and regional levels. Examples include the Heat-wave Plan for England, which addresses current climate related health risks. So far, the main focus of activity on climate change has been related to the mitigation of greenhouse gas emissions, but the Cornwall Council is proactive in the assessment of potential future risks. There is some interest at local level on planning for climate change adaptation in the health sector. The University of Exeter Medical School has been working alongside Cornwall Council to help identify health risks associated with climate change. Climate SouthWest (an independent partnership hosted by the UK Environment Agency) conducted a study on climate change vulnerability and impacts in the South West of England in 2010. It identified a number of risks for health, including heat stress, skin cancer and tick borne risks. However, the future sustainability of such actions is under threat, with Climate SouthWest ceasing activities in October 2015 due to budget cuts. Public Health England has also been involved in the dissemination of findings of recent research from the international and national level down to the local level; in part because of the changing nature of public health provision in the UK, recent changes moving public health from the NHS to local government control.

f) *Dartmoor*

The Dartmoor National Park Authority (DNPA) developed a climate change adaptation strategy in 2011. They state that this strategy was then translated into the 2014 - 2019 Management Plan, and will be implemented as such. The Management Plan, however, does not refer to the climate change adaptation strategy from 2011. It does include some adaptation measures though, albeit not under the heading of climate change. Severe, recent budget cuts to DNPA may explain the current lack of interest or focus on climate change impacts and adaptation.

The Mires on the Moor project on bog restoration (partly initiated and) funded by the South West Water (SWW) drinking water company and started in Exmoor National Park (ENP). It takes place on land owned by the Duchy (covering 120 ha), and (partly) used by the commoners. It is further facilitated by the Environment Agency and the DNPA. The project was criticised as SWW didn't indicate the amount for compensation payments and it (partly) failed to use the local expertise and to give locals an opportunity to respond. The project ended in 2015 and SWW will only fund the project further at ENP). The second project, Dartmoor Farming Futures (DFF) is a bottom-up agri-environmental scheme. It was initiated in 2010 by local farmers together with the Dartmoor Commoners Council, the Forest Commoners Council, the Haytor and Bagtor Commoners Council, the DNPA, the Cornwall Duchy, Natural England, RSPB, SWW and the Ministry of Defence. Local commoners who participate have signed agreements with Natural England and Defra. A first preliminary evaluation was conducted in 2013, and so far, it appears to be a successful bottom-up initiative.

g) *Doñana*

The Doñana region is a coastal wetland in the Guadalquivir River Basin District of Southern Spain, important for bird migration and rice plantations. The climate is changing, increasing temperatures and decreasing precipitation in the area, making Doñana a hotspot in the debates over climate change adaptation in Europe.

The recent high temperature and drought episodes are influencing the view of local communities about the need for adaptation in the Doñana natural ecosystems and agricultural systems. The water district is already under environmental pressure, the coastal vulnerability to sea level rise is high, and the potential increase of irrigation demand is very high. Drought episodes of the past fifty years in the Sothern Europe aggravate the structural water deficit in the Doñana coastal wetland and the policy strategies undertaken have been capable to deal with extreme situations, but ineffective to solve the conflict among users. Further, the water competition and conflicts will be increased due to a major pressure on freshwater resources as a result of climate change impacts, increased population, pollution problems from agriculture intensification and fragmented and uncoordinated adaptation policy strategies.

The BASE research aimed to address the social and environmental challenges for adaptation at Doñana. Two sources of information were combined to explore flexible adaptation options for the rice farming and the natural ecosystem. First, the magnitude of the impacts and the effects of policy by modelling the river basin system were defined. Second, a participatory data collection process to inform on the social challenge was done.

h) Green Roof

This case study does not have any adaptation history and BASE was the first adaptation initiative in the area. The national adaptation strategy was approved in 2015 and discussions regarding climate change adaptation are slowly emerging. The study area does not have a regional adaptation strategy. Two scenario workshops with stakeholders were carried out, listing potential measures and modelling the impact of the measures.

i) Holstebro

All Danish municipalities are committed by the Danish Government to present local climate adaptation plans. Holstebro municipality presented its Climate Adaptation Plan in 2014 with two overall aims: overview and systematised climate adaptation actions through mapping and prioritisation of actions, and holistic climate adaptation actions coordinated with neighbour municipalities, utility companies and rescue. This first plan for Holstebro is solely centred on problems derived from more precipitation and higher groundwater level. The Climate Adaptation Plan is a strategic plan which should be integrated into the administration and planning of the municipality and has an interface with other policy areas in the municipality, e.g. waste water, climate and water plans. In 2014 a risk management plan was developed for Holstebro city. Holstebro Municipality is part of a ‘collaboration forum for climate adaptation’ formed by the three municipalities which the watercourse Storåen runs through. The purpose being to coordinate the three local climate adaptation plans through coordinating initiatives and potential common development of ideas. Representatives from the municipalities and supply companies take part in the forum. Furthermore, the aim of the forum is to develop a common overall climate adaptation plan for Storåen, which can support the local climate adaptation plans.

One of the suggested climate adaptation measures is to use the farmers along the watercourse Storåen as water managers solving the problems for the city of Holstebro by letting their fields flood permanently or for periods. The case study on Holstebro is centred on ‘farmers as water managers’. The measure is also a chance for some farmers to earn an income from some fields, which might be exposed to flooding anyway.

j) Ijsselmeer

The national Delta Programme consisted of four phases. The results of each phase were reported to parliament, together with the planning and budget. The first phase (2011-2012) of the Delta programme was devoted to the problem analysis based on long-term delta scenarios. The second phase (2012) encompassed the development of possible strategies. During the third phase (2013) the most promising strategies were selected and in the fourth phase elaborated further and turned into one main strategy per sub-programme. These were combined in to five so called Delta-decisions and offered to the Dutch parliament in September 2014 (in the report called Delta Programme 2015).

k) Jena

The local adaptation strategy, known as JenKAS, was formally adopted by the City Council in 2013 as an informal planning principle. The strategy's backbone is a handbook on climate sensible urban planning which includes information on current and future climate conditions and their potential local impacts; information on legal aspects of climate change adaptation; exemplary economic assessments of adaptation options; and best practice examples of successful climate change adaptation in Jena and elsewhere. For each city district, impacts are described in detail and related risks are visualized using a traffic-light labelling system. Recommendations for urban planning in particularly affected areas are presented in form of a map. The handbook is complemented by the decision support system *Jenaer Entscheidungsunterstützung für lokale Klimawandelanpassung – JELKA*. Thereby, it is meant to accommodate the varying needs of different stakeholders and decision-makers.

The main focus of implementing JenKAS is on mainstreaming adaptation into administrative decision-making, i.e., the consideration of adaptation-related aspects in these processes. The Department of Urban Development and City Planning (DUDCP) promotes the mainstreaming through various in-house activities, e.g. JELKA trainings. As a consequence of these efforts, a constantly growing number of land development plans refer to JenKAS when making recommendations or substantiating restrictions. It is expected that the results of current research efforts, e.g., those of a project that develops site-specific recommendations for the use of tree species taking into consideration climate, locational, and aesthetic aspects,[2] will further promote this uptake. Beyond the actions directed at internal municipal processes, there are several activities addressing local citizens and associations, e.g., a nature trail with display boards financed by local businesses that provide information about important aspects of the changing urban climate as well as the local adaptation strategy. A municipal working group on climate change adaptation, which was formed by representatives of different administrative bodies (local and federal state administration) and scientists, meets 4-5 times per year. It was founded to promote the exchange between relevant actors, i.e. enable administrative staff to follow scientific progress, get advice and feedback from scientists regarding their adaptation-related activities but also promote the transfer of practical experiences to the scientific realm.

Within BASE, comparative multi-criteria assessments were used to consider future climate change in today's decision-making processes for selected publicly financed projects. These assessments aim to support

[2] The project was awarded the Environmental Prize of the federal state of Thuringia („Thüringer Umweltpreis") in 2015.

construction plan designs, which on one hand suit current and future climate conditions but on the other hand also take into account additional factors affecting decision-making, e.g., financial and aesthetic aspects.

l) Kalajoki

The case study has advanced climate proofing of flood risk management plans (FRMP) and river basin management plans (RBMP) in the Kalajoki river basin beyond the level that is likely to occur in the planning processes on their own. The case study has promoted the integration of adaptation considerations in the assessment of potential flood risk management measures. The assessment focused on if and how various measures proposed for the flood risk management plans supported adaptation to climate change. The case study has demonstrated how such evaluation can be carried out in practice using stakeholder-led multi-criteria analysis process. A new participation method combined multi-criteria analysis framework with specific adaptation support criterion.

Related to river basin management planning, the case study has promoted the integration of adaptation considerations in the assessment of planned water protection measures. The case study focused on assessing how climate proof the nutrient mitigation measures for the agriculture sector are at the regional level. The BASE project combined different models (hydrological, agricultural and climate change) to calculate nutrient loading and calculation cost-effectiveness of planned agri-environmental measures more comprehensive way gives a new climate adaptive method for planners and decision-makers. In both processes, the BASE case study has generated and delivered specific knowledge on adaptation impacts of proposed measures to complement existing, more general knowledge on the impacts of climate change. Thereby the BASE case study has contributed by showing how adaptation principles and policies can be implemented in practice at the local level.

m) Kalundborg

Denmark has adopted both a national strategy for climate change (2013) and a national strategy for climate change adaptation (2008). However, these strategies do not impose any obligation on municipalities to make their own strategies, nor do they provide municipalities with much information on how to proceed with such strategies. The situation changed somewhat when a new centre-left government won the general election in 2011. In autumn 2011 the new minister of the Environment announced that all municipalities have to make a climate adaptation strategy within the next two years (by end of 2013). The municipalities' climate adaptation strategies need to contain: a mapping of the risk of flooding in the municipality to create an overview of the situation for the municipality to be able to prioritize the needed actions. It is required that the climate adaptation strategy is implemented in the overall strategy for the municipality or as an appendix to the overall strategy for the municipality.

The 17 municipalities in the region of Zealand developed a climate strategy that ran from 2009-2013. In the making of the strategy the Municipality of Kalundborg served as part of the steering group. The regional climate strategy is non-binding for the municipalities involved, but calls for cooperation in the region on the climate area. Because of the participation in the BaltCICA project, the Municipality of Kalundborg has already taken steps towards defining the goals and priorities of adaptation to climate change. This has been done on the basis of economic and environmental calculations together with the involvement of stakeholders and citizens in the decision making process. The results from the BASE citizen summit (based on the results from the scenario workshop and technical analyses discussed in the municipality) were received and discussed

by city council members and have been taken into account for the adaptation strategy. The Kalundborg climate change adaptation strategy is being developed.

n) Leeds

Currently, a Flood Alleviation Scheme (FAS; including two movable weirs, cutting out an island and building wall defenses) is being constructed in the city centre. But there is no coordinated or planned process for adaptation and specific (often isolated) activities are mentioned here. The following are activities and initiatives that have advanced adaptation, either directly or indirectly, in Leeds. For example, the innovative approach at St Aidans, which was a big open cast coal mine restored as a wetland. It was designed to work as flood storage and as a nature reserve. The City Council owns it, the Royal Society for the Protection Birds (RSPB) manages it, and the Environment Agency (EA) manages the flood risk aspects. Another example is the Old Moor in Dern Valley, a coal storage area and colliery, which was restored as a nature reserve and provides washlands from the River Dern with the EA involved in management. Another example is the grey infrastructure efforts of Leeds City Council in Garforth (and other areas of Leeds), and now some areas do not flood as much as in 2007. The DEFRA pilot project in Garforth was fantastic for advancing the understanding on issues such as flows, culverts, etc. The Garforth community flood group has also been a conduit for engaging public bodies.

Partnerships are working to access alternative funding streams for flood risk management, e.g. Yorkshire Water with the Lead Local Flood Authority (LLFA) and communities. The Aire Action Leeds network was a good example, which advanced specific flood adaptation actions and communication between many stakeholders. Defra funding, either directly or through other organisations like the Forestry Commission, provides incentives to upland landowners who implement sustainable practices. Community education and consultation has worked in some areas. Especially, education on flood risk is given at schools but it is only happening in a sparse and uncoordinated nature. The Environment Agency (EA) has tended to be risk averse when it has come to trying new things, it is getting slightly less risk averse but until funding criteria changes they are quite narrowly focused in what's required.

The Leeds City Council (LCC) has a good flood alert system in place. The Council recommend the implementation of certain conditions in new developments (it isn't statutory) and there is some implementation being done (e.g. SuDS, bat boxes). There's a campaign to put SUDs into new developments, over the last 15 years, but it hasn't been entirely successful, although they were included in the LCC core strategy in 2014. Dissemination of knowledge from high level people in a wide array of organisations shows willingness to pursue flood risk adaptation.

o) Madrid

The National Adaptation Plan to Climate Change (PNACC; presented in 2006) was designed as a framework for coordination among public authorities in the activities of assessing impacts, vulnerability and adaptation to climate change. In the Madrid Region there is a Strategy on Air Quality and Climate Change (2006-2012), The Autonomous Community of Madrid approved it in 2007. Although this Plan recognised the effects that air quality can have on health, and diagnosed air pollutants emissions over human health effect thresholds, the objectives and measures designed and implemented do not cover the health sector. It only defines measures related to air pollutants monitoring systems and its effects on health and related to enhancing the information to citizens when daily air pollutants thresholds are exceeded.

The city of Madrid joined the Spanish Network of Municipalities against Climate Change (RECC) in 2005 and the Covenant of Mayors (CoM) in 2008. The Plan of Sustainable Energy Use and Climate Change Prevention 2008-2012 was approved as a requirement to join the CoM. It recognises the adverse effects of extreme temperatures on health, air pollution, food and water diseases transmission. Within the adaptation measures, the plan established a monitoring system and a protocol of measures to face the pollen concentration, particulate matters and other air pollutants. The European heat waves of 2003 raised the awareness of the necessity to implement prevention plans. In 2004 the Community of Madrid initiated a Plan of Alert and Prevention of heat waves. The main objective of the plan is to reduce the mortality and morbidity impacts of unusual increases in temperature. The plan consists of improving the information given to citizens about prevention measures and to professional health services and social authorities. The warning system of this plan, activate from the 1st of June to the 15th of September, has defined the threshold of alert at 36.5°C.

BASE research involved the use of Fuzzy Cognitive Mapping to elicit knowledge on the functioning of the urban system by interviewing a set of actors and experts on urban climate adaptation to heatwaves in the city of Madrid. An integrated model was built covering impacts and adaptation options to heatwaves. Through scenario building analysis, two relevant adaptation measures were identified: heat warning systems and green infrastructures development. Then a cost-benefit analysis was carried out for extensive green roofs and another of heat watch warning systems (HHWS) to analyse the long-term costs and benefits (2020-2100) of running the system under different climate scenarios and to identify the additional costs of implementation if acclimatisation processes are not properly considered. The HHWWS in Madrid was set up on 36.5°C until recently. The epidemiological study carried out in collaboration with the Instituto Carlos III found however that in the period 2001-2009 the threshold temperature has decreased to 34 °C compared to the period 1986-1997, in which this temperature was initially set. So in June 2015 the new threshold temperature was incorporated in the plan.

p) Prague

The city has no strategy dealing with climate change adaptation, but some tentative adaptation measures have been briefly mentioned in the city's strategic plan. A common understanding of the need for adaptation is yet to be developed. Since the 2002 floods, Prague municipality has been developing and implementing flood control measures. Future climate scenarios predict a change in the number and intensity of extreme events, inter alia, increasing the risk of river flooding.

The BASE research was focused on back-casting and therefore did not aim to make any changes in the adaptation process in the city. The measures were quite advanced in terms of efficiency and preparedness to a potential flood of a great extent (up to 500 year flood flow rate). The flood protection system had been planned for decades but the works themselves started just in the beginning of the new millennium. The flood protection system of Prague has been now finished and protects most parts of Prague from 500-year floods. It consists mostly of fixed and mobile barriers and safety valves in the canalisation network. To protect the city, its inhabitants and priceless historical heritage from such great floods there was a need for grey infrastructure. Green and blue measures are not included in the flood protection plan and do not seem to be of any priority when it comes to risk management in the city. At this moment new discussions have arisen especially due to in sufficient flood protection around the Prague Zoo and Troja district. The negotiations are expected to be quite complicated as the Prague city hall does not seem to be very keen on a further flood

protection development, which is apparent especially from new development plans for the area, which do not include any flood control measures.

q) Rotterdam

Climate change adaptation measures and strategies were revised at the second Delta committee in 2008 and its report to parliament lead to the instalment of the Delta programme. In a broad, joint fact-finding process this programme developed strategies on five broad themes for 6 regions, including the region of Rotterdam (Rijnmond-Drechtsteden). In the process there was an iteration from a broad scale problem assessment to a fine-tuned set of strategies adopted by the regional board, consisting of both municipalities, provinces, the water boards and national governmental stakeholders. This process is named 'adaptive delta management' (ADM) and it became the cornerstone of advancing the existing strategies already used in the Dutch flood risk context. Measures include dike reinforcement, Room for the River measures and multi-layer safety.

For the Rotterdam area, Room for the River measures are needed upstream in the Rhine-Meuse delta, to effectively reduce flood risk and projected climate change effects on peak discharges. The main activities to coordinate higher level measures influencing the area of Rotterdam came from the coordinating body of the national programme (the 'staff') and the regional staff responsible for the sub-programmes Rivers and Rijnmond-Drechsteden. The programme heavily focused on research into the feasibility and cost-effectiveness of both the overall strategy for climate change adaptation within flood risk, and specific measures like closing the Rijnmond estuary in the port of Rotterdam. This research followed the ADM approach and consisted of modelling studies, renewed calculations of the strength of flood barriers and the cost-effectiveness on a range of societal relevant domains. Overall conclusions of the iterative research approach are that the current measures are sufficient to deal with climate change, although tailor-made applications are necessary for local specificities, and that the main strategies depend on both the upstream catchment area and shipping ability when closing the Rijnmond estuary.

Design ateliers were set up, wherein spatial experts and water management collaborated with local stakeholders and governmental actors trying different landscape architecture designs. These initiatives were supported by both the national staff and the Delta commissioner, the regional director and the societal steering group which led to further involvement of landscape architects under supervision of a national atelier team. The institutional embeddedness and societal acceptability of the proposed adaptation measures and overarching strategy were explored through two main instruments. First, 'bestuurlijke tafels' a discussion platform on a regular basis with all different governmental layers and institutions invited to deliver input into the strategy-making process. Second was 'maatschappelijke adviesgroep' (MAG), a societal reflection board with key representatives of different societal groups which regularly reflected on the strategies, measures, and impossibilities of measures. This MAG included stakeholders from a range of sectors, including inland shipping, nature NGO's, logistics, industry, residents and was headed by the mayor of Rotterdam (MAG 2013). Currently, the strategies and future steps within a pathways approach are being implemented.

r) South Devon

The discussion after the extreme weather events in February 2014 seemed to have focused on adaptation of the railway connection only (rerouting), and did not link it to climate change or flood risk and erosion management. At the local level, a dialogue was said to have been started soon after the events, among the

actors Network Rail, Environment Agency and Teignbridge District Council about the future of this part of the coast and the railway. At the national level, there seems to be no dialogue between national departments involved (between the Department for Transport and DEFRA).

There were several adaptation measures considered (e.g. raising the sea wall, rerouting the railway more inlands), after extreme weather events severely damaged the seawall and railway. The option of raising the sea wall was abandoned, mainly after protests of local residents concerning privacy (i.e. that train passengers would be able to look into their houses), and loss of scenic amenity (i.e. they would lose their view on the sea, which would also lower the value of their property). Network Rail has started an 18-months study to identify the "real costs" of maintaining the current line, a 6-months study to identify the "real costs" of rerouting. Network Rail had stated that it intended to include the Environment Agency and Teignbridge District Council in these studies, but it did not indicate how that would be done.

s) South Moravia

The preparatory process for the Czech National Adaptation Strategy began in 2009 and was approved in 2015. Since the adaptation process in the Czech Republic is mostly top-down, the actual implementation of specific adaptation measures depend on the implementation of National Adaptation Strategy. In the case of wine growing, due to the non-existence of particular sectorial adaptation strategy, adaptation actions are rather fragmented and autonomous. These practices include mainly measures related to agricultural management practices, water retention and saving measures and insurance (soft measure) realized by farmers themselves. However, in case of integrated vine production new agro-envi-climate measures (AEKO) are currently in place under Czech agricultural policy of Rural Development Programme. AEKO consists of a variety of measures that aim to support farmers to protect and improve environment of farmland. The farmers are engaged in 5-year contracts to farm under conditions of integrated wine production. AEKO are co-financed by the EU European Agricultural Fund for Rural Development and by national resources of the Agriculture Ministry. Combining AEKO measures with organic farming is also possible. Integrated vine production is divided into two - basic and advanced protection of vineyards. Yearly support is 323 EUR/ha for basic and 675 EUR/ha for advanced production. The general difference between these two is the number of permitted treatments against main vineyard pests and diseases. The agro-envi-climate measures for integrated vine production are mainly focused on pest management, but also include measures, such as lighting of vine bushes, grassing of vine inter-row with set of certified seed mixture.

In November 2014, a quantitative questionnaire was distributed among wine growers situated in South Moravian region. We received answers from 29 respondents farming mainly in organic (33.3%) and integrated vine production (59.3%) in the Czech Republic. From the respondents, 100% were men; regarding education, 92% had secondary and higher education and had an average of 19 years of experience farming. The majority, 50%, were farming on an area of vineyard up to 10.5 hectares. One of the topics of the questionnaire was asking farmers whether they would be willing to implement particular adaptation measures, in order to protect their land against possible negative impacts of climate change. Measures to increase water retention (such as, infiltration zones, buffer strips, hedges, terracing) were highly preferred, 93% of respondents perceived these measures as important. The majority of respondents also support shifts in timing of agricultural practices, pest management and change in irrigation.

t) Timmendorfer Strand

The last severe storm surge hit the Lübeck Bay in 1872. The reconstruction in the following years was a great trigger of touristic development in Timmendorfer Strand and Scharbeutz as well as in Niendorf and Haffkrug. The tree alley on the promenade was originally a measure for coastal defence. However, as memories of the 1872 storm surge faded, coastal defence became less of a concern. By 1908, the first permissions were granted to construct buildings on the foredunes, directly exposed to the sea. Defence structures in the form of natural beach-ridges were lower than what would be required to withstand the statistical 100-year storm surge, and attempts by state authorities to heighten defences through artificial structures (walls) were turned down by the communities fearing reduced revenues from tourism as a consequence of limited sea views and narrowed beaches. As sea levels are rising, the need for new measures has become more and more urgent in the past decades.

The ministry (MELUR, then MLR) stepped in in 1999 and initiated a pilot of participatory coastal defence planning. In addition, the advisory board integrated coastal management was installed to facilitate information and communication in coastal planning. The project followed three steps: assessment of socio-economic values, sensitivity analysis, and ideas competition. In the sensitivity analysis, interdependences between all types of land uses, infrastructure and local activities were identified in a participatory exercise in which 25 local residents took part. The results were discussed in focus group discussions. Based on the outcomes of the first exercise, scenarios for various measures of coastal defence were discussed in further focus groups. Four engineering offices were asked to develop innovative ideas based on the scenario agreed on in the preceding discussions. The winner solution conceived a deep sea wall with a maximum height of 0.8 m above the level of the promenade. The landscaping of sand dunes, ridges and the promenade carefully integrates the wall, to reduce its impact as an aesthetical obstacle.

u) England

We examined the impacts of climate change on mental health in England based on data on climatic variation and prescriptions. This was to enable a first quantification of the impacts of changes in average conditions on mental health and assist in the development of adaptation strategies. The results suggest that the impacts will be positive (i.e. that mental health in terms of mild-moderate depression will improve). This may aid in planning for climate change and in resource allocation in the future.
This particular case study is important as it reduce the knowledge gap around the impacts of changes in background climatic conditions. The findings suggest that the impact of changes in mean climate conditions would offset to a certain extent the impacts of extreme events on mental health.

There is increasing interest in the relationships between environmental change, including climate change, and health at national and regional levels. However, specific adaptation measures are few – and those that there are may be considered low or no regret. For example, the Heat-wave Plan for England, which addresses current climate-related health risks. A number of government reports highlight the risks to mental health of flooding in particular – including the NHS Emergency Planning Guidance - which identifies ways that the mental health risks of floods can be prepared for and managed after a flood event - and New Horizons: A Shared Vision for Mental Health produced in 2009 that highlighted the need for cross agency working in the light of the risks of flooding for mental health and wellbeing (Vardoulakis and Heaviside, 2012).

v) Usti

The preparatory process for the Czech National Adaptation Strategy (NAS) began in 2009 and was approved in 2015. The adaptation process in the Czech Republic is mostly top-down, so implementation of specific adaptation measures will depend on the NAS. Adaptation at the regional and local level, and specific sectors is limited. In the case of hop farming, actions are rather fragmented and autonomous. These practices are mainly related to agricultural management practices, water retention and saving measures and insurance (soft measure) realized by farmers themselves. In March 2014, a quantitative questionnaire was distributed among hop growers in the Ústí region asking farmers whether they would be willing to implement particular adaptation measures.

w) Venice

The city, supported by the national government, is tackling the problem of periodic flooding since the occurrence of a major flood event in 1966. Since then generic flood protection measures, building restaurations, protection of historic monuments against high water, flood preview and alert systems have been put in place. Public pavements have also been raised to ease traffic and communication during flooding. Furthermore, a major flood protection measure, called Experimental Electromechanical Module (MOSE) is being implemented which aims at temporarily interrupting the influx of water into the lagoon in situations of high water. The MOSE project dates back to debates led during the 80's and its design was completed in 1992.

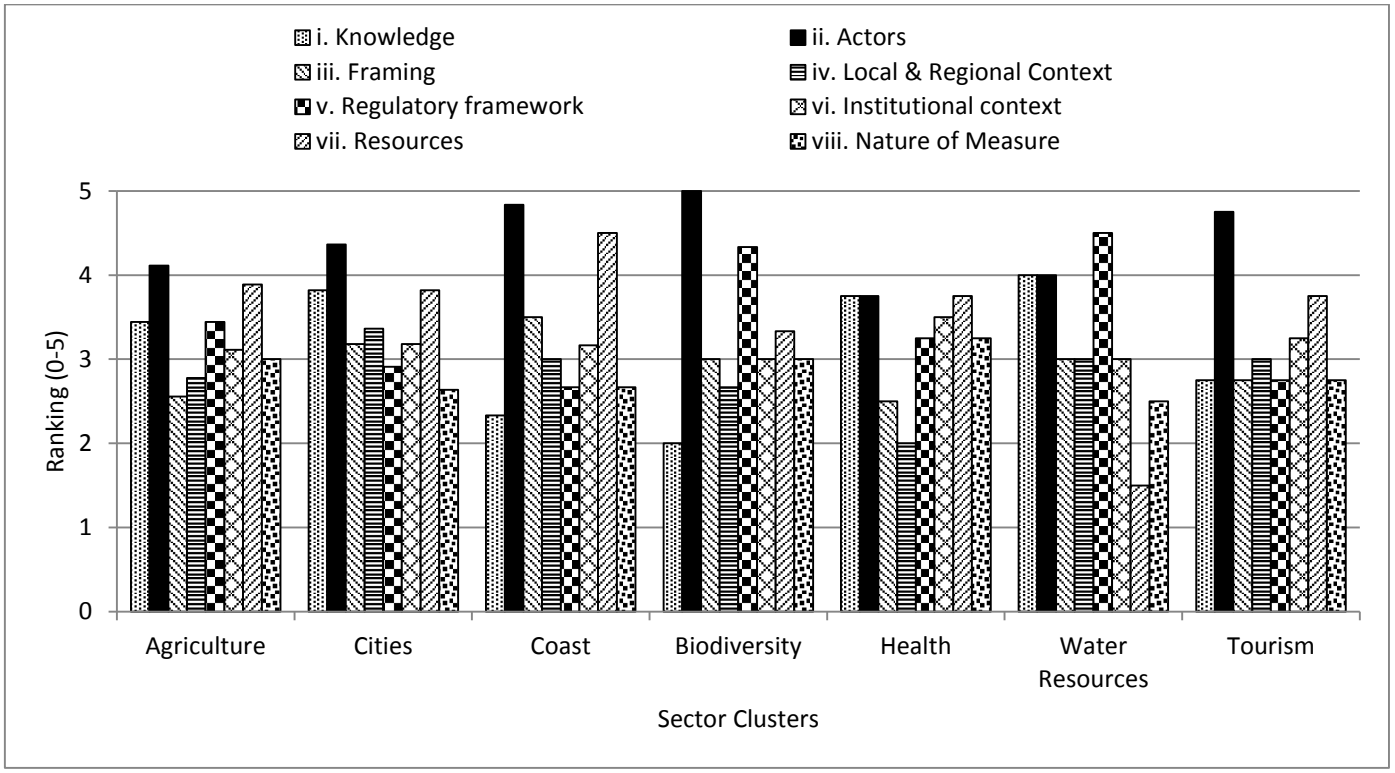
In recent years, climate change has gained some importance with respect to urban policies, but this has, up to now, led only to a series of international presentations of the Venice experience and strategies rather than to a change in local policies and a proactive policy of adaptation. The MOSE project is actually under heavy criticism because of the political turmoil caused by the arrest of the Venice Mayor and several officials and businessmen being arrested with the claim of bribery committed in relation to the public tender process of the MOSE project. The high costs of the project (the costs more than quadrupled with respect to the initial estimates, 5.4bn euros spent up to today and more than 6 billion € expected costs at completion) caused criticism among citizens and some scientists. Although not designed for changing climatic conditions and increased sea levels, the constructor states that the physical capacity can withstand increasing sea levels (and consequently storm surge levels) of up to 60 cm throughout the coming 100 years. The implications for the urban (and harbour) economy of the implementation of this infrastructure under increasing sea levels include delays and interruptions of the commercial traffic in the harbour.

With respect to the adaptation of the urban structure to rising sea levels, a common goal of ensuring a safeguard level independently from the mobile gates up to a medium high level of flooding led to some interventions on public floor space, rising floor levels as far as possible to the established measure of 120cm above the local tidal gauge. In parallel to these public interventions, private house owners started to adapt their dwellings to the rising flood levels, by raising ground floor levels and inserting small mobile flood barriers preventing flooding of ground floor units during "high water". The case study focuses mainly on these private activities, attempting to quantify the benefits in terms of reduced damages of these spontaneous private interventions.

Appendix 3: Table of adaptation-specific characteristics of case studies.

Case Study	Local Adaptation Strategy	Stage of Adaptation Development	BASE Research Advanced Adaptation	Autonomous Adaptation Present
Alentejo	No	4	Yes	Yes
Ílhavo and Vagos coast	No	4	Yes	Yes
Cascais	Yes	5	Yes	Yes
Copenhagen	Yes	5	No	Yes
Cornwall	No	1	No	No
Dartmoor	Yes	2	No	Yes
Doñana	No	1	No	Yes
Green Roof	No	2	Yes	No
Holstebro	Yes	3	No	Yes
Ijsselmeer	No	5	No	Yes
Jena	Yes	5	Yes	Yes
Kalajoki	No	3	Yes	No
Kalundborg	Yes	4	No	Yes
Leeds	No	5	No	Yes
Madrid	No	2	No	Yes
Prague	No	5	No	Yes
Rotterdam	Yes	5	No	Yes
South Devon	No	1	No	No
South Moravia	No	1	No	Yes
Timmendorfer Strand	No	4	No	No
England	(Yes)	2	No	No
Usti	No	1	No	Yes
Venice	No	1	No	Yes

Appendix 4. Figure showing average ranking of factors affecting adaptation for all clusters relevant to each case study.



Appendix 5. Summary table of barriers overcome and the corresponding solutions in the case studies

Case study	Barriers	Solutions
Alentejo	Lack of legality/permission for adaptation measure	Ecovillage illegally implements the innovative adaptation measure
	Lack of financial resources needed	Ecovillage used communication and publicity capacity to raise private funding
Ílhavo and Vagos coast	Absence of a culture of participation	Participatory process
	Lack of trust in the results of engagement by most social actors	A new political agenda generated solution-seeking collaborations/participation
	Scepticism on the part of municipality actors	BASE project action research process
	Technical uncertainty	Multi-criteria analysis (MCA), Adaptation Pathways (AP) and Tipping-Points methods in the Scenario Workshops (TP-SW)
	Climate uncertainty	MCA, AP, TP-SW, cost-benefit analysis (CBA)
Cascais	The lack of real political support and interest	Commitment and resourcefulness of key actor
		Close cooperation with several regular meetings and visits
		BASE action-research attitude
Copenhagen	Lack of system knowledge	Involvement of consultancy firms with expertise in the area
		Involvement of the public
	Funding issues due to the distribution of water competencies	Law changes
		Collaborative partnerships with the water company
	Reactive or limited household actions	Involving local communities in earlier stages of developing water management initiatives
		Providing guidance through locally based planners
Dartmoor	Protests and objections by farmers (bog project)	Partly overcome by starting a dialogue
		Partly overcome by providing more information
	Difficulty negotiating into the agri-environmental policy (Farming Futures Project)	A mediator, who facilitated the process between the farmers and Natural England
Holstebro	Lack of acceptance of adaptation measure	The farmer as water manager' network of actors
Ijsselmeer	Uncertainty on which adaptation measure to implement	A number of studies, including CBA
Jena	Conflict of goals between CCA and CCM	Responsibilities for adaptation and mitigation have been separated
		Planners sensitized to balance goals of both CCA and CCM

	High initial costs to produce valid information on local CCI	Intensification of networking, especially with academic partners
	Low availability of resources	
	Lack of knowledge regarding external funding	
	Production of data time-consuming & resource-intensive	Strengthen internal workforce and reinforce cooperations with external partners
	Stakeholders' low willingness to commit/participate	Leadership and commitment of key actor
	Critique regarding relevance of adaptation by (political) actors	Inclusive, non-confrontational communication strategy by the DUDCP head
	Climate change scepticism	Intensified participation and information provision to local government and associated stakeholders
	Uncertainty of data on CCI and adaptation benefits	Scientists provided state-of-the-art information with guidance on interpretation
Kalajoki	Uncertainty of roles and responsibilities of different actors	Guidance from national level
		BASE actions
		In the Flood Risk Management Plan (FRMP) process roles/responsibilities have been clarified
		Broad participation in new planning process
	Lack of awareness of citizens	A contingent survey, BASE researchers offered detailed calculations and information
		Stakeholder engagement activities improved participation and awareness building
		New guidance for building in flood risk areas
		National level discussions slowly influencing the attitudes of politicians and citizens
Kalundborg	Hard political choices about what to prioritise in adaptation	Partly overcome when the municipality carried out a large participatory process
	Lack of information and planning	Participation in the BaltCICA EU project motivated action
		Citizen summit results were discussed and taken into account
	Lack of administrative resources and political focus	Overcome by joining the whole process
Leeds	Citizens' disinterest	(Although reactive) community flood groups supported by the Environment Agency (EA)
	Problems with insurance companies	Some government negotiations with insurance companies
	Lack of knowledge of citizens	Some small community education projects implemented
	Lack of risk awareness	Government schemes (Green Deal Plan) help people realize the risks

	Lack of knowledge on adaptation	Flood risk adaptation exercises/studies, successful or not, are learning experiences
	Lack of adaptation implementation	Some incentives to promote measures that (indirectly) decrease flood risk
	Opposition by locals	Some developers communicate their plans openly and fund wider flood risk management schemes
	Lack of funding and attention	Particular interests are able to mobilize funding and media
	Rejected flood alleviation scheme	Revised (cheaper) Flood Alleviation Scheme (FAS) by the EA (with active involvement of the council)
	Lack of communication	(Temporal) partnership, Aire Action Group coordinated by the EA
Rotterdam	Possible resistance by different stakeholders	Participatory approach, integrating measures within the regional/local landscape
	Unclear effects of the measures	Pilot projects within a participatory approach
Timmendorfer Strand	Scepticism of community members and local stakeholders	Partly overcome by the involvement of key actors, scepticism was taken seriously
		Partly overcome by the financial support guaranteed by the municipality.
		Participatory workshops, community decided on more attractive solutions/add-ons
	Fear (resistance) of the tourism sector and by citizens	A compromise was found with the stakeholder and citizens
Venice	Public sector inaction	Construction of the MOSE infrastructure project

Appendix 6. Table with description of future adaptation prospects for each case study.

Case Study	Positive Future Prospects	Negative Future Prospects
Alentejo	▪ Regarding the Tamera Ecovillage, the future prospects of adaptation consist on monitoring the water retention landscapes, increasing soil conservation, regenerating earthworks like swales and forestation, and using animals holistically to promote soil regeneration. ▪ They intend to strengthen the applied research to actions they implement on site and use the knowledge acquired in education and tourism. ▪ Regarding the Alentejo region farmers, the situation is farm-specific. ▪ Typically farmers will continue to monitor the climate and its impacts and to experiment with farm elements and cheap and feasible solutions; while trying to acquire more knowledge and funding for climate adaptation.	▪ Farmers in non-irrigated areas have negative vision of the future and are at a disadvantage.
Ílhavo and Vagos coast	▪ At this stage the process is in the hands of local municipalities who are attempting to apply for study grants and funding in order to implement the suggested measures. ▪ However, central administrative bodies are responsible for implementation, namely the National Environmental Agency (NEA); therefore, any plan must include this entity. ▪ The most discussed measure at the moment is a submerged breakwater, new to the Atlantic coast. The cost-benefit analysis showed the benefits of this measure would be higher than the costs, and local and regional policymakers are interested in moving forward with implementation.	▪ Members of the NEA were included in BASE work, but no follow-up action has been done by this institution. ▪ Even though more funds are available for coastal protection in Portugal (particularly since 2014), adaptation options proposed are extremely expensive and will require additional co-financing from the EU. ▪ Local municipalities stated that adaptation options proposed would need around 75% of EU funds, 30% from central government and 5% municipal funding.
Cascais	▪ Cascais is the leading Portuguese municipality regarding adaptation and it has a strong commitment to remain so. The PECAC 2.0 Action Plan has been	

	published and was officially presented at the GreenFest (October 2015). ▪ The next step is to fully integrate the PECAC 2.0 into all existing municipal strategies and plans while implementing the top three measures in the next 2 years. ▪ Two participatory workshops on adaptation financing are planned, the last step before implementation.	
Copenhagen	▪ Implementation of the Adaptation Plan and the Cloudburst Plan, and further development of locally adapted technical and social solutions.	
Cornwall		▪ Overall the prospects for health adaptation in Cornwall are currently limited. ▪ For skin cancer, the importance of the climate linkage is starting to be identified by a number of actors, including Public Health England. ▪ The difficulty of local level action includes losses in key staff due to institutional reforms. Other options beyond public health campaigns, include planning measures. ▪ These may require inclusion of factors such as shading and albedo of surfaces in the creation of new developments. ▪ The difficulty is that this is a multi-sector problem, cutting across a number of stakeholders and implementation will require action at a number of levels.
Dartmoor	▪ The most likely way vulnerabilities will be addressed is through the Management Plan, not as climate change adaptation.	▪ On the whole, prospects are not promising. ▪ The National Park Authority claims they have insufficient resources to specifically address adaptation. ▪ The funder for the bog project, a relatively expensive project, has withdrawn. ▪ The DFF initiative will probably not be continued because of the new agri-environmental policy.

Doñana	▪ Data will be validated by stakeholders and activities will be further disseminated. ▪ There is more environmental awareness and conservation goals are not at risk due to their EU importance. ▪ Farmers will likely react to their needs and will realise that unsustainable practices are unfeasible.	▪ Adaptation might take a long time and conflicts might develop, plus more droughts and some deterioration of the park. ▪ Actions might happen eventually but it they will be reactive not proactive.
Green Roof	▪ Adaptation activities might be implemented in the form of new nature conservation measures and adjusted forest management.	▪ Potential future adaptation activities will probably not take place before the implementation of the National Adaptation Strategy.
Holstebro	▪ An initiative like the farmer as water manager network, which is a bottom-up measure by an agricultural organisation, and includes many different actors, has the potential of maturing the idea of 'farmers as water managers'.	▪ This is difficult to assess at the moment (June 2015). ▪ A number of obstacles have to be overcome, related to the regulatory framework and financial constraints. ▪ In the end, as 'farmer as water manager' is a voluntary measure, if farmers are not interested in being part of the measure, there will be no measure, unless the Danish authorities decide to expropriate farmers, which is unlikely. ▪ Consequently, the realisation of the measure is dependent on the type of incentives provided to farmers and on the ability and will of the farmers to participate in this agri-environmental scheme. ▪ This is complex as farmers have different abilities and willingness.
Ijsselmeer	▪ The current process revolves around the implementation of a flexible water level; a study of its operationalization is taking place now. ▪ All water management authorities are involved. The study will result in a water management agreement between the authorities and the water levels installed.	
Jena	▪ Current observations of weather anomalies confirm high relevance to prepare for changing climate conditions. ▪ Consideration of adaptation aspects in the planning process will become a routine for urban planners as it is	▪ If – for some reason – an update and/or extension of the knowledge base won't be possible anymore, in the medium-term perspective this would have a negative impact on the mainstreaming activities.

	already common for other environmental concerns. ▪ Many other actors, e.g. fire brigade, disaster managers, (urban) foresters, will also increasingly consider adaptation in their daily work. ▪ There are positive initial signals that the building sector will make use of information provided in the context of the JenKAS initiative. ▪ The JenKAS working group will continue to stimulate adaptation. ▪ New projects to validate and update the knowledge base are already planned for the next 2-3 years. ▪ An increase and reliable assurance of financial resources is a precondition to ensure that local knowledge about climate impacts and potential adaptation measures is kept up to date. ▪ Mainstreaming adaptation into urban planning relies on up to date, locally specific information.	
Kalajoki	▪ The regulatory framework guarantees periodic updating of flood risk management plans (FRMP) and river basin management plans (every six years) and regular monitoring. ▪ The EU directive gives relatively strong justification for planning. The FRMP defines the roles and responsibilities of different actors in implementation and how the plan will be monitored (including indicators). ▪ Regarding the implementation of the FRMP in the Kalajoki river basin, much depends on allocation of budget and resources by local policymakers in the relevant municipalities, as well as possible investment contributions and other support by the state. ▪ Further implementation of the National Adaptation Strategy into land use planning at local and regional level is crucial to add resilience to the area. ▪ Increasing knowledge and awareness of the impacts of climate change is likely to	▪ The future of the planning process itself is still uncertain, there are many future challenges. ▪ Instability of the financial situation has promoted on-going alterations to the administrative structure, which leads to insufficient resources and loss of expertise. ▪ For example, the ELY-centres are government operators with high regional and local knowledge and expertise, which are seen as objective and are respected. ▪ With retirements, resource cuts and outsourcing, their status might be compromised. ▪ Responsibility for implementation of adaptation measures through flood risk management is likely to shift even further towards local actors. ▪ The planning processes thus play a key role in increasing their awareness of climate risks.

	support future consideration of adaptation needs in the area. ▪ Through active participation of implementing parties in the planning process and associated acceptance of measures, opportunities for successful implementation of adaptation actions and increased resilience can be improved.	
Kalundborg	▪ Future adaptation will highly depend on the political developments, not only locally but also regionally and nationally. ▪ The national demand for municipalities to produce local adaptation plans has not been followed up with an implementation plan nor funding. ▪ Therefore, a great deal will depend on each municipality's technical and financial ability to oversee the sought for adaptation actions. ▪ Whether there will be an increased focus on actually implementing the adaptation plan also highly depends on future climatic conditions and particular incidents, such as storm-surges and inland flooding. ▪ Saline intrusion is a potential threat and since the city of Kalundborg, with all its vital economic interests and infrastructure, is located on the coast, severe flooding or unnerving projections are bound to spark action.	▪ As the municipality's plan is laid out, the main argument for protection will be financial, as property prices have been used to determine the places where adaptation should be prioritised. ▪ Second, the municipality is by law required to follow the national legislation, and has to apply centrally when making adaptation solutions along the coast. ▪ Otherwise the rule of thumb is that every property owner is required to adapt for him/herself, which will be a mess unless they receive guidance and coordination from the local government. ▪ There is certainly the potential to foresee a negative development in the area. ▪ Adaptation planning in the context of municipal Denmark does not have a standardised way of determining the value of protected nature areas, or culturally/historically important areas or buildings. ▪ The municipality has maintained a conservative position on the subject, choosing not to rate protected nature areas higher. Instead, agricultural land and the local industry have been favoured. So, one of the key drivers in future adaptation will inevitably be housing and land prices. ▪ Planning for climate change adaptation is a hot political topic. Part of the obstacle is making hard political choices about what to

		prioritise when adapting to future floods. The basis of this was economic assessments, local interests and taxpayers at risk. ▪ The municipality will have to balance between wanting to uphold a level of security and making financial priorities, since not everything is 'worth' protecting.
Leeds	▪ Leeds City Council financial documents show that several small flood alleviation schemes will be implemented around the Leeds district (in residential areas). ▪ There seems to be a tendency towards a wider, holistic catchment approach. An ecosystem services approach highlighting, quantifying and costing multiple benefits not just flood risk reduction. DEFRA is interested in this; the current government is putting a value on natural capital, so there's an opportunity to start generating that debate. ▪ There is an interest in an independent long-term body to manage flood risk, formed by representatives of key stakeholders, that leads and takes actions forward. A coordinating approach by all agencies is needed. River stewardship is a potential mechanism that the EA is already considering, e.g. in Sheffield. A separate organisation could be set up which can get funding from somewhere to be held in trust for river maintenance, for whatever way communities want to spend it. Partnerships between key stakeholders and the University of Leeds will be strengthened, particularly through cross-faculty hubs dedicating staff to this networking. Stakeholders like LCC and EA could be clearer on what the Universities could produce to help their work, involving agencies from the start and feeding this into funding proposals. Also should include businesses, Local Enterprise Partnerships (LEP), local nature reserves, and Local Nature Partnerships (LNP).	▪ There needs to be a way of quantifying the benefits of flood risk management for businesses. ▪ Even highlighting the repercussions a major flood in Leeds would have on the local and national economy, as it is a northern power house. ▪ By emphasising that Leeds is the place to be, which requires investment in other areas first, which will then further justify the investment in flood risk. This is linked to the fact that new sources of funding are needed, the government doesn't have the money, and it needs to come from the private sector. ▪ There needs to be a clear local policy, although it should initially come from DEFRA to start with, but then it needs to lead on to having a local vision.

	▪ It seems eminent that financial incentives might develop for flood risk adaptation of households (e.g. SuDS), similar to the Green Deal Plan. For example, in London there is a (social housing) project on water efficient homes (showers, white appliances, etc.), which incorporates flood protection, so when a household renovates it considers all aspects. Also, the reductions possible in water bills by disconnecting from surface water could be more widely publicised or put into practice (see OFWAT website). There are expectations that the adaptation report submitted by the climate change adaptation minister to parliament should open opportunities. ▪ Here is a strong push for advancing the inclusion of green measures in new developments. A stronger voice at the national level would support this and a long-term economic model would help to set the agenda, especially to developers. ▪ Greater involvement of businesses in flood risk management might develop, particularly an incentive process for new businesses to contribute to flood prevention.	
Madrid	▪ The city of Madrid (as Mayors Adapt signatory) is developing an adaptation plan. ▪ A vulnerability study has been finalized identifying the most critical sectors. The threshold temperature is likely to be adapted and implemented in the heat warning system by the Community of Madrid. ▪ Research is likely to continue.	▪ For heat waves, changing the threshold temperature could end in having more warnings in the summer. This could lead to a loss of credibility by the population. ▪ For green roofs, the future prospect is less certain due to a negative cost-benefit analysis, it is a very dry climate and at national institutional level they are pushing/funding grey infrastructure.
Prague	▪ Flood protection of the city of Prague is on a very high level. ▪ There are some issues in certain non-protected parts of the city (districts of Lahovice and Troja), which need discussing. ▪ Attention will (or should) be also given to ecosystem-based flood adaptations,	▪ We can expect subsequent development and negotiations regarding the districts of Lahovice and Troja, but the outcomes are highly unpredictable and uncertain.

	mainly in minor streams, because even though the city is at this moment well protected against river floods from the Vltava river, there is still a high risk of damage caused by small streams. ▪ As the city is well protected from fluvial floods at the moment, there is space to consider adaptation to other phenomenon such as flash floods (caused by rainfall) or urban heat island and heatwaves. The latter will probably play a major role within the city in next couple of years. ▪ Adaptation to these effects of changing climate will most likely lie in green-blue infrastructure and soft measures. Even though such events do not cause great direct damages to property they have significant effects on people's health and the national economy.	
Rotterdam	▪ By using Adaptive Delta Management (ADM) as the underlying approach for creating strategies and determining measures in the Rijnmond-Drechtsteden case, the future is already integrated into the current strategy. ▪ The pathways approach underlies ADM, and is an attempt to anticipate possible future climatic and other changes. ▪ In the current standards for dikes, a robustness factor is already taken into account by over-dimensioning the height of the dikes and taking conservative assumptions about possible river discharge and storm set-up into the equation. ▪ The strategy has some capacity to be adapted over time by the pathways, possibly leading to upscaling measures, or alternating between different measures. ▪ For climate change adaptation activities it is also required by the Delta Programme legislation that climate change prognosis be incorporated into standards and budgets for governmental action.	
South Devon		▪ The current national government is Conservative and is not expected to

		actively start considering, developing and /or supporting climate change adaptation strategies and policies. ▪ The local authorities do not have the funding to enhance the resilience of the existing line, or develop a new line. ▪ Network Rail has stated clearly and multiple times that their task is only to maintain the current line, not to go beyond to address climate change.
South Moravia	▪ Future prospects and opportunities might be seen when the National Adaptation Strategy and the new common agricultural policy are implemented.	▪ Agricultural adaptation is currently rather autonomous, institutional and governance support is needed to support effective adaptation.
Timmendorfer Strand	▪ To ensure a wide sandy beach groins in one part of town were constructed. ▪ After evaluating the success of the groins there are plans to extend the groins to other parts of town. Since this is not classified as coastal defence measure, costs have to be covered by the community with no financial support from the state of Schleswig-Holstein. ▪ There are intentions to communicate this attempt of coastal protection. For example, upon request, there are guided tours along the promenade or presentations at various events. ▪ At least one City of the German Baltic Sea is thinking of implementing glazed retentions walls as a coastal defense measure.	▪ After completing the measure, there is currently no discussion for further coastal protection.
England	▪ Overall, in terms of mental health and climate change, adaptation measures are being put in place in terms of action plans to assist in emergency response to extreme events.	▪ The case study shows there should be a general reduction in demand for services – with reduced prescription rates suggesting less demand. ▪ In the longer term, reallocation of resources to alternative uses may be possible but in the short term there may be inefficiencies in the level of service provision.
Usti	▪ Future prospects and opportunities might be seen when the National	▪ Agricultural adaptation is currently rather autonomous, institutional and

	Adaptation Strategy and the new common agricultural policy are implemented.	governance support is needed to support effective adaptation.
Venice		▪ The economic assessment shows that with increasing sea levels, residual damages are increasing, and critical limits for the efficiency of private building-based measures could be reached soon. ▪ Although it is not clear how these limits will be defined, partly because of socioeconomic transformations, especially the increasing transformation of private dwellings into tourist accommodation which will accelerate the rate of uptake of the most expensive (and efficient) among the flood proofing measures. ▪ As tourists lack the local knowledge and experience Venetians use for dealing with local flood risk.