BOTTOM-UP CLIMATE ADAPTATION STRATEGIES TOWARDS A SUSTAINABLE EUROPE

Title: **Climate change, impact and adaptation scenarios for case studies**

Summary: This deliverable, structured in three chapters, provides an in-depth review of BASE case studies, including baseline climate change, impact and adaptation scenarios.

Using data from the Case Study Living Document (CSLD) and from the updated climatic and socio-economic models, as well as preliminary results from case study research, chapters report and discuss the state of adaptation planning in different countries and case study groups.

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SEVENTH FRAMEWORK PROGRAMME

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Contents

Introduction

By Jouni Paavola & Inês Campos

The **B**ottom-up Climate **A**daptation Strategies towards a **S**ustainable **E**urope (BASE) project addresses the need to develop research on sustainable climate adaptation by combining bottom-up and top-down strategies.

To gather insights on drivers, opportunities, barriers, costs and benefits for actions at the local level, BASE examines climate change adaptation case studies across Europe. Different geographical locations have diverse climatic and socio-economic contexts. Therefore, case studies were selected to represent a contextual variation in Europe and organized in sectorial subgroups, with a focus on six sectors:

(1) agriculture and forestry; (2) biodiversity and ecosystem services; (3) coastal zones; (4) cities and infrastructures; (5) human health and (6) water resources.

Each sector is represented by a number of case studies. All case studies are analysed from multiple research agendas, such as: public policy and governance, socioeconomic characteristics, public participation; perceptions of risk and vulnerability; adaptative capacity and adaptative action; and economic assessments.

Moreover, an additional group of international case studies, includes studies from other continents, with the objective of drawing lessons on adaptation preferences, policies and practices for Europe.

Bottom-up research of BASE case studies is informed by a common case study research approach (see deliverables 4.1, 6.1a and 6.1b). This common strategy has been defined in order to coordinate a multi–prescriptive, inter-disciplinary and trans-disciplinary research approach. A uniform approach would have not been feasible, given the heterogeneity of cases: some are ex post evaluations (retrospective), others are forward-looking (prospective). Some cases are researcher-led analyses and evaluations, others engage with multi-scale and multi-level adaptation processes, while studying and experimenting with participatory approaches at various levels of stakeholder engagement. Furthermore, the scope and depth of the case study analysis varies, resulting in different resources allocated.

The common case study approach seeks to achieve a coherent aggregation and comparability of results by establishing a framework, guided by common perspectives, questions and methods. Case study owners' work together to provide additional instruments for coordination, while sharing expertises, as well as developing innovative research approaches, methodologies and tools.

To facilitate dialogue among case study owners, a coordination instrument has been designed: the Case Study Living Document (CSLD). This should be seen as a guiding structure that all case studies use to align their research perspectives and methodologies and report their findings congruently. The document also allows for higher comparability, since its sections highlight the need to provide results on specific topics (i.e. impacts, adaptation, methodologies, economic assessments, participatory approaches, policy and governance, implementation of adaptation actions).

The present deliverable has been drafted based on the use of the CSLD, which has been filled out and regularly updated by all case study owners. The functioning of the CSLD should be seen as a solution to promote consistent and aggregated case study reporting, though flexible enough to allow for further possibilities of improvement.

In the Description of Work (DoW), Deliverable 5.1 is described as:

"*Climate change, impact and adaptation scenarios for case studies: Assessment of baseline case specific climate change impacts and adaptation scenarios - is linked to task 5.1."*

Additionally, Task 5.1 is described as:

"Partners will first generate an information base on case specific contextual and background factors to foster the implementation of subsequent tasks in each case study. The task will also map the state of art regarding adaptation planning and actions in the case studies. Where possible, existing downscaled climate change scenarios and impact assessments will be used/adapted. In addition, socio-economic data on economic activities, demography, infrastructure, environment, vulnerabilities, risks and uncertainties will be generated to identify how and to what extent climate change is likely to impact case study sectors and areas. The observations will be consolidated to brief case-specific climate change impact and adaptation scenarios. This task directly seeks to contribute to BASE objectives 1, 2, 3 and 4 (see section1)."

The purpose of this deliverable is therefore to report the first set of observations from BASE case studies, namely:

1) report on case specific contextual and background factors;

2) map the state of the art of climate change impacts with a focus on case studies and respective adaptation drivers;

3) outline downscaled climate and socio-economic scenarios, as well as impact assessments at the case study group level;

4) report on climate change perceptions of risk, uncertainty and vulnerabilities, and the incorporation of adaptation planning, measures and actions, at the subgroups and individual case study levels.

Moreover, while economic assessments and case specific adaptation measures and actions are to be thoroughly reported on deliverables 5.2 and 5.3, this document already reports on guidelines and approaches to develop these assessments.

To meet these goals, the deliverable has been organized in three chapters. In what follows, Chapter 1 reports on climate change and socio-economic scenarios and its potential uses in case studies. Chapter 2 reviews key elements regarding climate change impacts and relates these to adaptation drivers and pathways. This chapter also provides preliminary findings of case study groups, while highlighting the state of the art of adaptation strategies and options for each case study. Chapter 3 provides a discussion on the information collected regarding the practitioners' perceptions of climate change adaptation and their needs, as well as perceptions and responses to various dimensions of risk and vulnerability. The conclusion reflects on the observations made, on the data being gathered and preliminary results.

1 Climate and Socio-Economic Scenarios

Authors: Francesco Bosello & Enrico Scoccimarro

This section will describe the updated climatic and socio-economic scenarios and its relevance for all BASE case study groups and case studies.

The strategic choice made by the BASE research consortium in the definition of the social and climate change scenarios, has been to refer to the new, and partly still ongoing, scenario building process undertook by the IPCC, instead of addressing the consolidated, but old IPCC SRES scenario exercise (IPCC, 2000).

Socio-Economic Scenarios (National level)

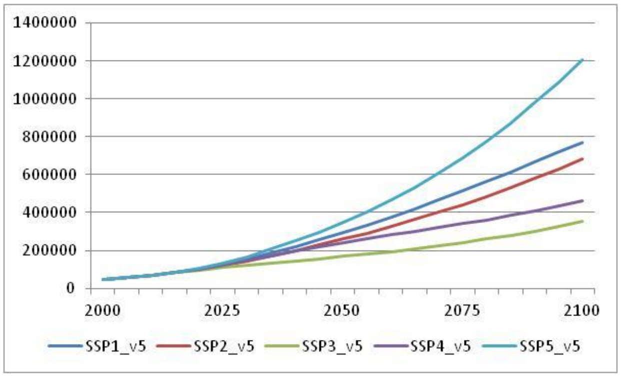
This new process consists in the parallel definition of "shared" social economic development pathways, the SSPs (O'Neill et al. 2012), and of representative concentration pathways, the RCPs (Van Vuuren et al. 2012). The first part is a describtion of possible future evolution of selected key economic drivers: population, GDP and urbanization. The second part, the evolution of radiative forcing and of atmospheric carbon dioxide concentration.

There are five SSPs. They characterize different challenges for adaptation and mitigation (for a complete description refer to BASE D3.1. Bosello et al (2013)). **The final decision of the BASE consortium has been to use as social-economic references SSP2 and SSP5.**

SSP2 represents a sort of "business as usual" that can allow to characterize adaptation needs and challenges in a world were both social-economic growth and environmental concerns evolve following "current trends". Indeed, according to its "narrative[1]", it is also called the "Middle of the Road" or "Dynamics as Usual", or "Current Trends Continue" scenario. Its global population and GDP growth trends fall exactly in the middle of the SSPs range (see Figure .**1**). Specifically, world population is foreseen to increase up to 9.8 billion by 2100, with almost all of the increase concentrated in the first half of the century, to then stabilize after 2060. World GDP highlights an almost ten-fold increase between 2010 and 2100, again more pronounced in the first half of the century.

SSP5 reflects instead a world with high emissions where climate change policies are unable to limit increases in CO2 concentration and temperature. It is centred on "conventional development" leading to an energy system dominated by fossil fuels.World GDP growth between 2010 and 2100 is the highest among all the SSPs, and almost double compared to SSP2. On the contrary, population growth is lower than that of SSP2, almost the lowest across all SSPs, and reach 7.6 billion in 2100. SSP5 population trends are mostly determined by the lower population growth in developing countries, often declining in the second half of the century, while developed societies highlight stable or moderately increasing populations.

[1] https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf



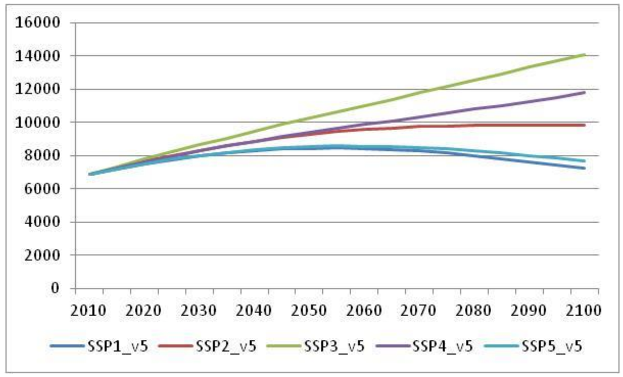
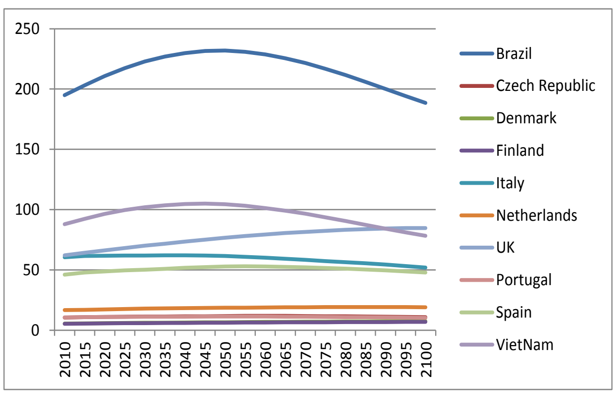


Figure 1.1. World GDP, OECD source, US$ billion (left) and population, IIASA source, million, (right) in the SSPs[2]

These global trends are replicated when the countries focus of the BASE analyses are considered singularly (see **Figure 1.1**, **Figure 1.2**, **Figure 1.3).**



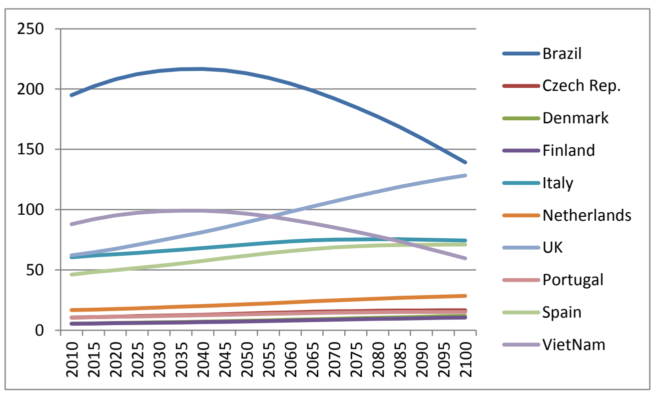


Figure 1.1. Population in the BASE cases study countries, IIASA source, million. SSP2 (left), SSP5 (right)[3]

[2] Source: https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=welcome

[3] Source: https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=welcome

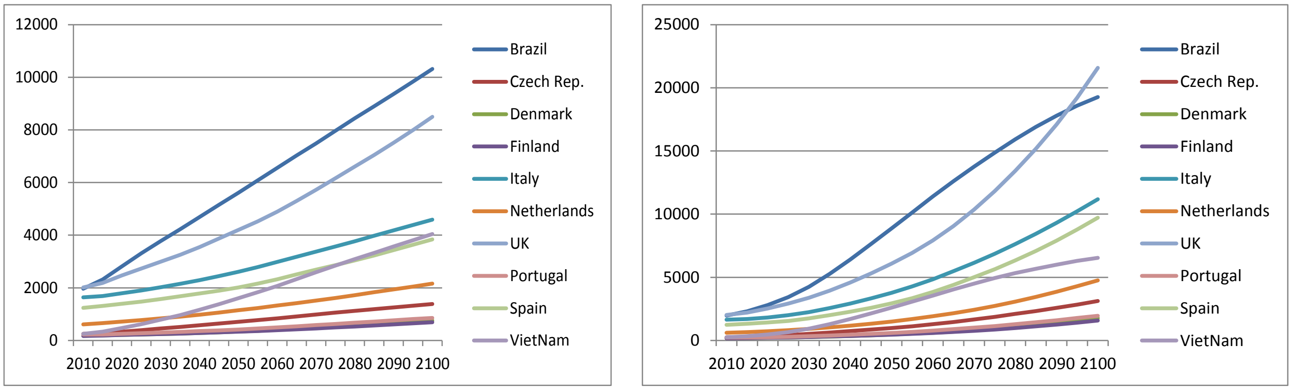


Figure 1.2. GDP in the BASE cases study countries, OECD source, US$ billion. SSP2 (left), SSP5 (right)[4]

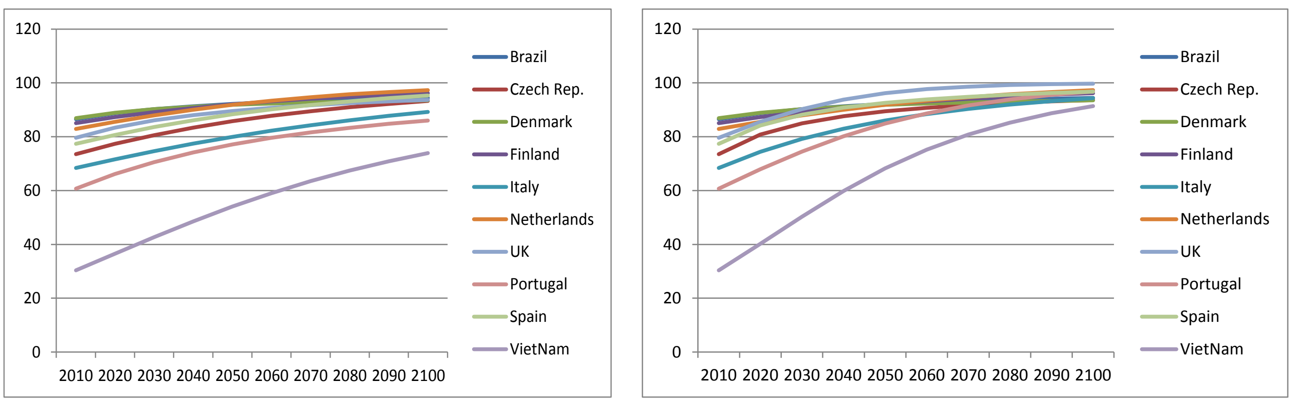


Figure 1.3. Urbanization rates in the BASE cases study countries (%). SSP2 (left), SSP5 (right)[5]

As general comment, the chosen SSPs highlight short-term GDP growth rates for developed countries that, also in the “lower growth” SSP2, are quite “optimistic” especially when compared to what historically observed in the last ten years. Nonetheless, all the SSPs still maintain the assumption of relative convergence, which postulates even higher GDP growth in developing countries. Below, follows a short description of the main features of SSP2 and SSP5 by country.

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[4] Source: https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=welcome

[5] Source: https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=welcome

Brazil

In SSP2, population in Brazil presents a bell shaped trend, peaking to almost 232 million in 2050, then declining, reaching 139 million by the end of the century. SSP5 is more conservative: the population maximum is lower (216.6 million) and reached ten years earlier. The subsequent population decline is also more acute than in SSP2 leading to 139.1 million people in 2100. Overall, across the 2010 - 2100 period, net population balance of the country is negative scoring a -3.3% and -28.6% in SSP2 and SSP5 respectively. GDP shows a steady increase in both scenarios: on average the 1.95% per year between 2010 and 2100 in SSP2, and the 2.75% per year between 2010 and 2100 in SSP5. In both scenarios growth is more pronounced in the first half of the century, in SSP5 this pattern is more evident. The country urbanization rates are the same across the two scenarios: they slightly increase from the already high 86.5% in 2010 to the 94.4% in 2100.

Czech Republic

In SSP2, along the 2010-2100 period, Czech population increases up to 2060 and decline thereafter. The net result is an almost stable average yearly growth rate of the 0.04%. In SSP5 it grows the 0.5% per year totalling a 57.7% increase with respect to the 2010 level (10.4 million) by the end of the century. Czech GDP levels are among the lowest of the “BASE countries”, but its growth rates are the second highest. The country scores a 2.2% and a 3.04% average yearly GDP growth rate (1.97% and 2.45% in per capita terms) along the century in SSP2 and SSP5 respectively. Only Viet Nam performs better. Urbanization increases at the very similar rates of the 0.29% and 0.3% in SSP2 and SSP5 respectively, leading the country to host roughly the 93% of population in urban areas in 2100.

Denmark

Denmark population shows a moderate increase in the SSP2 (0.3% per year on average) and one roughly three times larger in SSP5 (0.85%). Within the 2010-2100 period GDP increases almost uniformly the 1.67% per year and the 2.71% per year in SSP2 and SSP5 respectively. Urbanization rates are increasing and the same across SSP2 and SSP5. The initial 86.8% in 2010 becomes 93.5% in 2100.

Finland

Finland population depicts a 0.27% and a 0.76% average yearly growth rates between 2010 and 2100 leading to a total population increase of the 27% and the 95% in 2100 compared with 2010 levels in SSP2 and SSP5 respectively. GDP average yearly growth rates are high: 1.6% and 2.6% in the two SSPs. Urbanization rates are the same across the two scenarios: starting from the 85% in 2010 they reach 96.1% in 2100.

Italy

Differently from the majority of developed countries, Italy population in SSP2 is slightly declining: between 2010 and 2100 average yearly growth rates are negative (-0.17%) leading to a total population loss of the 14.3%. The decline is concentrated in the second half of the century, while, in the first, population is basically stable. SSP5 on the contrary, projects for the country a moderate population growth (0.2% per year) implying a 22.7% total increase along the whole period. GDP is assumed to increase 179% and 581% in 90 years, meaning quite positive average yearly growth rates of 1.2% and 2.2% respectively in SSP2 and SSP5. In 2010 Italy urbanization rate is the second lowest amongst the group of countries analysed: 68.3%. This is projected to increase to reach in 2100 89.2% and 94.3% respectively in SSP2 and SSP5.

The Netherlands

Both SSP2 and SSP5 project constant population increases in The Netherlands along the century. In the first scenario however, average growth rate is the 0.15% per year against the considerably higher 0.6% of SSP5. Economic growth is assumed to proceed steadily at a rate of the 1.45% and 2.41% per year along the century in the two scenarios respectively. This figures out a 3.5 and 7.8-fold increase of The Netherland GDP at the end of the century with respect to the 2010 levels in SSP2 and SSP5 respectively. The share of total population living in urban areas raises from the 82.8% in 2010 to 97.3% in 2100. This change is uniform across the two SSPs.

UK

Between 2010 and 2100 UK population increases the 36.5% in SSP2 and roughly doubles (106.8%) in SSP5. GDP performances are amongst the best across the countries considered by BASE cases study: in the 90 years considered UK GDP more than quadruples in SSP2 (321.8%) and it increases almost 10 times (971%) in SSP5. This places the country as the third best performer in 2100 after Vietnam and the Czech Republic. The urbanization rate is 79.6% in 2010. It is projected to increase in both scenarios: in 2100, in SSP2 it reaches 93.7% while it peaks to 99.7% in SSP5.

Portugal

In SSP2 Portugal population increases up to 2050 at the average yearly growth rate of the 0.14%; then it declines at the rate of the 0.2% per annum until 2100. The net outcome is a slight population decline of the 4.3% along the century. SSP5 depicts a steady population increase of the 0.39% per year over the century, slightly less pronounced in the last years of the century. Portugal GDP increases the 272.7% according to SSP2 and the 749.5% according to SSP5 along the century. In per capita terms this amounts respectively to an increase of the 289% and 498% respectively. The country's quite low urbanization rates of 2010 (60.7%) reach in 2100 the 86% and 96.8% in SSP2 and SSP5 respectively.

Spain

According to SSP2, Spain population increases up to 2055 at the average yearly growth rate of the 0.31% to decline thereafter at the rate of the 0.23% per annum until 2100. The net outcome is a slight population increase of the 3.6% along the century. SSP5 depicts instead a steady positive population yearly average growth rate of the 0.5% over the century, which however tend to fall close to zero since 2090. According to SSP2, Spain GDP roughly triples its 2010 levels in 2100 (209%); it is the 682% larger according to SSP5. In per capita terms, this amounts respectively to an increase of the 198% and 408% respectively. The country urbanization rates moves from the 77.3% in 2010 to 95.2% and 96.7% in 2100 in SSP2 and SSP5 respectively.

Vietnam

Vietnam population takes a bell shape both in SSP2 and SSP5, but more pronounced in this last. SSP2 population peak is in 2045 at almost 105 million, that of SSP5 in 2035 at 99.1 million. Then growth trends are negative leading the country to reach in 2100 population levels which are the 10.9% and the 32.2% lower than those of 2010 in the two scenarios respectively. GDP performances of the country are impressive. In 90 years it increases 15 and 25 times (17 and 37 times in per capita terms) in SSP2 and SSP5 respectively. Also urbanization rates boom. The 2010 30% transforms into almost 74% and 91% in 2100 according to SSP2 and SSP5.

Climate Scenarios

Having defined the SSPs, these have been associated to 2 RCPs. Namely: SSP2 to RCP4.5 and SSP5 to RCP8.5.

1.1 Climate projections over the Iberian Peninsula as represented by high resolution regional climate model

This section provides a description of the mean present climate and two possible scenarios for the XXI century (up to 2100) over the Iberian peninsula (Figure 1.1 shows the considered domain), based on the data set delivered by CMCC to the BASE project users. This data set derives from results produced by the latest version of the high resolution Regional Climate Model (RCM) developed at the Rossby Centre, the climate modelling research unit of the Swedish Meteorological and Hydrological Institute (SMHI). The horizontal resolution of the considered RCM is about 15 km, allowing the detection of the small scale features of the climate signal.

Temperature and precipitation over the present climate will be discussed in section 1.1.1 and their future projections in 1.1.2. Section 1.1.3 describes present climate and future projections over three case study regions: Aveiro Coast, Cascais and Alentejo. For a deep discussion on the RCM and the relative simulations please refer to Scoccimarro and Gualdi (2014).

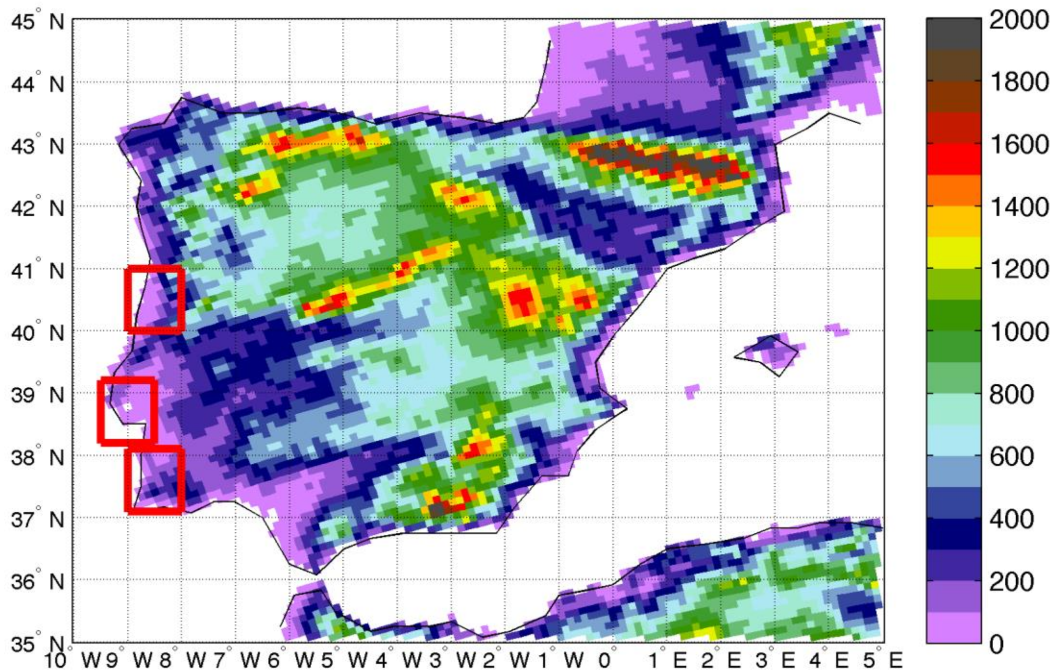


Figure 1.4: Iberian Peninsula domain. The picture shows the representation of the orography. Units are [m]. The upper/central/lower red box indicates the Vagueira/Cascais/Alentejo case study domain.

1.1.1 Present climate over the Iberian Peninsula

In this section we discuss the ability of the regional model to reproduce the observed present climate over the Iberian Peninsula in terms of 2-meter temperature and precipitation comparing model results to observations.

The simulated 2-meter air temperature (TAS) has been assessed using observational data from the Climatic Research Unit (CRU, Harris et al. 2013. The data are available at the web site http://badc.nerc.ac.uk/view/badc.nerc.ac.uk__ATOM__dataent_1256223773328276), representing month-by-month variations in climate over the last century or so. These data are available on a relatively high-resolution grid (0.5ºx0.5º), and they are the result of an analysis performed on an archive of monthly mean temperatures provided by more than 4000 weather stations distributed around the world. Simulated precipitation (PR) is compared with observations from the E-OBS dataset (Haylock et al. 2008), a very high resolution data set with a 0.22° regular latitude-longitude resolution on a grid with rotated pole in order to have almost equal areas over Europe. The reference period is 1997-2005, according to the availability of the precipitation observational dataset within the CMIP5 historical epoch.

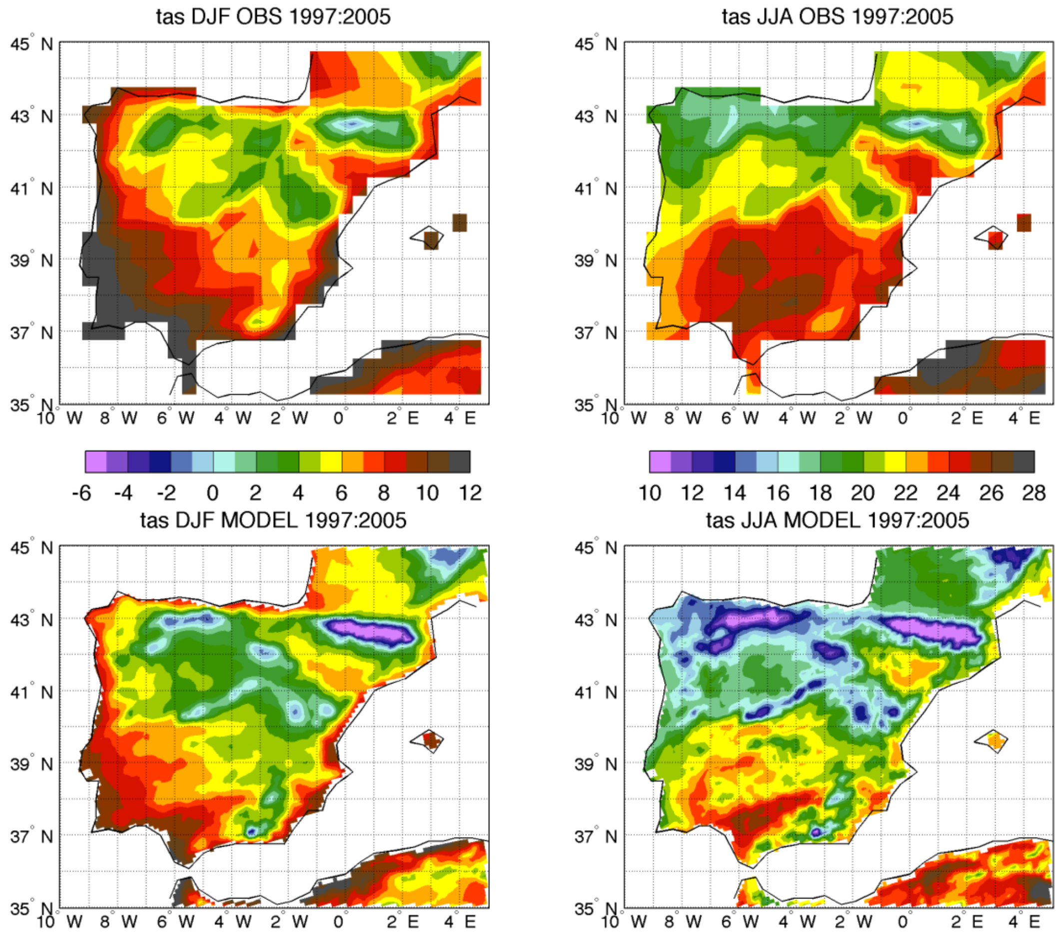


Figure 1.1.1: 2-meter air temperature (TAS) seasonal means as represented by the model (lower panels), compared to CRU observations (upper panels), during the 1997-2005 period. Left panels show the northern winter (DJF) means and right panels show the northern summer (JJA) means. Units are [ºC]. Colour interval is 1ºC.

The modelled 2-meter temperature captures the main features of the observed spatial patterns in both seasons (**Figure 1.1.1**), despite a tendency to underestimate TAS over the considered domain, especially during summer (June to August – JJA). During winter (December to February – DJF) the underestimation is less pronounced, except over the orographic features such as the Pyrenees. These biases are similar to the CMIP3 and CMIP5 fully coupled GCMs ones, which tends to simulate colder climate than observed and other RCMs (Cattiaux et al. 2013, Dosio et al. 2013).

During winter the mitigation effect induced by the Atlantic Ocean on TAS over the coastal regions is well kept by the model, both over the Atlantic and Mediterranean sectors. The modelled colder climate in the central-northern part of the Iberian Peninsula during both seasons, if compared to the costal areas, is realistic, and the meridional temperature gradient within the Iberian Peninsula is similar to the observed one. When compared to observations, some additional features appear around the regions with a more realistic representation of the orography (**Figure 1.4**) in the very high resolution RCM results: the horizontal resolution of the model is about one fifth of the CRU one.

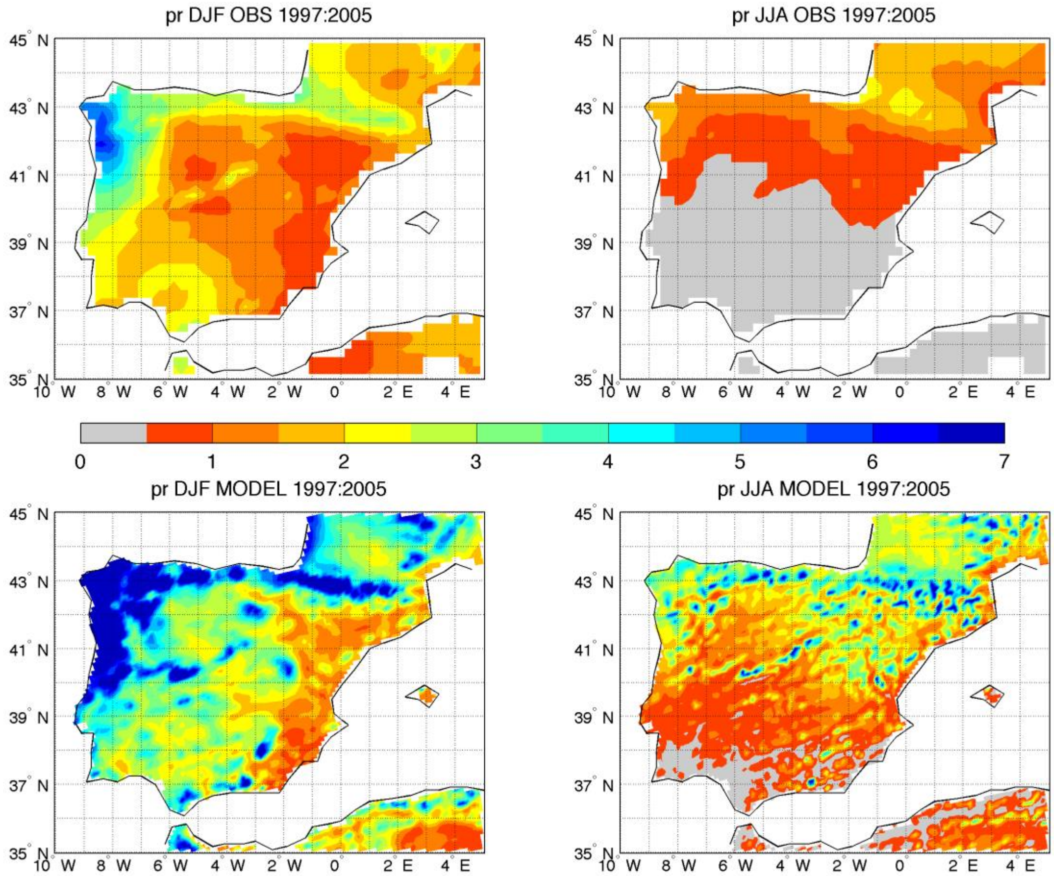


Figure 1.1.2: Seasonal mean precipitation (PR) as represented by the model (lower panels), compared to E-OBS observations (upper panels), during the 1997-2005 period. Left panels: winter mean (DJF); right panels: summer (JJA) mean. Units are [mm/d]. Color interval is 0.5 mm/d.

The precipitation seasonality is well presented by the model (**Figure 1.1.2**), despite the tendency to overestimate precipitation in both seasons. The main differences appear over the region where a better representation of the orography in the model, compared to the E-OBS, becomes more evident. In general, we notice that the biases over topography are similar to what is found for most RCMs (Piani et al. 2010, their figure 2).

1.1.2 Future projections over the Iberian Peninsula

In order to investigate future climate scenarios over Europe we leverage on two CMIP5 Representative Concentration Pathways (RCPs) defined within the CMIP5 project: RCP4.5 and RCP8.5 (Riahi et al. 2011, Taylor et al. 2012).

Both scenarios show the largest TAS increments over the Pyrenees during winter and over Pyrenees and central part of the Iberian Peninsula during summer (**Figure 1.1.3**), with a less pronounced warming along the coasts. The 2071-2100 RCP8.5 mean winter temperature over the Pyrenees is about 5ºC warmer (**Figure 1.1.3**, bottom left panel) if compared to the reference period (1976-2005). This effect is less pronounced in the RCP4.5 scenario (**Figure 1.1.3**, upper left panel). The warming is more pronounced during summer, doubling the winter corresponding value over most of the domain but the Pyrenees, where the warming results similar during both seasons, ranging from 5ºC (in winter, **Figure 1.1.3**, bottom left panel) to 7ºC (in winter, **Figure 1.1.3**, bottom left panel) in the RCP8.5 scenario, and from 2ºC (in summer, **Figure 1.1.3**, top right panel) to 4ºC (in winter, **Figure 1.1.3**, top left panel) in the RCP4.5 scenario.

Averaging the projected temperature over the entire domain, the model projects an increase of about 3ºC/4.5ºC during winter/summer at the end of the business as usual RCP8.5 scenario and 1ºC/2ºC during winter/summer at the end of the moderate RCP4.5 scenario.

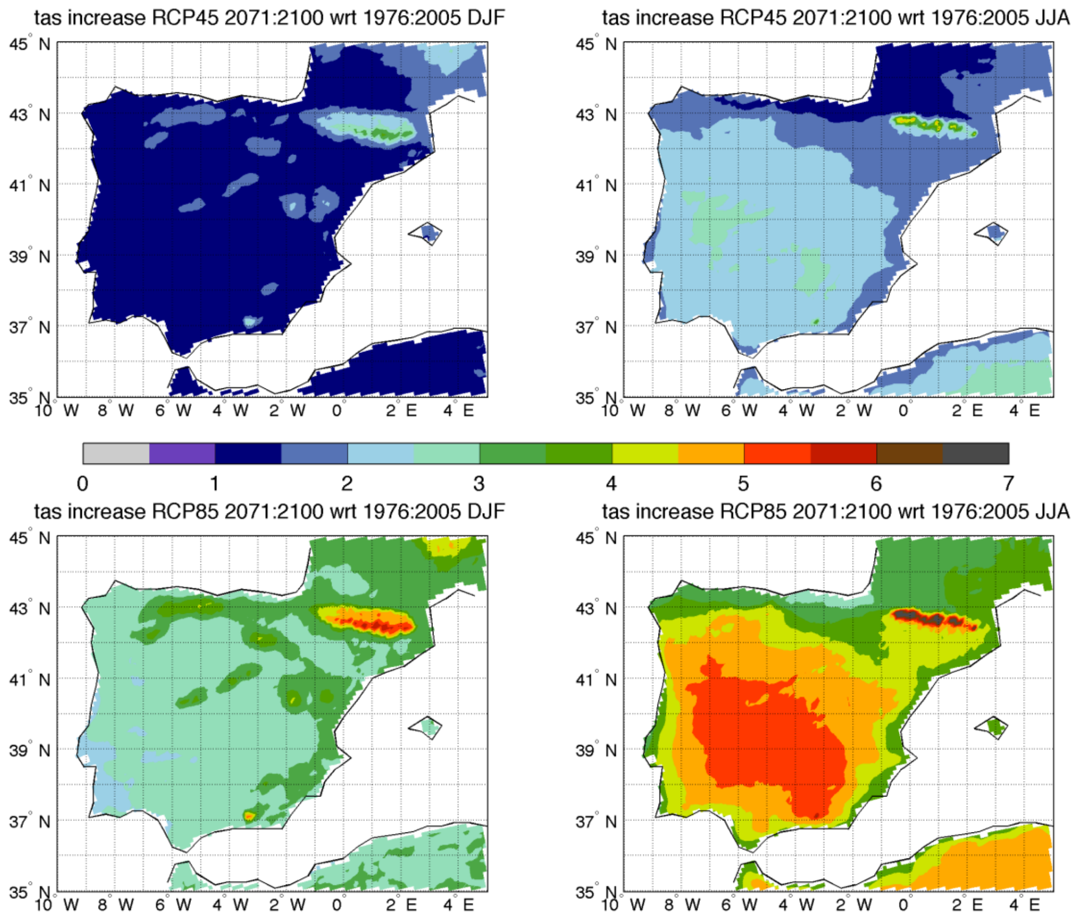


Figure 1.1.3: Changes in 2 meter air temperature at the end of simulated RCPs (2071-2100) with respect to the historical period (1976-2005) under RCP4.5 (upper panel) and RCP8.5 (lower panel). Left panels: winter mean (DJF); right panels: summer (JJA) mean. Units are [ºC]. Colour interval is 0.5ºC.

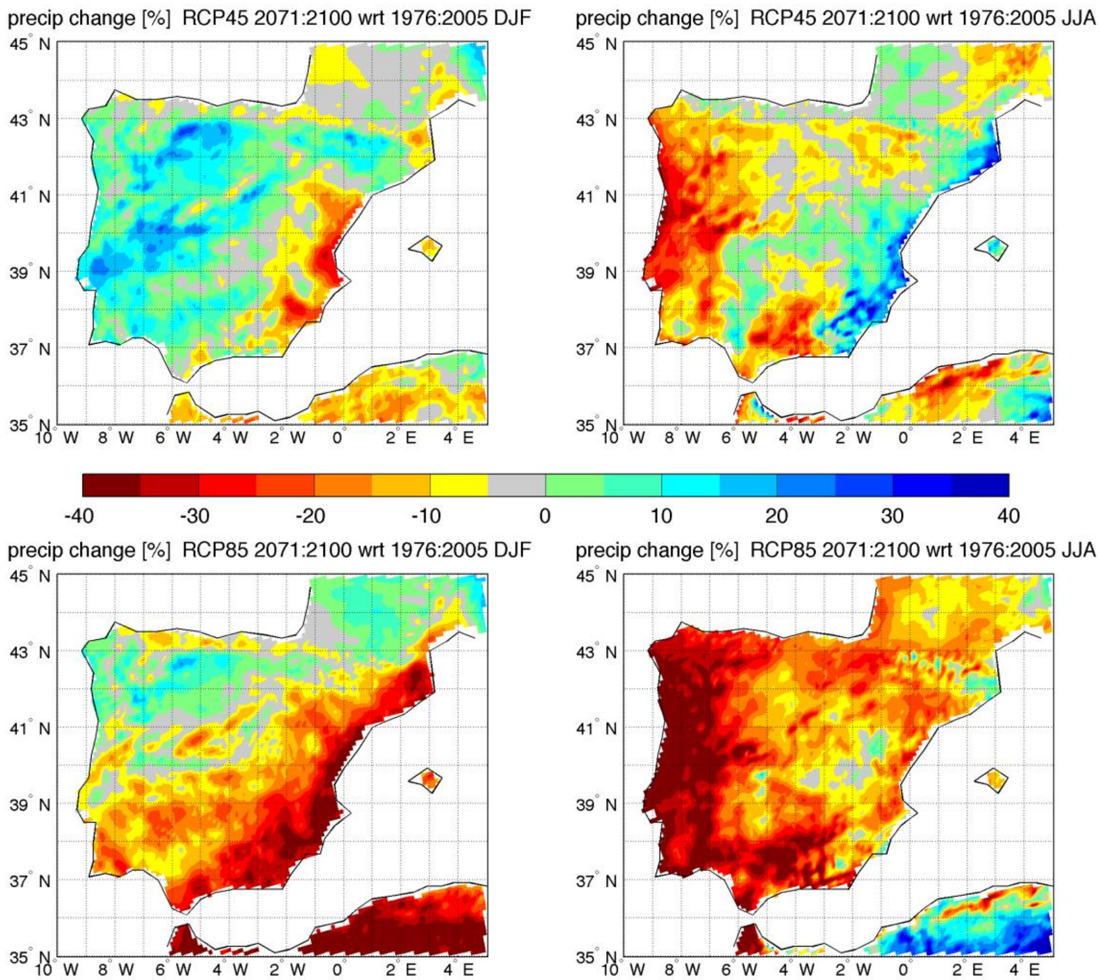


Figure 1.1.4: Changes in precipitation at the end of simulated RCPs (2071-2100) with respect to the historical period (1976-2005) under RCP4.5 (upper panel) and RCP8.5 (lower panel). Left panels: winter mean (DJF); right panels: summer (JJA) mean. Units are [%] and the colour interval is 5%.

A less clear climate change signal appears is terms of precipitation: the projection at the end of both scenarios (**Figure 1.1.4**, same as for TAS projections shown in **Figure 1.1.3**,) varies significantly within the Iberian Peninsula domain.

The RCM results are partially consistent with previous findings obtained using the CMIP5 climate change projections (Scoccimarro et al. 2013), where a common negative tendency is found for the averaged precipitation over the Iberian Peninsula, in a multi-model framework under the RCP8.5 scenario.

The detailed information provided by the regional model highlights winter and summer tendencies in western and eastern part of the domain, with of the opposite sign (**Figure 1.1.4**). In particular in the western part of the peninsula, summer precipitation (**Figure 1.1.4**, right panels) appears to decrease down to -20%/-40% in RCP4.5/RCP8.5 respectively and winter precipitation (**Figure 1.1.4**, left panels) tends to increase up to 10% in RCP4.5 scenario and depicts a less coherent signal in RCP8.5. In the eastern part of the peninsula the model project a decrease of about -

30%/-20% during DJF/JJA in RCP8.5. On the other hand, following the RCP4.5 scenario the eastern part of the peninsula is affected by a decrease/increase of about 20% during winter/summer.

It is important to note that, despite a strong signal in terms of percentage projections over some regions (**Figure 1.1.4**), the tendencies are not statistically significant (precipitation projection in different case studies is investigated in detail, in section 2.13). This is more evident during the summer season when the present climate precipitations is of the order of a fraction of 1 mmd^{-1} (**Figure 1.1.4**, right panels), thus small changes in future precipitations can lead to huge percentage differences (**Figure 1.1.4** bottom right panel).

1.1.3 Future projections at the case study level: Aveiro Coast, Cascais and Alentejo cases

A more detailed analysis, considering three case studies (Aveiro Coast, Cascais and Alentejo) is the focus of this chapter. Both Temperature and precipitation are investigated considering annual, winter (DJF) and summer (JJA) averages, in order to disentangle the relative role of the two different seasons in modulating long term changes in the mean climate and variability.

Aveiro Coast

A box of 1ºx1º, around Vagueira Beach (South of Aveiro) is considered when averaging 2 meter temperature and precipitation fields to represent future climate evolution in the region (see red box north of 40 ºN in **Figure 1.1.1**). Only grid point over land are taken into account. Noteworthy, sensitivity tests suggest no particular dependence of the projected results on small changes in the dimension/position of the defined box. **Figure 1.1.5** shows the 2 meter temperature anomaly projected in the two considered scenarios, computed with respect to the present climate period (1971:2005). The annual TAS average is expected to increase up to 4 ºC at the end of the XXI century following the business as usual scenario RCP8.5 and 2 ºC following the more moderate RCP4.5 scenario. In both scenarios the contribution of the winter warming (up to 5 ºC in RCP8.5) seems to be the dominant component of the annual average tendency, since summer warming is expected to do not exceed 3 ºC and 1.5 ºC in RCP8.5 and RCP4.5 respectively.

The decadal variability signal in the TAS anomaly during the XXI century results more related to the winter contribution (blue lines in figure 6), with a less intense signal induced by the summer variability (red lines in **Figure 1.1.5**). In the middle of the XXI century, a warming of about 1.5 Celsius degrees is expected in the annual average of TAS in both scenarios, strengthening the reliability of the suggested trend in the next 50 years. The annual mean TAS tendency (linear trend), during the entire XXI century, is of the order of 0.4 ºC/decade in RCP8.5 and 0.2ºC/decade in RCP4.5. Both trends are statistically significant (the statistical significance mentioned through the paper is verified at the 99% level with a bootstrap method).

The model tends to overestimate the precipitation over the Aveiro region (**Figure 1.1.6**), especially during winter, reaching a positive bias of the same order of magnitude of the observed precipitation, but the precipitation seasonal cycle is well represented. At the end of the RCP8.5 scenario, precipitation is projected to decrease of about 30% during the summer season (**Figures 1.1.5** and **Figure 1.1.6**, red solid line) and to decrease of about 10% during the winter period (**Figure 1.1.5** and **Figure 1.1.6**, blue solid line). No statistically significant trends are found in RCP4.5 projected precipitation, either in winter and summer. The decadal variability seems to be mainly modulated by winter precipitation (blue lines in **Figure 1.1.6**) in both scenarios.

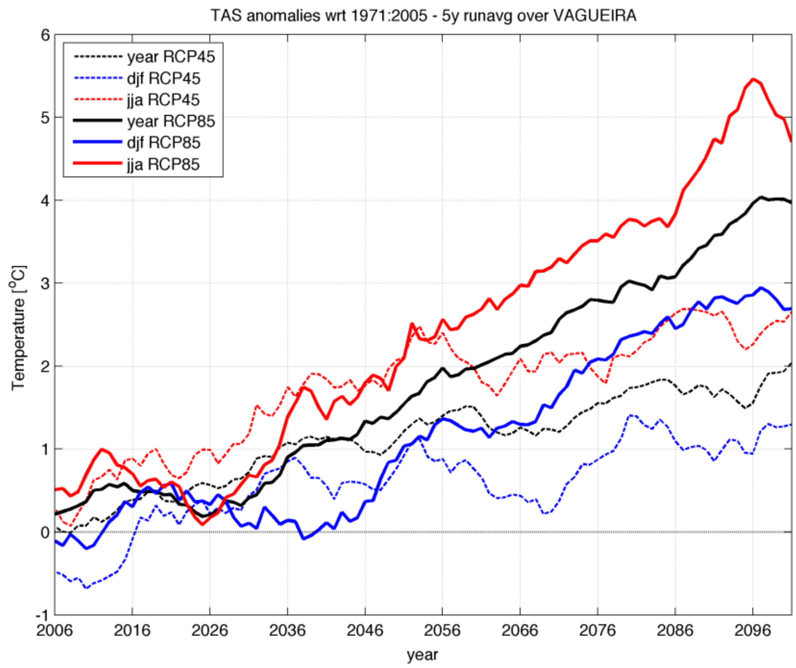


Figure 1.1.5: Projected 2 meter temperature anomalies over Aveiro. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [ºC].

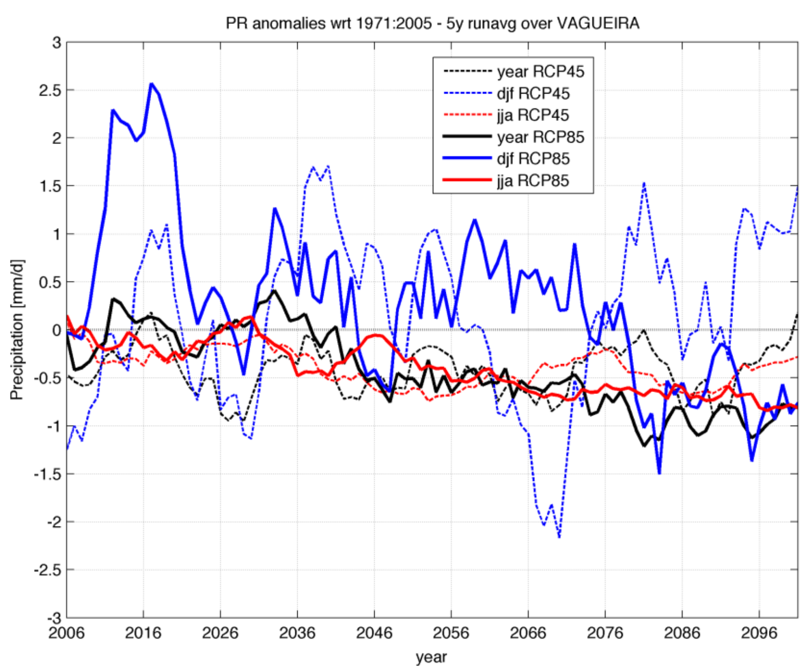


Figure 1.1.6: Projected precipitation anomalies over Aveiro. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [mm/d].

The Cascais Case

Same as for the Aveiro case, a box of 1ºx1º, centered in Cascais is considered when averaging 2 meter temperature and precipitation fields to represent future climate evolution in the region (see the red box around 38.5ºN in figure 1).

Figure 1.1.7 shows the 2 meter temperature anomaly projected in the two considered scenarios, computed with respect to the present climate period (1971:2005). The annual TAS average is expected to increase up to 3.8 ºC at the end of the XXI century following the business as usual scenario RCP8.5 and 1.8 ºC following the more moderate RCP4.5 scenario. These results are very similar to what is found in the Vagueira case study described before.

In both scenarios the contribution of the winter warming (up to 5ºC in RCP8.5) is still the dominant component in determining the annual average, since summer warming is expected to do not exceed 3 and 1.2 ºC in RCP8.5 and RCP4.5 respectively.

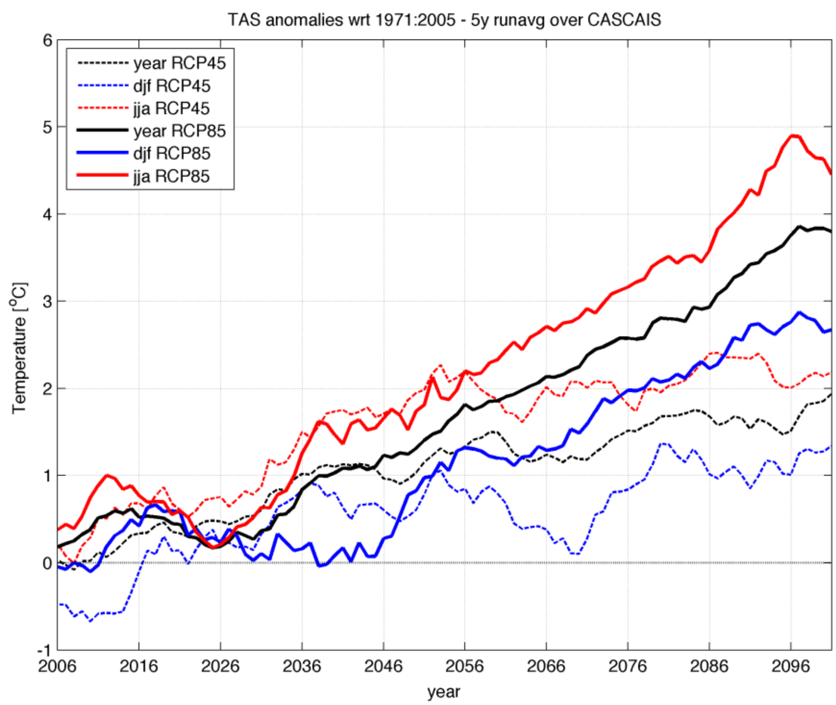


Figure 1.1.7: Projected 2 meter temperature anomalies over Cascais. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [ºC].

Even in the the Cascais case the decadal variability signal in the TAS anomaly during the XXI century results more related to the winter contribution (blue lines in **Figure 1.1.7**), with a less intense signal induced by the summer variability (red lines in **Figure 1.1.7**). Moreover the decadal variability in the two considered cases is in phase (see blue lines in **Figures 1.1.6** and **1.1.7**), suggesting a modulation induced by large scale circulation patterns covering the Iberian Peninsula.

A warming of about 1.2 Celsius degrees is expected in the annual average of TAS in the middle of the century, in both scenarios, strengthening the reliability of the suggested trend in the next 50 years. The annual mean TAS tendency (linear trend), during the entire XXI century, is of the order of 0.4ºC/decade in RCP8.5 and 0.2ºC/decade in RCP4.5. Both trends are statistically significant.

The model tends to overestimate the precipitation over the Cascais region (**Figure 1.1.8**) of about 1 mm/d in both seasons but, even in this case study, the seasonal cycle is well represented. The maximum precipitation over Cascais is registered during winter, in both observations and model results.

The precipitation decrease projected for the summer season (**Figure 1.1.4** right panels and **Figure 1.1.8**) is not statistically significant in both scenarios, and the only significant (-0.1 mmd^{-1}/decade) trend is found in RCP8.5 during winter. In both scenarios, the decadal variability seems to be modulated by winter precipitation (blue lines in **Figure 1.1.8**).

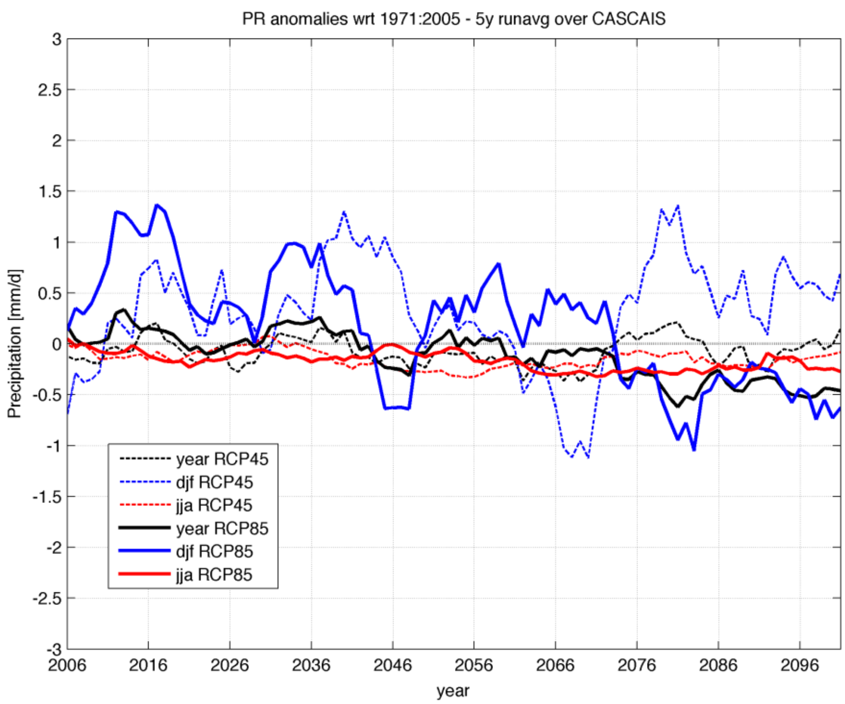


Figure 1.1.8: Projected precipitation anomalies over Cascais. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [mm/d].

The Alentejo Case

Same as for the Aveiro and Cascais cases, a box of 1ºx1º, around Alentejo is considered when averaging 2 meter temperature and precipitation fields to represent future climate evolution in the region (see the red box south of 38ºN in **Figure 1.1.1**).

Figure 1.1.9 shows the 2 meter temperature anomaly projected in the two considered scenarios, computed with respect to the present climate period (1971:2005). The annual TAS average is expected to increase up to about 4 ºC at the end of the XXI century following the business as usual scenario RCP8.5 and about 2 ºC following the more moderate RCP4.5 scenario.

These results are very similar to what is found in the Vagueira and Cascais case studies described before. In both scenarios the contribution of the winter warming (up to 5ºC at the end of the RCP8.5) is still the dominant component in determining the annual average, since summer warming is expected to do not exceed 3 and 1.2 ºC in RCP8.5 and RCP4.5 respectively.

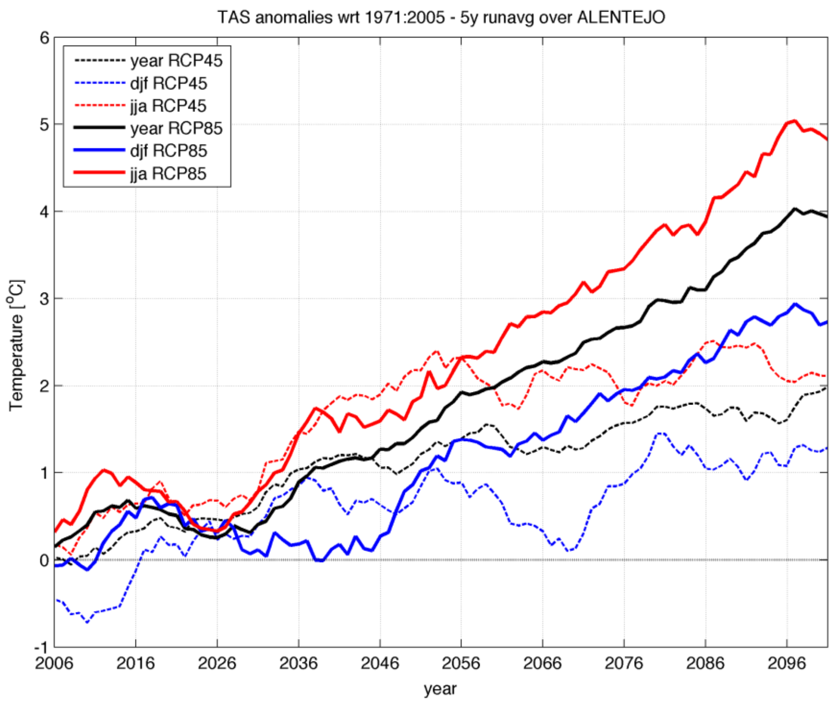


Figure 1.1.9: Projected 2 meter temperature anomalies over Alentejo. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [ºC].

Even in the the Alentejo case the decadal variability signal in the TAS anomaly during the XXI century results more related to the winter contribution (blue lines in **Figure 1.1.9**), with a less intense signal induced by the summer variability (red lines in **Figure 1.1.9**).

Moreover the decadal variability in the three considered cases is in phase (see blue lines in **figures 1.1.5, 1.1.7** and **1.1.9**), suggesting a modulation induced by large scale circulation patterns covering the Iberian Peninsula. A warming of about 1.2 Celsius degrees is expected in the annual average of TAS in the middle of the century, in both scenarios, strengthening the reliability of the suggested trend in the next 50 years. The annual mean TAS tendency (linear trend), during the entire XXI century, is of the order of 0.4ºC/decade in RCP8.5 and 0.2ºC/decade in RCP4.5. Both trends are statistically significant.

The model tends to overestimate the precipitation over the Alentejo region (**figure 1.1.3**) of about 2 mm/d during winter, and the very dry observed summer is well represented: less than 0.5 mmd^{-1} are expected during JJA over this region in the present climate. The precipitation decrease projected for both seasons (**Figure 1.1.4** and **Figure 1.1.9**) is statistically significant only for the RCP8.5 scenario, during winter (-0.14 mmd^{-1}/decade). Same as in the Aveiro and Cascais cases, in both scenarios, the decadal variability of the precipitation over Alentejo is modulated by the winter signal (blue lines in **Figure 1.1.9**).

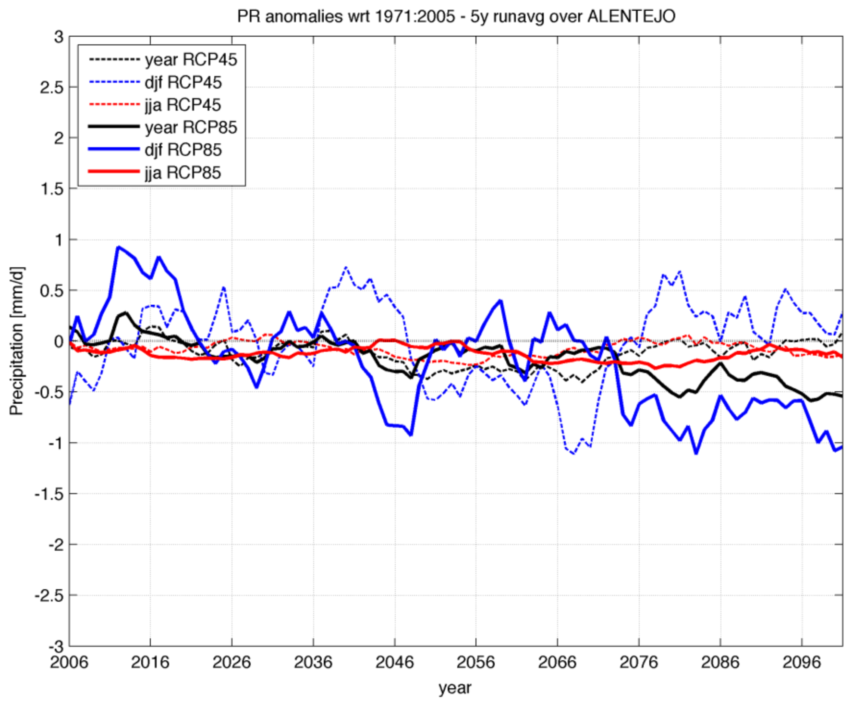


Figure 1.1.10: Projected precipitation anomalies over Alentejo. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [mm/d].

1.2 Climate projections over Northern Europe as represented by a high resolution regional climate model

This section provides a description of the mean present climate and two possible scenarios for the XXI century (up to 2100) over Northern Europe (**Figure 1.2.1** shows the considered domain), based on the data set delivered by CMCC to the BASE project users. This data set derives from results produced by the latest version of the high resolution Regional Climate Model (RCM) developed at the Rossby Centre, the climate modelling research unit of the Swedish Meteorological and Hydrological Institute (SMHI). The horizontal resolution of the considered RCM is about 15 km, allowing the detection of the small scale features of the climate signal. Temperature and precipitation over the present climate will be discussed in chapter two and their future projections in chapter three. Chapter four describes present climate and future projections over two case study regions: Copenhagen and Prague. For a deep discussion on the RCM and the relative simulations please refer to Scoccimarro and Gualdi (2014).

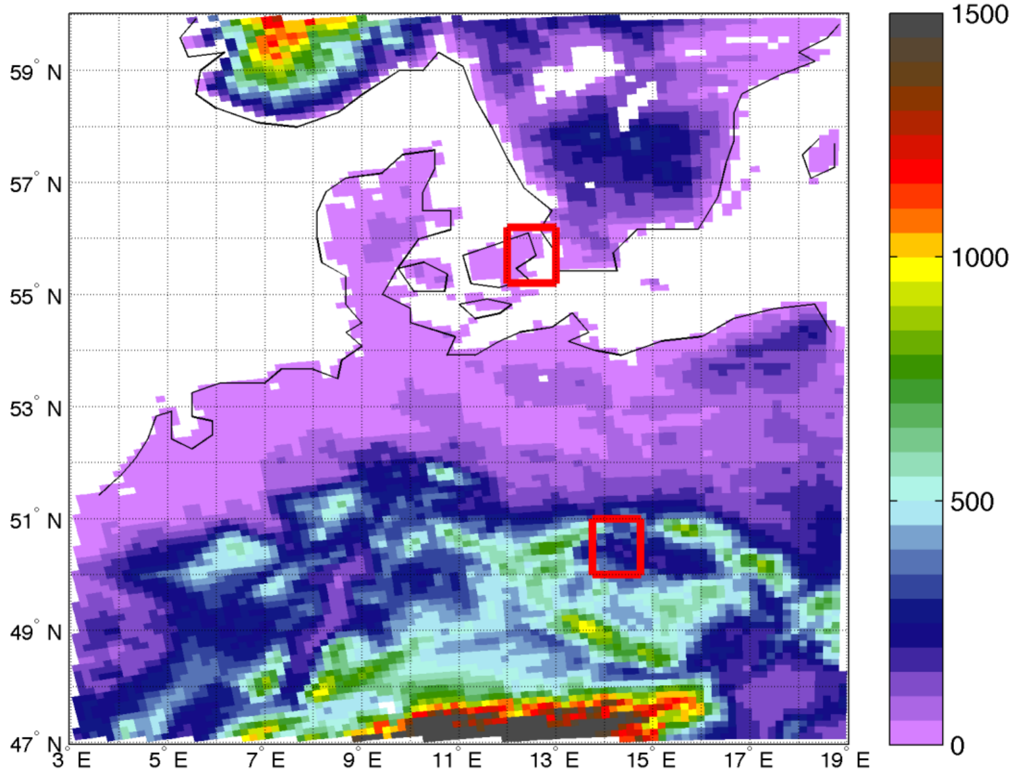


Figure 1.2.1: Northern Europe domain. The picture shows the representation of the orography. Units are [m]. The red box in the northern/southern part of the domain indicates the Copenhagen/Prague case study domain.

1.2.1 Present climate over northern Europe

In this paragraph we discuss the ability of the regional model to reproduce the observed present climate over northern Europe in terms of 2-meter temperature and precipitation comparing model results to observations.

The simulated 2-meter air temperature (TAS) has been assessed using observational data from the Climatic Research Unit (CRU, Harris et al. 2013. The data are available at the web site http://badc.nerc.ac.uk/view/badc.nerc.ac.uk__ATOM__dataent_1256223773328276), representing month-by-month variations in climate over the last century or so. These data are available on a relatively high-resolution grid (0.5°x0.5°), and they are the result of an analysis performed on an archive of monthly mean temperatures provided by more than 4000 weather stations distributed around the world. Simulated precipitation (PR) is compared with observations from the E-OBS dataset (Haylock et al. 2008) a very high resolution data set with a 0.22° regular latitude-longitude resolution on a grid with rotated pole in order to have almost equal areas over Europe. The reference period is 1997-2005, according to the availability of the precipitation observational dataset within the CMIP5 historical epoch.

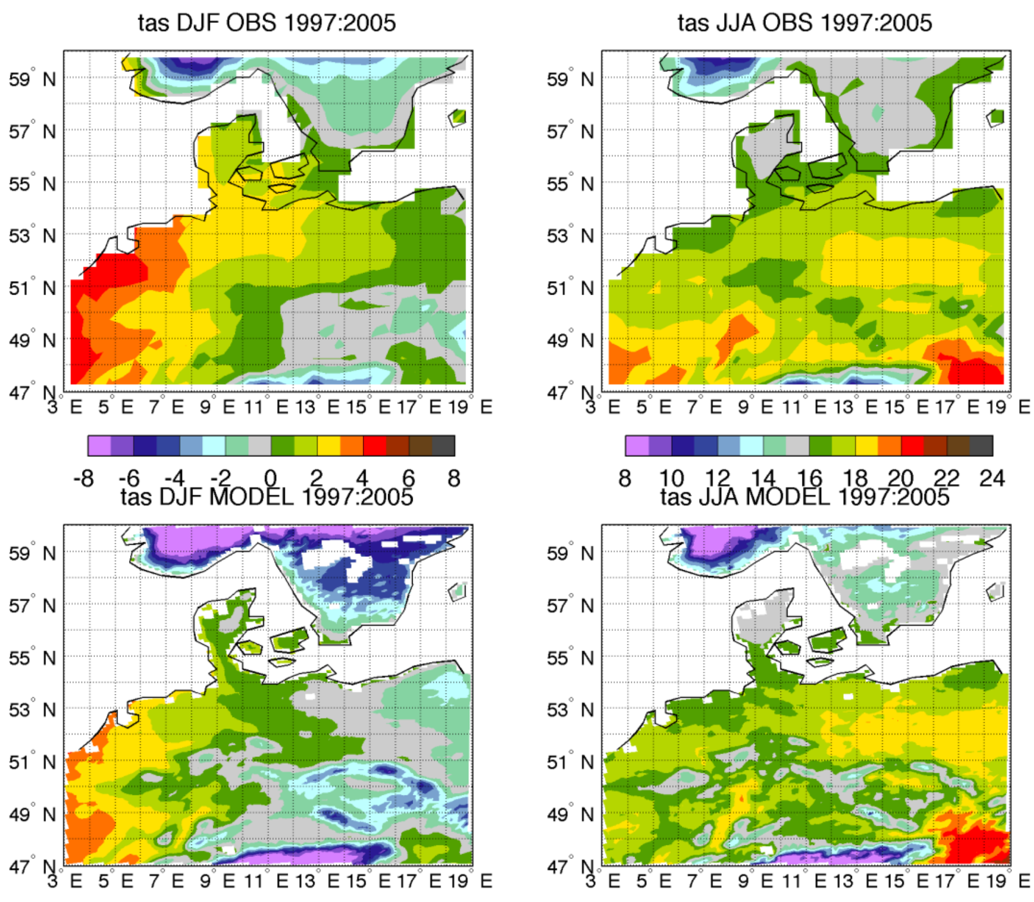


Figure 1.2.2: 2-meter air temperature (TAS) seasonal means as represented by the model (lower panels), compared to CRU observations (upper panels), during the 1997-2005 period. Left panels show the northern winter (DJF) means and right panels show the northern summer (JJA) means. Units are [°C]. Colour interval is 1°C.

The modelled 2-meter temperature captures the main large-scale features of the observed spatial patterns in both seasons (**Figure 1.2.1**, left and right panels), despite a tendency to underestimate TAS over the considered domain, especially during winter (December to February – DJF). During summer (June to August – JJA) the underestimation is less pronounced, except over Alps and Norway. These biases are similar to the CMIP3 and CMIP5 fully coupled GCMs ones, which tend to simulate colder winters than observed (Meehl et al. 2007, Cattiaux et al. 2013) and other RCMs (Dosio et al. 2013).

During winter the mitigation effect induced by the Atlantic Ocean on TAS over the coastal regions is well kept by the model, such as the corresponding zonal gradient. When compared to observations, some additional features appears around Czech Republic in the modelled results, coherently with a realistic representation of the orography (**Figure 1.2.1**) in very high resolution RCM results (the horizontal resolution of the model is about one fifth of the CRU one).

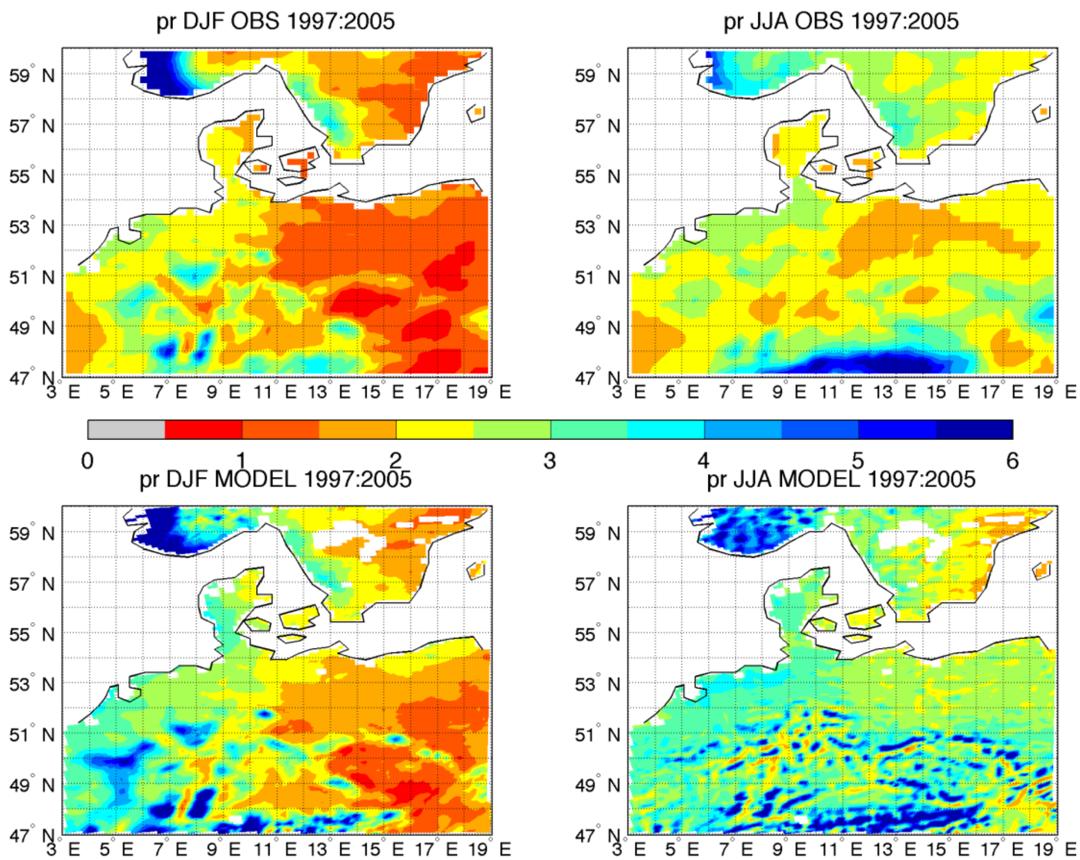


Figure 1.2.3: Seasonal mean precipitation (PR) as represented by the model (lower panels), compared to E-OBS observations (upper panels), during the 1997-2005 period. Left panels: winter mean (DJF); right panels: summer (JJA) mean. Units are [mm/d]. Color interval is 0.5 mm/d.

The seasonal mean rainfall is well captured by the model (**Figure 1.2.3**), despite a slight model tendency to overestimate the precipitation especially during summer. The main differences appear over the mountain regions, where the effects of the improved model orography (compared to the E-OBS) become more evident.

In general we notice that, for both seasons, the biases over area with complex topography are common in most RCMs (Piani et al. 2010, their figure 2). The positive bias over the Alps during winter is less pronounced during summer. Noteworthy, the model is able to represent the two maxima around the Alsatian region (i.e. the Vosgi mountains), with a slight tendency to overestimate them in both seasons.

1.2.2 Future projections over Northern Europe

It is well known that over Europe, local thermodynamical mechanisms, including cloud processes and snow or soil moisture feedbacks, are likely to modulate European temperature changes. Moreover both large-scale circulation and local processes may particularly influence the fate of summer heat-waves and winter cold spells (Cattiaux et al. 2013). To investigate future climate scenarios over Europe we leverage on two CMIP5 Representative Concentration Pathways (RCPs) defined within the CMIP5 project: RCP4.5 and RCP8.5 scenarios (Riahi et al. 2011, Taylor et al. 2012). Both scenarios show the largest TAS increments over the eastern part of the considered domain during winter and over Alps and southern part of Norvay during summer (Figure 4). The 2071-2100 RCP8.5 mean winter temperature over eastern part of the investigated domain is about 6ºC warmer (**Figure 1.2.4**, bottom left panel) if compared to the reference period (1976-2005). This effect is less pronounced in the RCP4.5 scenario (**Figure 1.2.4,** upper left panel). The warming is more pronounced during winter, doubling the summer corresponding value over most of the domain but the Alps, where the warming results similar during both seasons, ranging from 5ºC (in summer, **Figure 1.2.4** bottom right panel) to 6ºC (in winter, Figure 4 bottom left panel) in the RCP8.5 scenario, and from 2ºC (in summer, **Figure 1.2.4** top right panel) to 3ºC (in winter, **Figure 1.2.4** top left panel) in the RCP4.5 scenario.

In the climate change projections analysed, summer precipitation (**Figure 1.2.5**, right panels) appears to increase in the future period of about 20-30% compared to the present climate, over the northern part in both the RCPs scenarios. During winter a spread increase of about 30-40% is found over the entire domain, more pronounced in the RCP8.5 scenario. These results are consistent with previous findings obtained using the CMIP5 multi-model climate change projections (Scoccimarro et al. 2013). In the southern part of the domain (south of about 50ºN), during summer, the model suggests a tendency to decreased precipitation (right panels). This signal is consistent between the two investigated scenarios.

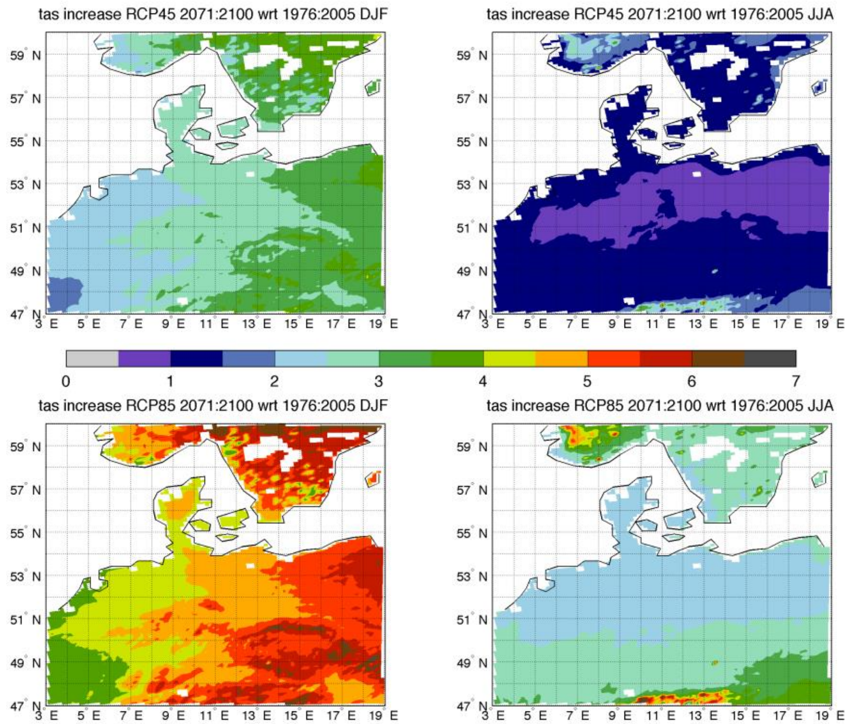


Figure 1.2.4: Changes in 2 meter air temperature at the end of simulated RCPs (2071-2100) with respect to the historical period (1976-2005) under RCP4.5 (upper panel) and RCP8.5 (lower panel). Left panels: winter mean (DJF); right panels: summer (JJA) mean. Units are [ºC]. Colour interval is 0.5ºC.

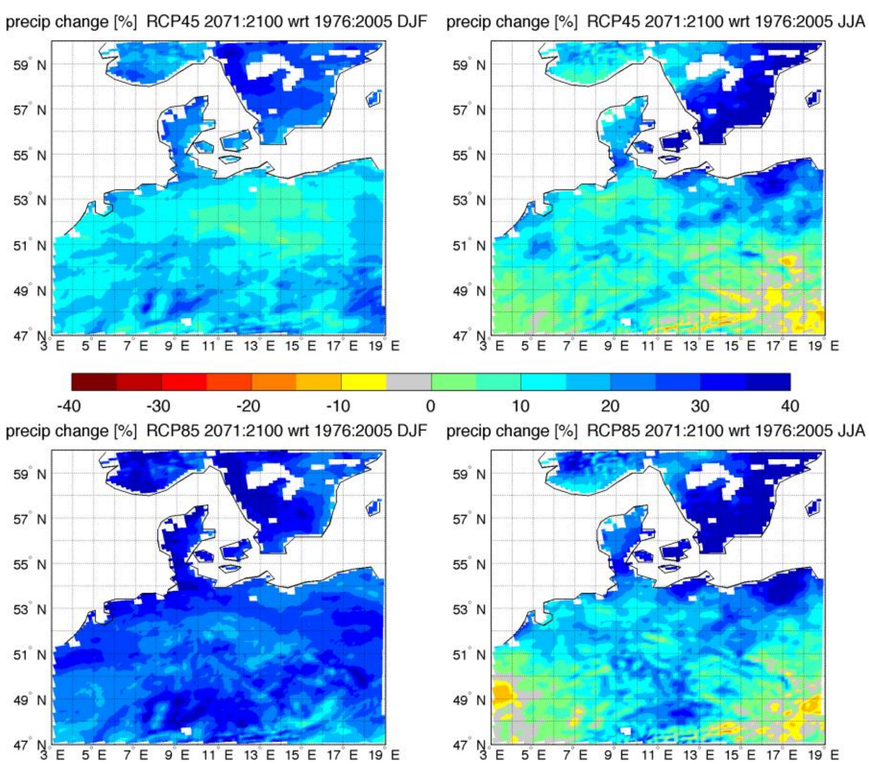


Figure 1.2.5: Changes in precipitation at the end of simulated RCPs (2071-2100) with respect to the historical period (1976-2005) under RCP4.5 (upper panel) and RCP8.5 (lower panel). Left panels: winter mean (DJF); right panels: summer (JJA) mean. Units are [%] and the colour interval is 5%.

1.2.3 Future projections at the case study level: the Copenhagen and Prague cases

A more detailed analysis, considering two case studies (Copenhagen and Prague) is the focus of this chapter. Both Temperature and precipitation are investigated considering annual, winter (DJF) and summer (JJA) averages, in order to disentangle the relative role of the two different seasons in modulating long term changes in the mean climate and variability.

The Copenhagen Case

A box of 1ºx1º, centered in Copenhagen is considered when averaging 2 meter temperature and precipitation fields to represent future climate evolution in the region (see red box north of 55 ºN in **Figure 1.2.1**)**.** Only grid point over land are taken into account. Noteworthy, sensitivity tests suggest no particular dependence of the projected results on small changes in the dimension/position of the defined box. **Figure 1.2.6** shows the 2 meter temperature anomaly projected in the two considered scenarios, computed with respect to the present climate period (1971:2005). The annual TAS average is expected to increase up to 4 ºC at the end of the XXI century following the business as usual scenario RCP8.5 and 2 ºC following the more moderate RCP4.5 scenario. In both scenarios the contribution of the winter warming (up to 5 ºC in RCP8.5) seems to be the dominant component of the annual average, since summer warming is expected to do not exceed 3 and 1.5 ºC in RCP8.5 and RCP4.5 respectively.

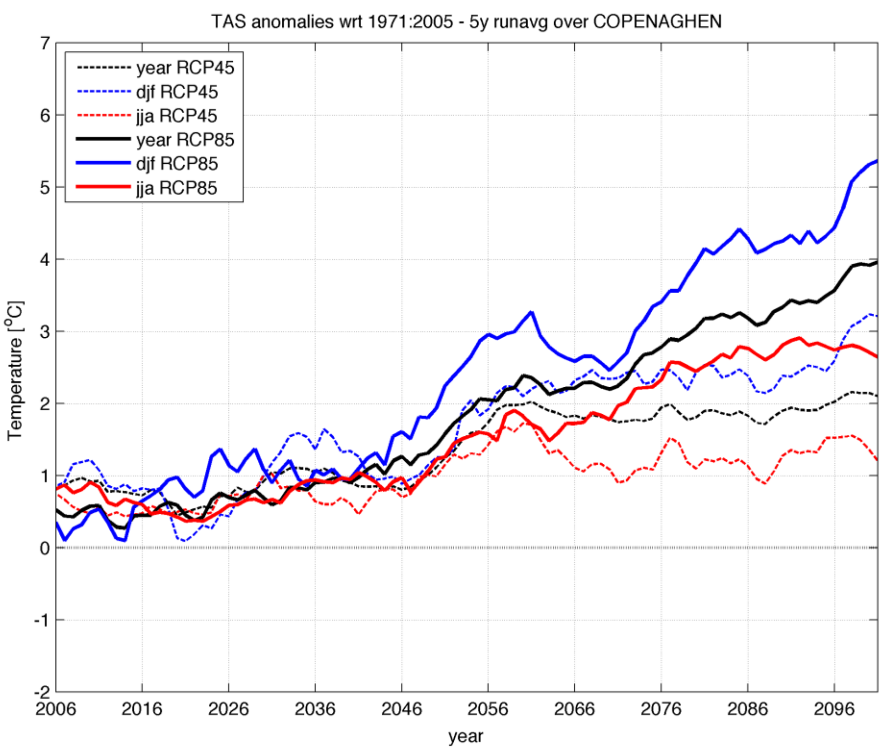


Figure 1.2.6: Projected 2 meter temperature anomalies over Copenhagen. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [ºC].

The decadal variability signal in the TAS anomaly during the XXI century results more related to the winter contribution (blue lines in **Figure 1.2.6**), with a less intense signal induced by the summer variability (red lines in **Figure 1.2.6**). It is interesting to note that in the middle of the XXI century, a warming of about two Celsius degrees is expected in the annual average of TAS, in both scenarios, strengthening the reliability of the suggested trend in the next 50 years. The annual mean TAS tendency (linear trend), during the entire XXI century, is of the order of 0.4 ^{o}C/decade in RCP8.5 and 0.2^{o}C/decade in RCP4.5. Both trends are statistically significant (the statistical significance mentioned through the paper is verified at the 99% level with a bootstrap method).

Despite a slight tendency of the model to overestimate the precipitation over the Copenhagen region (**Figure 1.2.3**), there are no substantial differences in winter and summer precipitation amount during the present climate. This is not confirmed in a warmer world (i.e. following RCP8.5 scenario), where summer precipitation is projected to increase up to 50% (**Figures 1.2.5** and **1.2.7**) and with a halved increase (less than 30%) during the corresponding winter period. The differences between precipitation projections in the two scenarios are not pronounced and the decadal variability seems to be modulated by both winter and summer precipitation (blue and red lines in **Figure 1.2.7,** respectively). In terms of precipitation, no significant trends are found in the first 30 years of the XXI century in both scenarios. On the other hand, considering the entire time series, all of the seasons/RCPs (**Figure 1.2.7**) show statistically significant trends, with a maximum of 0.1 mmd^{-1}/decade for the RCP8.5 during summer.

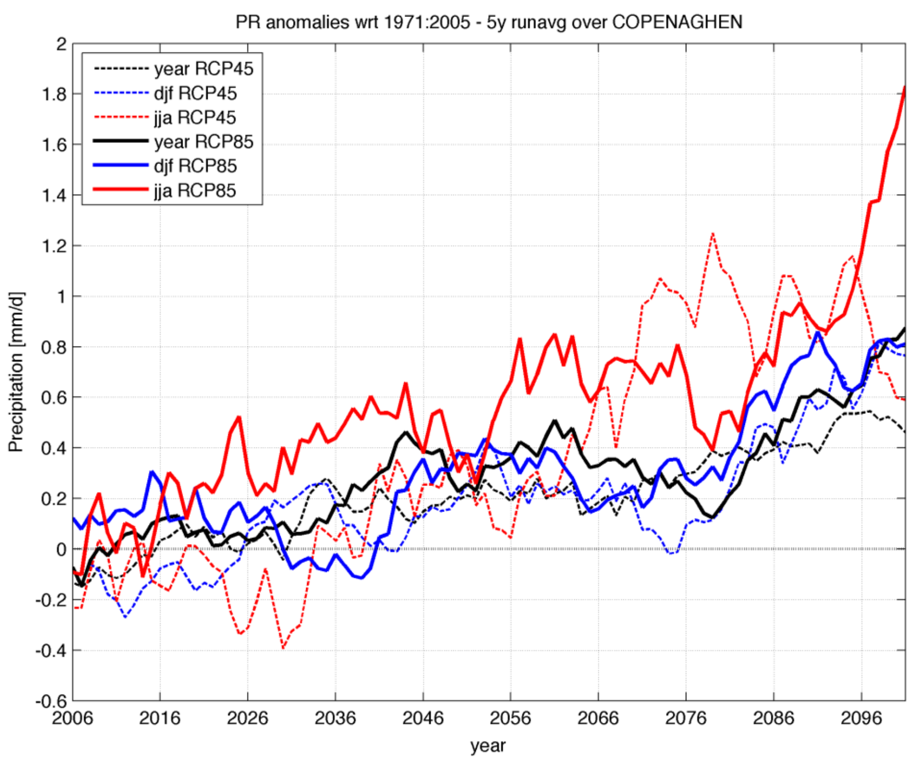


Figure 1.2.7: Projected precipitation anomalies over Copenhagen. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [mm/d].

The Prague Case

Same as for the Copenhagen case, a box of 1ºx1º, centered in Prague is considered when averaging 2 meter temperature and precipitation fields to represent future climate evolution in the region (see red box south of 51ºN in **Figure 1.2.1). Figure 1.2.8** shows the 2 meter temperature anomaly projected in the two considered scenarios, computed with respect to the present climate period (1971:2005). The annual TAS average is expected to increase up to 4.2 ºC at the end of the XXI century following the business as usual scenario RCP8.5 and 2.5 ºC following the more moderate RCP4.5 scenario. These results are very similar to what is found in the Copenhagen case study described before. In both scenarios the contribution of the winter warming (up to 6ºC in RCP8.5) is still the dominant component in determining the annual average, since summer warming is expected to do not exceed 3 and 1ºC in RCP8.5 and RCP4.5 respectively.

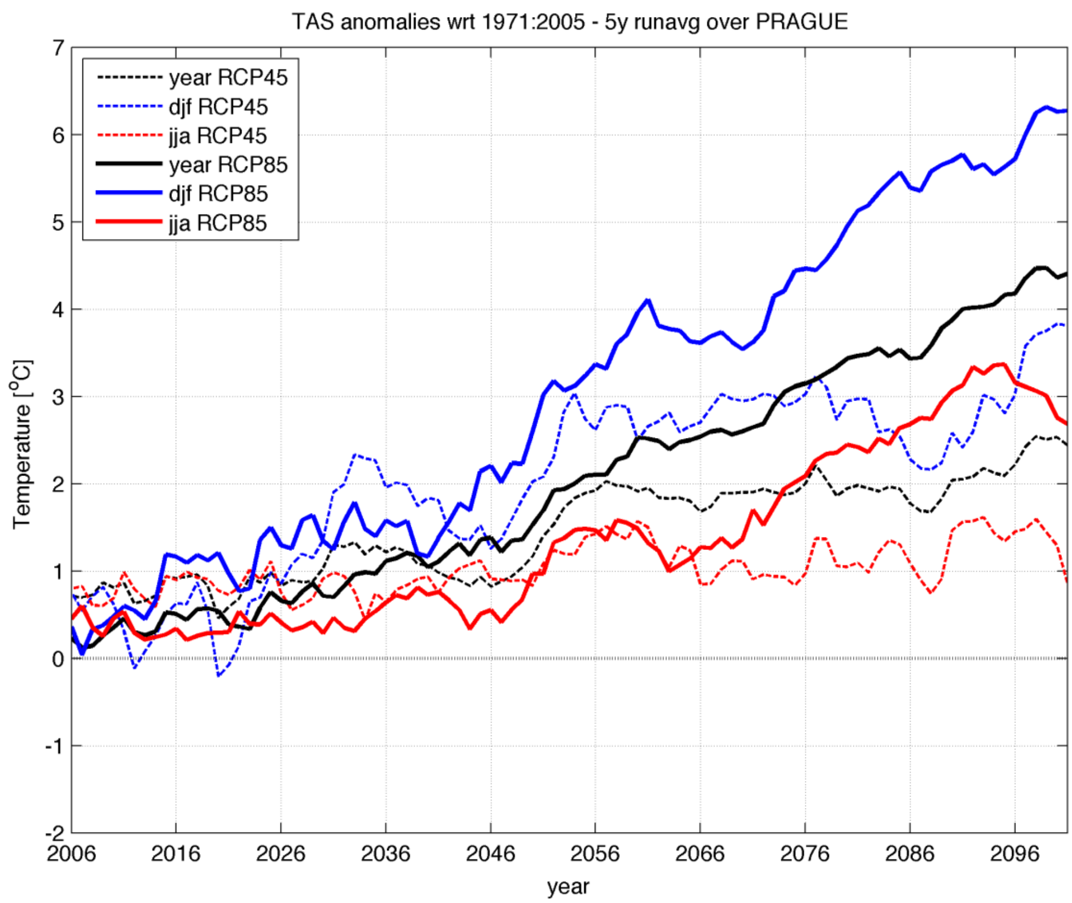


Figure 1.2.8: Projected 2 meter temperature anomalies over Prague. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [ºC].

Even in the Prague case the decadal variability signal in the TAS anomaly during the XXI century results more related to the winter contribution (blu lines in **Figure 1.2.8**), with a less intense signal induced by the summer variability (red lines in **Figure 1.2.8**). Moreover the decadal variability in the two considered cases is in phase (see blue lines in **Figures 1.2.6** and **1.2.8**), suggesting a modulation induced by large scale circulation patterns covering the northern part of Europe. A warming of about two Celsius degrees is expected in the annual average of TAS in the middle of the century, in both scenarios, strengthening the reliability of the suggested trend in the next 50 years. The annual mean TAS tendency (linear trend), during the entire XXI century, is of the order of 0.5ºC/decade in RCP8.5 and 0.2ºC/decade in RCP4.5. Both trends are statistically significant.

The model tends to overestimate the precipitation over the Prague region (**Figure 1.2.3**) especially during summer. The maximum precipitation over Prague is registered during summer, in both observations and model results. The precipitation increase projected for the summer season (**Figure 1.2.5** right panels and **Figure 1.2.9**) is less pronounced than what is expected for the winter season (**Figure 1.2.5** left panels and **Figure 1.2.9**), suggesting a weaker seasonal cycle in the future over Prague.

The differences between precipitation projections in the two scenarios are not pronounced, with a slightly stronger signal in RCP8.5 scenario. In this scenario, the decadal variability seems to be modulated by both winter and summer precipitation (blue and red lines in figure 7, respectively), but the variability in the two seasons in not in phase, inducing a smoothed decadal signal in the annual average (black line in **Figure1.2.9**). Even in this case study no significant trends are found in the first 30 years of the XXI century in both scenarios. Considering the entire time series, only RCP8.5 scenario shows a significant trend in winter (0.06 mmd^{-1}/decade) and annual (0.05 mmd^{-1}/decade) precipitation (**Figure 1.2.9,** blue and black solid lines respectively).

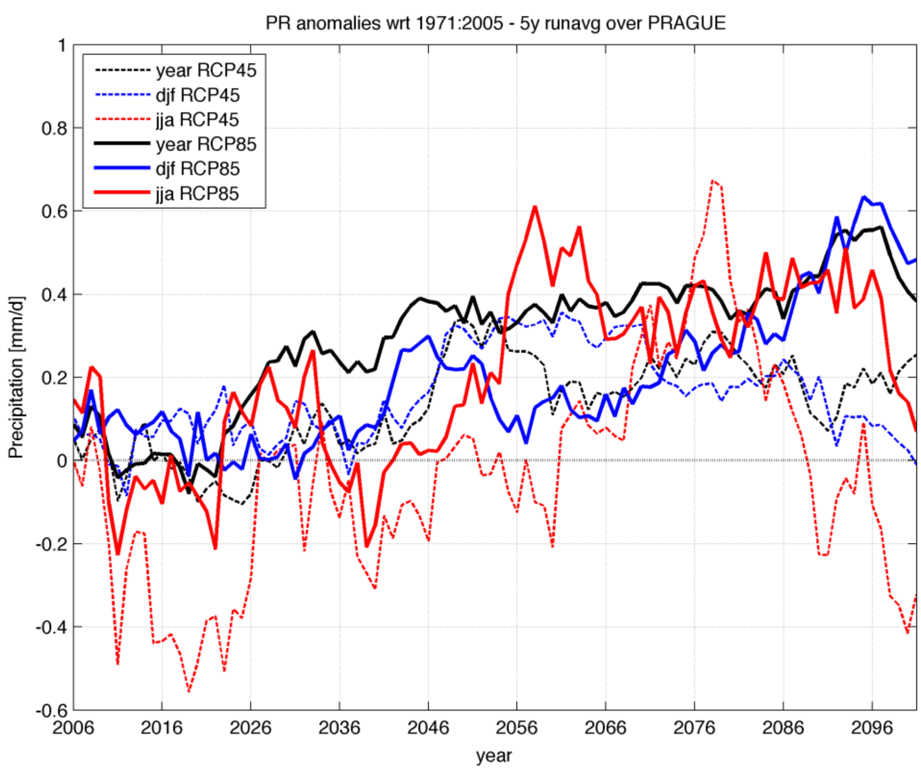


Figure 1.2.9: Projected precipitation anomalies over Prague. Dashed/Solid lines represent RCP4.5/RCP8.5 scenario. Black lines refers to annual averages. Red/blue lines refers to summer/winter season. The anomalies are computed with respect to the period 1971-2005. A 5 year running average is applied. Units are [mm/d].

2 Impacts and Adaptation Strategies – Preliminary Results from Case Studies

Authors: Ad jeuken; Ana Iglesias; Anders Branth Pedersen, André Vizinho; Andreas Hastrup Clemmensen; Anne Jensen; Anne-Mari Rytkönen; Dabo Guan; Duncan Russel; Eliska Lourencova; Filipe Alves; Gil Penha-Lopes; Grit Martinez; Inês Campos; Jenny Troeltzsch; Jouni Paavola; Margaretha Breil; Milla Mäenpää; Oliver Gebhardt; Pedro Iglesias; Sébastien Foudi; Søren Gram; Timothy Taylor; Volker Meyer; Helle Ørsted

Introduction

By Inês Campos and Filipe Alves

This chapter reports on the preliminary findings of BASE case study reserach, by providing an overview of impacts and adaptation strategies in different groups and specific case studies. These groups were formed during task 4.1 and have been described in deliverable 4.1.

Within the subgroups, case studies vary in their geographic, social, political and economic characteristics, but also in their research approaches, a few being retrospective, others retrospective and prospective. While some case study owners are developing cost-benefit analysis of adaptation actions which have already been implemented, others are developing integrated assessements of potential adaptation actions (including economic analysis). Additionally, while in some cases there is a strong stakeholder engagement through participatory approaches and methodologies, in others analysis draws from non-participatory methods, models and tools.

Finally, from the point of view of climate adaptation, case studies vary greatly in their impacts and existent or potential adaptation actions (in some cases, adaptation measures are still not known, and will result from the ongoing research). The table below summarizes impacts and adaptation measures in all case studies. Most cases already have some information on past, present or future adaptation actions. Preliminary findings will be described in detail in sections 2.1.1 to 2.1.28

Table 2.1 – List of Case Studies, Impacts and Adaptation Actions studied

Case Study	CC Primary Impacts	Adaptation Actions analyzed during BASE
Alentejo (FFCUL)	Drought || Water scarcity || Heat Waves	Water Retention Landscapes
Agriculture (AU)	Flooding || Shift of Seasons	To be determined
Agriculture South Moravia (CZECH GLOBE)	Droughts || Flooding	To be determined

Case Study	CC Primary Impacts	Adaptation Actions analyzed during BASE
Agriculture Usti Region (CZECH GLOBE)	Droughts || Flooding	To be determined
Green roof (CZECH GLOBE)	Flooding || Water Scarcity	Land use/land cover changes
Dartmoor (EXETER)		To be determined
Aveiro (FFCUL)	Extreme Weather Events || Sea Level Rise	Re-localization of population || Dike-in-dune || Sand feeding
South Devon Coast (EXETER)	Sea level rise || Flooding	To be determined
Timmendorf (EI)	Extreme weather events || Flooding	Coastal Defense System (Dike)
Kalundborg (DBT)	Flooding || Sea level rise	To be determined
Venice (CMCC)	Flooding from Sea level rise	Pavement levels || Emergency services/Alert Systems
Cascais (FFCUL)	Water scarcity || Heat Waves	Green Corridor || Reduction in water distribution waste and losses || Training and awareness raising workshops
City of Prague (CZECH GLOBE)	Flooding	To be determined
Copenhagen (AU, DBT)	Flooding || Storms || Sea level rise	Green/Blue spaces for water retention || Dike
JENA (UFZ)	Flooding || Extreme temperatures	Measures to mitigate heat stress, e.g. Degree and way of soil sealing, size and characteristics green/blue structures

Case Study	CC Primary Impacts	Adaptation Actions analyzed during BASE
LEEDS (Uni Leeds)	Flooding || Extreme weather events	sustainable drainage system, ecosystem services for upstream peatland, hard-engineering solutions for river flooding
Mental Health UK (Exeter)	Extreme events/flooding	Options for treatment
Cornwall Health (Exeter)	Mixture including Flooding, Heatwaves, temperature and precipitation increase	Primary, Secondary and Tertiary health interventions
Kalajoki River Basin (Syke)	Flooding (from precipitation) Shift of Seasons	Flood Risk management plans (FRMP) ||, River basin management plans (RMB)
Iberian (UPM; BC3; FFCUL)	Water scarcity || Droughts	Re-thinking water usage||Co-benefits water and health
Mekong Delta (Deltares)	Flooding || Water Scarcity	To be determined
Brasil (FFCUL)	Extreme weather events	Reforestation || Sustainable University
Cuba (FFCUL)	Extreme weather events	Early warning System || Urban small scale farming
US East Coast	Extreme Weather events	Intruments to support adaptation actions

2.1 Agriculture and Forestry
Overview of Impacts and Adaptation Challenges

By Anders Branth Pedersen and Helle Østed Nielsen

According to the European Commissions strategy on adaptation to climate change (2013b: 3):

"Climatic changes will have consequences for the availability of basic natural resources (water, soil) leading to significant changes in conditions for agriculture and industrial production in some areas. Global warming may provide opportunities for specific sectors in certain areas, such as increased crop yields and forest growth, more hydropower or less energy needed for heating in northern Europe. However, the potential regional net benefits are highly uncertain"

FAO's (2009: 8) expectation is that agricultural production in ".... some areas will benefit from global warming, at least through a transitional period, though most areas will be adversely affected" – this might rise food security concerns.

In general, agriculture is a key sector for the study of climate adaptation as: ".....agricultural production is widely affected by both biophysical impacts of climate change as well as the resulting socio-economic impacts" (FAO, 2007). Farmers are used to cope with year to year changes in climate, but human-induced climate change is expected to accelerate the need and magnitude of farmers' adaptation (Wheeler and Tiffin, 2009). The European Commission (EC, 2013b: 13) expects that impacts of climate change on agriculture will be increasingly visible towards 2050" (BASE Deliverable 4.1, p.18)

Additionally, according to an UNCTAD (2013: iii) report, "(...) agriculture is not only chiefly affected by global warming but also one of its driving forces".

As described in Deliverable 4.1 of BASE "Biophysical impacts of climate change on agriculture and forestry can roughly be divided into the following categories" (FAO, 2007: 2; see also FAO 2009; Hoffmann (2013)):

- Physiological effects on crops, pasture, forests and livestock (quantity, quality)
- Changes in land, soil and water resources (quantity, quality)
- Increased weed and pest challenges
- Shifts in spatial and temporal distribution of impacts
- Sea level rise and changes to ocean salinity
- Sea temperature rise causing fish to inhabit different ranges
- Socio-economic impacts are for instance (ibid):
- Decline in yields and production
- Reduced marginal GDP from agriculture
- Fluctuations in world market prices
- Changes in geographical distribution of trade regimes
- Increased number of people at risk of hunger and food insecurity
- Migration and civil unrest

In BASE agricultural case studies focus on:

- Climate adaptation responses to flooding problems in two Danish predominantly rural municipalities.
- Climate adaptation responses to drought and water availability problems in two regions of the Czech Republic.
- Drought adaptation in the region of Alentejo in Portugal.
- Climate adaptation in the Tagus River Basin of Spain.

The agricultural case studies will provide an overview of the status and the focus of climate adaptation efforts in case communities and countries, indicating what kind of risks and opportunities farmers are aware of, respond to and how they respond. Likewise they will provide a state of the art review of national and EU adaptation responses for the agricultural sector and its effect on the ground.

The agricultural case studies will add to the sparse literature on costs and benefits of climate adaptation in agriculture. Some of the case studies will provide knowledge on specific industries - hop and wine production in the Czech Republic, and sugar production in Denmark.

The BASE agricultural subgroup is commonly addressing five groups of research questions within agricultural climate adaptation:

- How do farmers perceive climate adaptation and the need for climate adaptation actions? What is their risk perception? How are farmers motivated to take actions?
- What climate adaptation actions have farmers already taken (if any)? And what are the costs? Are there any experienced benefits? (information to be used in WP3 and WP6)
- How is climate adaptation knowledge disseminated from the top (municipality, government etc.) to the bottom (farmers)? (information to be used in WP2 and 7)
- How is climate adaptation knowledge fed into the top (municipality, government etc.) from the bottom (farmers)? (information to be used in WP2 and7)
- Do farmers experience conflicts between climate adaptation policy and sectorial policies (e.g. in the CAP)? (information to be used in WP2 and 7)

One of the primary instruments for making comparative analyses among the BASE agricultural case studies is farmer questionnaires which will be send to farmers in the four different countries. The agricultural case studies will all have a common pool of questions – these common questions will make it possible to make comparative analyses between agricultural climate adaptation in the four countries. The common questions are centered around the following subjects:

- Perception of climate change – is climate change occuring according to farmers?
- Observation of climate related events (e.g. more heavy precipitation, drought etc.).
- Crop effect of climate related events.
- Change in practice (e.g. choice of crops) due to climate related events (and other types of factors).

- Economic importance of climate related events compared with other factors influencing farm economy.
- Concern about future climate related events.
- Who has the responsibility for protecting the farm from potential negative effects of climate change?
- Barriers for adaptation measures.

Besides the common questions, each case study is having some questions regarding socio-economic background and other questions adapted to the local context.

Below follows a description of the case studies. Regarding the Portuguese case study there is a description of early results too.

2.1.1 Alentejo Region

By Inês Campos and André Vizinho

Alentejo is a Southern region of Portugal characterized by a Mediterranean climate with temperate winters, very hot and dry summers with long periods of no rain; with a reduced anual precipitation (average about 600mm /m2 .year), high maximum temperatures in the summer (> 30C) and periodic droughts. The region is generaly characterized by a high risk of desertification due to the present quality of soils, land use patterns and predicted increase in the frequency of droughts, reduced precipitation and heat.

In Alentejo, the original characteristics of the soil and landscape coupled with the effects of deforestation and intensive cereal cultures led to increased soil erosion and reduced agricultural productivity (ENNAC, 2010). This reduced productivity, and an increased mechanization, as well as the European open market and consequent competition with cereal cultures from other European countries and the world, led to a reduction in employment in agriculture in Alentejo and a massive migration from rural to urban areas (Belo et al., 2009). Therefore, in this region there is a strong need to identify and evaluate traditional or innovative adaptation options for water scarcity, drought and soil erosion in agriculture and forestry in order to support sustainable livelihoods and ecosystems, and prevent further land abandonment (Figueiredo et al, 2011), as well as further migration of people (ENNAC, 2010). Because Alentejo is similar to many Mediterranean regions, the solutions identified here have a high potential of replication and adaptation to other Mediterranean regions.

Impacts

Based on Heim's dominating indices (Heim, 2002), drought can be divided into four categories: (1) meteorological, (2) agricultural, (3) hydrological and (4) socioeconomic. Alentejo is likely to be most affected by meteorological, agriculture and socioeconomic drought, according to the National Climate Change Adaptation Strategy for the region (ENNAC, 2010). *Meteorological drought* is defined by a reduction of precipitation associated with other atmospheric conditions (such as evaporation, heat, wind and air moisture), creating a lack of water and dryness. *Agricultural drought* is characterized by the lack of water in the soil needed for the agricultural crops. This kind of drought is dependent on the type of crops and land cover of the region, which affects the water in the soil. Finally, *socioeconomic drought* is associated with the supply and demand of some economic activities, affecting human well-being.

Alentejo agriculture landscapes can be broadly described as being of two types: irrigation farming and rainfed agriculture (also referred as dryland farming). This means that while some regions are irrigated by dams and local rivers, others depend on rainwater. Soil erosion and agriculture and socioeconomic draught (Heim, 2002) may be highest in rainfed farming lands. Moreover, while in both types of landscapes, efficient water management and soil preservation are important issues, adaptating to a changing climate in rainfed landscapes needs to account for social and political dimensions, since apart from water retention solutions, there is a need for a transition to a more sustainable way of living in those landscapes.

Case Study Research and Adaptation

The case study is developed along two levels of research.

At the first level**,** we investigate how farmers and different bottom-up rural initiatives are adapting to climate change impacts, namely drought, and develop economic assessments of solutions for retaining more water in a dry landscape. The main objectives of this research level are to compare bottom-up and top down perspectives on the strategies and policies for adaptation, and identify prioritarized measures to be assessed through cost benefit analysis.

Within this research level we have:

- done a participatory workshop to discuss climate change adaptation options for the region of Alentejo (on November, 2013) through the interaction of high level and local stakeholders, namely regional and national planners, decision makers, researchers, farmers and NGOs. We've called this workshop the **Participatory State of Art of Climate Adaptation in Alentejo**.

- and a questionnaire to 30 farmers, to identify current and possible agricultural practices that support adaptation to agricultural drought.

Within the second level of analysis, our focus has been on an in-depth study of innovative adaptation measures and projects in the region of Alentejo, that are engaging in changing the ways of living in a rainfed agricultural area, where over the past 30 years there has been a growing land abandonment and socioeconomic desertification. Within this research level, we have planned:

- an in-depth analysis of an autonomous adaptation project in the region, designated as the Convergence Center at Aldeia das Amoreiras;
- and a in-depth analysis of Tamera ecovillage, to support a cost-benefit analysis its off-stream lakes (a solution for retaining water in the landscape).

We will now describe in more detail each of these research levels.

Level 1 – Regional assessment of climate change adaptation

To develop a regional integrated assessment of climate change adaptation actions, by approaching the region's challenges in adapting to drought, and discuss an adaptation strategy, our methodology approach is based on farmers' interviews and stakeholder workshops.

30 semi-structured interviews have been done to Alentejo farmers, between May and July, 2014. Farmers were chosen based on their geographical location, size of their property and type of farming practices. Interview results are currently being analysed. Information was collected on the farmers' perceptions about climate change, and the problem of increased drought in Alentejo; on farming practices that support soil regeneration and irrigation, on the perceived impact of policies and regulations to support sustainable farming.

Two stakeholder workshop have been projected: one focussing on discussing existent adaptation knowledge for the region and possible adaptation solutions; the second focussing on designing an adaptation plan for Alentejo, using the Scenario Workshop method. The first workshop took place on November, 20th, 2013. The second is scheduled for November, 2014.

The November 2013 event brought together 36 stakeholders from academia; NGOs, regional and national authorities and decision-makers to map out the state of the art of the knowledge of climate adaptation in the region, highlighting its core challenges, barriers and opportunities.

The workshop was named "Participatory State of the Art on Adaptation to Climate Change in Alentejo"and focused on the Agriculture and Forestry sectors. The main objective was to share the existing knowledge on climate change with the different stakeholders, while at the same time discuss the prioritization of research and adaptation actions and identify next steps and cooperation possibilities.

In the morning session of the workshop, participants (maximum one per institution) were invited to provide very quick presentations on their research related to climate change adaptation in the Alentejo region.

Image 2.2.1: Participatory State of the Art

The presentations can be found online in Pdf format. To access them, click on the image or the link bellow.

https://drive.google.com/folderview?id=0B851oFGazkUXbVJEcV9kWURMaW8&usp=sharing

In the afternoon session, participants were randomly divided in four different discussion groups. The “world café” methodology was used. This is a structured conversational process in which the participants discussed four topics in different tables, with individuals switching tables periodically and getting introduced to the previous discussion at their new table by a facilitator. Each group/ table had about 7-9 people.

Image 2.2.2: Participatory State of the Art

At the end of the four sessions of group discussions, the outcomes of the group discussions were presented to all the participants by the facilitators.

In general, the participants agreed on the need to update information on local impacts. There was a general agreement about missing information regarding: indirect impacts (e.g. soil salinization due to increase of irrigation), synergies with other non-climatic impacts (e.g. cattle stocking density), cross-cutting impacts (e.g. decrease of groundwater levels) and positive impacts (e.g. opportunities to grow new varieties).

Another topic discussed was the priorization of the main adaptation measures of Climate Change in the Agriculture and Forestry sectors of the Alentejo region, based on the Portuguese national adaptation strategy (ENAAC).

During the discussion sessions, the official selection of adaptation measures for Portugal [Agriculture and Forests Sectorial Report of the Portuguese National Adaptation Strategy] drawn from the agriculture and forestry strategy, was read and explained to the participants. Afterwards each participant was given the task to attribute five dots to the list of adaptation measures. Those measures with more dots were then proposed to be in the priority list of adaptation actions for the Alentejo region in the agricultural and forestry sectors. Furthermore, the groups identified adaptation measures that, although not present in the national strategy, were considered very important, relevant and prioritary.

The list of adaptation measures considered priorities were:

- Increase the knowledge in climate change scenarios (!)
- Promote the efficient use of water (!)
- Reinforce mechanisms and instruments needed to improve forests and fight land abandonment (!)
- Reinforce the role of agriculture and forestry in the protection of soil and water (!)
- Soil conservation and promotion of organic matter in soils
- Preservation of water resources
- Agricultural insurances
- Increase the capacity for water storage and irrigation
- Protect and restore water lines
- Environmental education in schools
- Rural extension / farmers counselling
- Value the animal, vegetable and microbe genetic patrimony
- Keep the population inhabiting rural areas *
- Promote access to land and the renewal of farm owners and workers.
- Support the creation and adoption of precision models for animal grazing rotation in time and area covered*
- Pay farmers based on their ecological services*
- Create alert systems for environmental impact (using indicators of impact and not of effect)*
- Develop simple technologies for the use of natural species adapted to future climates*
- Adjust the cultures calendar to climate*
- Promote a local and systemic view on farm and regional planning*
- Promote applied and interdisciplinary research*
- Create and disseminate useful knowledge*

[The measures marked with * are new and are not mentioned in the national strategy of the adaptation]

Regarding financiang mechanisms, policies and strategies for adaptation, participants agreed that National Rural Development Plan (NRD) was considered by most as the only support base for adaptation policy and implementation in the region. Participants concluded that the NRD should finance both mitigation and adaptation actions, while supporting soil conservation approaches or sustainable irrigation techniques, which are adequate to Alentejo’s farming and land use realities. Moreover, it was considered that sustainable agriculture should always integrate adaptation actions which are mostly considered “no regret” measures in a region such as Alentejo, where soil erosion and rural desertification are already a problem, regardless of climate change. Participants thought that essentially two types of action should be undertaken: (i) the production of scientific knowledge on climate change and (ii) the implementation of alternative sustainable farming practices.

Regarding strategies and policies, participants referred to the need for a “regionalization of support bases” integrated in “long-term planning” and a “continuously update of existing scientific and real life information”.

Concerning long-term planning, it was noted that this is currently a “counter-culture” in the political arenas, since regional planning is fundamentally based in municipal annual plans, which, according to the participants, reflect dominant economic and political interests for the short-term. Moreover, it was emphasized that most municipal plans find it difficult to integrate an impalpable reality, still perceived as a set of assumptions towards a possible future, as is the case of climate change. Participants were thus more inclined to recommend that all adaptation actions are of a “no-regret” type, and are able to contribute to regional socioeconomic development. Furthermore, it was suggested that there should be an effort to produce scientific knowledge which is useful for land use planning and development that meets the municipalities’ present day realities.

As regards political strategies and research topics, it was noted that it would be important for agriculture research to be a driver for economic and demographic development. Framers should be seen as agents of change and as service providers to their communities. The importance of the relocation of new families in rural Alentejo was also highlighted as an adaption action, and it was noted that agroindustry and the farmer’s part as an active promoter of community services should be interlocked with a continuous investment in environmental education.

Participants also agreed on improving Science-Practice interfaces, arguing that „useful information does not reach people that need it and want it and it was highlighted that communication should be of higher quality and quantity and it should integrade data and societal relevant information.

Level 2 – In-depth analysis of adaptation project

Level 2 has started with an in-depth research of the Convergence Center of Aldeia das Amoreiras (CCAA), a local project against rural abandonment. Analysis of the Convergence Center took place between June and November, 2013.

The Convergence Center (CCAA) was designed in 2005 as part of a program against rural desertification of a Portuguese Environmental NGO (GAIA) that promotes sustainable living and ecological practices. The Center operates at the Amoreiras village, a village with about 150 people, mostly construction workers (29%) and farmers (15%) and over 40 years old (60%), located at the Odemira district in Alentejo, which is the biggest district in Portugal (a total area of 1720, 25 km2), but has only about 26.000 residents. The Center is understood as a physical and immaterial meeting point where people may “converge to do things” (interview transcript). In this “convergence center” different organizations, individuals, artists and scientists, from multidisciplinary backgrounds, have converged over the years in a joint strategy to promote rural lifestyles, supporting new governance dynamics, ecological living and local social and economic development. The group’s activities include youth work, organic farming, eco-construction, community art, cultural initiatives, environmental education and local governance.

To understand the impact of Centro de Convergência da Aldeia das Amoreiras (CCAA) in promoting local adaptive capacity, and on sustainable adaptation actions for the region, we opted for a retrospective analysis of the case study where stakeholders were engaged from the beginning stages of the study. Our methodological approach followed the systematization of experiences method (Thede, 1999; Jara, 2010).

The systematization of experiences method is an action-research approach (Whitehead, and McNiff, 2006) to retrospective analysis, which can be described as a comprehensive participatory project retrospective (Kerth, 2000) where all members are engaged in co-designing the process. Our core research question in this analysis has been: “How has CCAA been an innovative adaptation project?”

To prepare the project retrospective we conducted in-depth Interviews to 17 out of the 30 people who, over a period of seven years, were part of CCA and lived (for one or more years), or still live, in the village. Following the interviews, our meetings lead to the organization of the three-day Residential Workshop**.**

The retrospective results have shown that the presence of this group and its dynamics of influence promoted a transition to a sustainable village by creating a space for dialogue between old and traditional practices and new practices on land use, as well as new social and governance dynamics. We argue that this influence has grown beyond the frontiers of the village, and along the whole district of Odemira, Alentejo, which one of the interviewees has called “the Alentejo Bermuda Triangle”, and where recently similar projects have been blooming, led by new residents concerned with the effects of drought. We are currently mapping these offshoot projects and assessing their adaptation actions. Moreover, the intentional migration of new families engaged in this type of projects has had a positive impact in the region’s demographic characteristics. In the case of the CCAA, the average age of its members, as they moved to the region was 27; the average age of the new residents currently residing in the village or nearby villages in a ratio of 15 Km is 33. These people have also brought their children or had children since their arrival. Field diary notes registered a total of 14 children that came with the new residents, and interview respondents were parents of 12 young children. This is an important contribution in a rural area with aged population and deserted or closed schools. Currently, according to workshop results, between 40 to 50 people aged between 25 and 40 have moved to villages and its neighboring lands, with the intention of promoting ecological lifestyles and offset social desertification, as a result of their interactions with CCAA.

Based on these findings, a key conclusion from our retrospective analysis it that an adaptation strategy identified for this area dealing with desertification and the threat of drought, is what we have called the “intentional migration” phenomena to Alentejo. The new residents, who migrated from big cities (mostly from Lisbon) have followed their dreams for a life in a rural village, but have also come with the intent to contribute to adaptation to drought and desertification, through their everyday life practices and working activities. Further research is ongoing to determine how “intentional migrations” can be supported locally, through interviews to other adaptation projects which are also being studied in Alentejo, namely Tamera; and a survey to farmers in the region.

Apart from identifying the “intentional migrations” phenomena, research results show that during the last seven years the Convergence Center group developed a number of activities and projects that to some extend have met its initial objectives of fighting rural exodus and soil desertification. These activities include demonstrating and introducing irrigation and farming techniques new to the area and that promote more efficient soil water retention and soil regeneration; and at the social and governance levels promoting and participating in local associations and networks that support the development of local production and consumption, and counter tendencies for social desertification. Finally, at the cultural level, the group has lead a number of artistic activities both with and for the local population who have made the local cultural and artistic landscapes more attractive and dynamic.

At this stage, level 2 of the Alentejo case study continues with a Cost-Benefit Analysis of adaptation measures on water retention, namely of the off-stream lakes in the Tamera ecovillage project. Expected results for this CBA will be available in October, 2014.

2.1.2 Denmark: two rural municipalities

By Anders Branth Pedersen and Helle Ørsted Nielsen

The case study on Danish agriculture focuses on climate adaptation responses in predominantly rural municipalities. The study analyses the climate adaptation activities of two Danish municipalities (Lolland and Holstebro) and farmer responses to these and revolves around two main research questions (besides the common questions for the agricultural subgroup): 1) The first question concerns policy coherence, that is the interaction between local climate adaptation responses and strategies at local, national and EU level as well as conflicts and synergies between climate adaptation responses and agricultural policies. Consequently, the case study focuses on multiple levels: Farm level, local level (municipalities), regional level, national level and EU level. 2).The other main question concerns the use of knowledge in the design of, and decision making strategies regarding, climate adaptation responses among key actors at the local level.

The main impact focus of the Danish case studies is flooding although a range of other aspects of climate adaptation will also be addressed through the planned farmer questionnaires (see below). Directive 2007/60/EC (EC 2007) requires Member States to assess if water courses and coast lines are at risk from flooding, and to map the flood extent and assets and humans at risk in these areas, and to take adequate and coordinated measures to reduce this flood risk.

Impacts

Denmark experiences a temperate climate: “Denmark is situated in the zone between three European climatic zones (Borea influence in the north, Atlantic influence in the west and Continental influence in the east); the climate throughout Denmark is a mixture of these influences. Generally, the western parts of the country have atlantic climate and the eastern parts a more continental influenced climate” (Weatheronline (15.11.2013)).

In the 21st century Denmark expects sea water rise of beetween 10-120cm, more extreme precipitation, more precipitation in general, warmer climate, more wind and more powerful storms. Potentially, more precipitation can affect the risk of flooding from watercourses and lakes (Ministry of Environment and Ministry of Transport 2011; klimatilpasning.dk).

In general, higher temperatures and an extended season are expected to increase the agricultural production in Denmark. New crops as winter-wheat, winter-oats, winter-broadbeens, sunflowers, soya beans, feed maize and grapes for wine production will probably be possible to grow in the future. The potential for growing feed crops will increase. On the other hand, areas with spring-barley, spring-wheat and maybe potatoes will probably shrink and there will be an increase in weed, insects and fungis, what might increase pesticide consumption. There is a risk for new types of livestock diseases in Denmark. Increased precipitation will lead to more floodings and problems with more wet fields. Leaching of nitrogen to watercourses, lakes and the sea might increase. If increased precipitation leads to an increase in wetlands there might be environmental benefits of this. Wetlands can e.g. increase recreational benefits and lower climate gas emissions (klimatilpasning.dk, April 2014).

The Danish Meteorological Institute (DMI) operates with different scenarios for Danish climate changes in the period until 2100 (see **Figure 2.2.3**). Scenario A2 and B2 are based on IPCC scenarios while EU2C is based on the EU goal of temperature increases of no more than 2 degrees based on the level before the industrial era. Before 2050 there is not much difference between the scenarios and therefore decisions are here based on only one scenario – A1B.

Climate changes towards 2100	**A1B**	**A2**	**B2**	**EU2C**
Temperature, year	+2.9 (±0.3ºC)	+ 3.2 (± 0.3ºC)	+ 2.5 (± 0.2ºC)	+ 1.9 (± 0.2ºC)
Temperature, winter	+ 3.5 (± 0,3ºC)	+ 3.8 (± 0.3ºC)	+ 3.0 (± 0,3ºC)	+ 2.3 (± 0.2ºC)
Temperature, summer	+ 2.2 (± 0.2ºC)	+ 2.6 (± 0.2)	+ 2.0 (± 0.2ºC)	+ 1.5 (± 0.1ºC)
Precipitation, year	+ 14 % (± 6 %)	+ 15 % (± 7 %)	+ 11 % (± 6 %)	+ 9 % (± 4 %)
Precipitation, winter	+ 25 % (± 6 %)	+ 27 % (± 7 %)	+ 21 % (± 5 %)	+ 17 % (± 4 %)
Precipitation, summer	+ 5 % (± 8%)	+ 5 % (± 9%)	+ 3 % (± 7%)	+ 2 % (± 5 %
Maximum precipitation 24-hours		+21 %	+20 %	+22 %
Wind				
Middle wind over sea	+ 4 %	+ 4 %	+ 2 %	+ 1 %
Max strength of storms	+ 4 %	+10 %	+ 1 %	+ 1 %

Figure 2.2.3 Scenarios for Danish climate changes
Source: Danish Meteorological Institute cited at klimatilpasning.dk.

Case study research and adaptation

Holstebro Municipality and Lolland Municipality both include areas which are among ten Danish areas which have been appointed by the Danish Government, based on historical data and the criteria in Directive 2007/60/EC, as areas which might experience extreme climate events in the future (Ministry of Environment and Ministry of Transport 2011). The report descripes the appointment process, including a hearing process in the Danish municipalities, which was not a demand from the European Commission. At some crucial points, farmers in Lolland and Holstebro can expect very different consequences of climate change. In Holstebro, farmers might be part of the solution for solving flooding problems in the nearby city of Holstebro, while in Lolland many farmers experience flooding problems at their own farm.

It is well documented that the city of Holstebro experiences damaging flooding problems from time to time. A time series for the water level in the watercourse Storåen, running through Holstebro city, goes back to 1918. At a minimum of nine occasions Storåen has overflowed its banks in Holstebro city. The 1970 flood can be considered a 100 year event as the 1970 water level is the highest registered for the period (Ministry of Environment and Ministry of Transport 2011). In 2011, Holstebro again experienced flooding problems (Holstebro Municipality 2014). One of the suggested responses to the flooding problems is to use the farmers along the watercourse Storåen as water managers solving the problems for the city of Holstebro (Holstebro

Municipality 2014). The case study on Holstebro is centered on ‘the farmers as water managers’. For instance by analysing how much compensation farmers will need to be motivated to take agricultural land out of production and becoming water managers.

The island/municipality of Lolland was among those Danish areas hit by a severe storm surge back in 1872 which led to servere destruction and loss of human lives. The likelihood and possible effect of another 1872 events has been analysed in several projects (Ministry of Environment and Ministry of Transport 2011). The 1872 incident can be considered a trauma on the two islands of Lolland and Falster, which were the hardest struck areas in Denmark – 52 people were killed by the storm on Falster and 28 on Lolland (Lokalhistoriske Arkiver i Sydøstdanmark 2014). The 1872 incident led to a strengthening of the dikes at Lollands south coast and to a draining of large areas behind the dike to Nakskov Fjord (ibid). Since 1872, there has been several floodings on Lolland. The last severe incident was in August 2011, where a substantial part of the crops was lost. Lolland is very central for the Danish sugar production as a large part of the Danish sugar beet crop is located at Lolland. Some possible actions to solve the problems at Lolland could be to:

- Improve the dike.
- Better management of (rain) water behind the dike.
- Integrated coastal zone management.
- Private adaptation options (farmers): change in crops and farming practices.

The Danish case study will address all the common subjects and research questions of the agricultural subgroup (see above). Methodologically, the case study is based on document analysis, semi-structured qualitative interviews and quantitative questionnaires to farmers. Semi-structured qualitative interviews are performed with central stakeholders. Online questionnaires have been developed for:

- App. 200 farmers organised in a farmer organisation in the Holstebro area.
- App. 200 farmers organised in a farmer organisation in the Lolland area.
- App. 1500 farmers in a national survey (in collaboration with the NORD-STAR centre og excellence which AU is leading).

The questionnaires are running in April 2014.

2.1.3 South Moravian Region

By Eliska Lorencova

The South Moravian Region lies in the southeast of the Czech Republic, on the borders with Austria and Slovakia. The region is home to the Czech Republic’s second largest city Brno. Agricultural land covers 60 % of the area of the region, of which 83 % is arable land. A particular specialty of South Moravia is winegrowing, with more than 90 % of the total area of vineyards in the Czech Republic. Moreover, water management also plays an important role in this region.

The aim of South Moravian Region case study is to investigate suitable and sustainable adaptation measures and strategies in the agricultural (particularly wine growing) and water management sector to deal with changing climate (mainly water availability), while incorporating perceptions of local stakeholders. Moreover, our aim is to investigate perceptions of local stakeholders towards climate change (in particular drought) as well as preferences towards suitable adaptation measures and strategies in the agricultural sector.

Impacts

As agricultural practices are climate-dependent and yields vary over years depending on shorter term weather patterns, the agricultural sector is particularly exposed to climatic change (Moriondo et al., 2010). Changes in temperatures and rainfall patterns directly affect crop yield and subsequent food production and indirectly effect changes in water availability (Nelson et al., 2009).

Žalud et al. (2009a) describes the main climate related risks posing significant hazard for agro-ecosystems in the Czech Republic. These risks include: (a) hydrometeorlogical extremes (such as storms, short periods of very warm weather in winter, spring frost, flood, drought, heat wave, etc.), (b) occurrence of harmful agents (pathogens, pests, weeds), and (c) change of farming conditions (changes and shifts in production regions).

The case study area is located in a temperate climate zone. Ústí region together with South Moravia are one of the driest areas in the Czech Republic with yearly precipitation approximately 450 mm.

Based on drought analysis performed by Brázdil et al. (2009), the results for the area of the Czech Republic during time period 1881–2006 indicate a clear tendency towards prolongation and greater severity of drought episodes. Moreover, the study confirms the statistically significant tendency of more intensive dry episodes in the region, driven by temperature increase and precipitation decrease. These drought episodes have a substantial impact on national and regional agricultural production, with yields being consistently lower than in normal years.

Drought can be characterized as “sneaky extreme event”, which is gradually accumulated during longer time period (weeks to months) and can cause extensive economic losses. Due to climate change, increasing frequency and intensity of dry periods is expected. The impact of drought can be apart from the length and intensity influenced by the season of the occurrence (e.g. phenological phase) and also by suitable adaptation measures (e.g. change of cropping, irrigation, increased runoff from reservoirs) (Žalud et al., 2009b).

Case study research and adaptation

As this case study is prospective, it does not have any long adaptation history. At the national level, national adaptation strategy has not been approved yet and discussion regarding climate change adaptation is slowly emerging. Very few programs currently exist to support adaptation on the national, regional level.

In general, the National subsidy program of the Ministry of Environment "Support of restoration of natural landscape features" aims to design and implement adaptation measures to mitigate the impacts of climate change in water, forest and non-forest sectors.

The case study is focusing on perception of local farmers (wine growers) to climate change impacts, such as drought and preferences towards suitable adaptation measures and strategies in the agricultural sector.

To investigate suitable and sustainable adaptation measures and strategies in the agricultural (particularly wine growing) and water management sector to deal with changing climate (mainly water availability), while incorporating perceptions of local stakeholders. Moreover, the aim of South Moravian case study is to investigate perceptions of local stakeholders towards climate change (in particular drought) as well as preferences towards suitabl adaptation measures and strategies in the agricultural sector.

Our main research questions are:

- How is the climate change adaptation concept integrated in key sectors?
- What are the main challenges resulting from climate change in agriculture (mainly wine growing) and water sectors in region?
- What are the current adaptation measures in agricultural and water sectors that deal with changing climate? What is the estimation of their costs and benefits?
- How local farmers and other relevant stakeholders perceive the concept of climate change and adaptation?
- What are the potential future adaptation measures that should be implemented to deal with climate change?
- What are the barriers and opportunities of implementation adaptation policies?

Our Stakeholders include:

- Local farmers – wine growers - key stakeholder with regard to the climate change perception, adaptation actions
- Farmer association - Union of the Wine producers of the Czech Republic - stakeholder officially representing the wine growing sector – sectoral representative
- Companies – regionally based sectoral companies – local scale
- Water management authorities - stakeholder mainly responsible for potential measures in water sector – regional scale
- Regional Authority of the South Moravian Region - regional management authority – regional scale.

Methodology

- Semi-structured interview with relevant stakeholders
- Questionnaire-based survey (data collection) – that would investigate farmers perceptions to climate change, current adaptation measures and costs
- Analysis of relevant documents and policies in sectors
- PRIMATE tool might be used (if data relevant for CBA are available)
- Our expected outcomes include:
- Assessment of stakeholders’ attitudes towards climate change and adaptation;
- Investigating preferences towards suitable adaptation measures and strategies in the agricultural sector, analysis of current adaptation measures and pathways (incl. barriers and opportunities) and their assessment;
- Identification and analysis of future adaptation measures.

2.1.4 Usti

By Eliska Lorencova

Ústí Region lies in Northwest Bohemia and shares a border with Germany. It is one of the most densely populated regions in the Czech Republic, with the tradition in industrial and agricultural production. Concerning the agricultural sector, hop cultivation is the traditional agricultural activity in the region. More than 73 % of the total hop planting area in the Czech Republic is situated in the Usti region.

Based on the climate scenarios in the period 2051-2100, hop yield will decline up to 7-10% and a quality determinant, α-acid content by 13-32%. The concentration of hop cultivation in a comparatively small part of the Czech Republic makes it more vulnerable than if the crop were grown in more areas with different climates (Možný et al., 2009).

The aim of Ústí Region case study is to investigate suitable and sustainable adaptation measures and strategies in the agricultural (particularly hop growing) and water management sector to deal with changing climate (mainly water availability), while incorporating perceptions of local stakeholders. Moreover, the aim of Ústí case study is to investigate perceptions of local stakeholders towards climate change (in particular drought) as well as preferences towards suitable adaptation measures and strategies in the agricultural sector.

Impacts

As agricultural practices are climate-dependent and yields vary over years depending on shorter term weather patterns, the agricultural sector is particularly exposed to climatic change (Moriondo et al., 2010). Changes in temperatures and rainfall patterns directly affect crop yield and subsequent food production and indirectly effect changes in water availability (Nelson et al., 2009).

The case study area is located in the temperate climate zone. Ústí region together with South Moravia are one of the driest areas in the Czech Republic with yearly precipitation approximately 450 mm. Similarly to South Moravia, this case study is prospective, it does not have any long adaptation history.

Case study research and adaptation

The case study is focusing on perception of local farmers (hop growers) to climate change impacts, such as drought and preferences towards suitable adaptation measures and strategies in the agricultural sector. Our core research objective is to investigate suitable and sustainable adaptation measures and strategies in the agricultural (particularly hop growing) and water management sector to deal with changing climate (mainly water availability), while incorporating perceptions of local stakeholders. Moreover, the aim of Ústí case study is to investigate perceptions of local stakeholders towards climate change (in particular drought) as well as preferences towards suitable adaptation measures and strategies in the agricultural sector.

Thus, our main research questions are:

- How is the climate change adaptation concept integrated in key sectors?
- What are the main challenges resulting from climate change in agriculture (mainly hop growing) and water sectors in region?
- What are the current adaptation measures in agricultural and water sectors that deal with changing climate? What is the estimation of their costs and benefits?
- How local farmers and other relevant stakeholders perceive the concept of climate change and adaptation?
- What are the potential future adaptation measures that should be implemented to deal with climate change?
- What are the barriers and opportunities of implementation adaptation policies?

The main stakeholders are:

- Local hop farmers – key stakeholder with regard to the climate change perception, adaptation actions (cca 100-120 hop growers in the region) – local scale
- Farmer union - Hop Growers Union - stakeholder officially representing the hop growing sector – sectoral representative
- Companies – regionally based hop business companies – local scale
- Water management authorities - stakeholder mainly responsible for potential measures in water sector – regional scale
- Hop research institute – research institute focusing on research in the area of cultivation, harvest and post-harvest treatment of hops – research institution
- Regional Authority of the Ústí Region – regional management authority – regional scale

Our methodology uses the following techniques:

- Semi-structured interview with relevant stakeholders
- Questionnaire-based survey (data collection) – that would investigate farmers perceptions to climate change, current adaptation measures, potentially their costs
- Analysis of relevant documents and policies in sectors
- PRIMATE tool might be used (if data relevant for CBA are available).

Our main expected outcomes, include:

- Assessment of stakeholders' attitudes towards climate change and adaptation
- Investigating preferences towards suitable adaptation measures and strategies in the agricultural sector, analysis of current adaptation measures and pathways (incl. barriers and opportunities) and their assessment
- Identification and analysis of future adaptation measures

2.1.5 Spain – Agriculture in the Tagus Basin

By Ana Iglesias

Agriculture in the Tagus basin faces a multiple exposure to serious challenges that will bring an uncertain future: markets, policy and climate. The conciliation between strict regulations and intensified pressures on markets, with projected restrictive conditions of decreased precipitation require a deep analysis of adaptation options able to integrate all these aspects in the decision framework.

Agriculture in the Tagus is typically Mediterranean, with a mixture of dryland and irrigated systems. Extensive dryland systems include cereals and pastures that sustain a large livestock industry. Irrigated crops include alfalfa and grain maize, also for animal feeding. In addition there are large areas devoted to fruit tree production and grapes for wine that are irrigated with highly technified systems in some areas.

Irrigated agriculture is the main user of water (over 50% of total water use) in the Tagus basin. Water for agriculture competes with water foe ecosystems and water for people (i.e., urban areas and recreation).

Impacts

The trends of decreasing precipitations and increasing temperatures in the basin intensify this situation and are of special international concern in the context of climate variability and change (IPCC, 2013). The large climate variability – characteristic of the region- makes drought events appear as a recurrent phenomenon in the area, causing important damages in both the economy of farmers and the environment (Iglesias and Moneo, 2005).

Agriculture is extremely important for rural development in the basin, and changes in the climate conditions have important implications in different social, environmental and economic aspects, requiring a level of coordination among sectors that is not easily reached. Pressures derived from agricultural activity or population demands, on one side, and standards imposed by the Water Framework Directive on demand satisfaction and water quality on the other, derive in management conflicts that are hardened and emphasized during drought periods. Emerging policies seek to balance water for human use and water for environmental needs (Iglesias and Moneo, 2005).

These normative recent developments (WFD and the CAP reform) expose the uncertainty facing the Tagus agriculture sector in general and farmers in particular, therefore the baisn stands at a crucial point and adaptation strategies are extremely important.

Case study research and adaptation

Adaptation to climate change is part of complex, multi-disciplinary effort overarching a wide range of stakeholders with different interests, technical expertise, and priorities. Successful planning requires effective land and water planning. Economic factors continuously push the intensification of land and natural resources use even if there is a generalised acceptance of the risk associated to climate change. A better understanding of interactions among climate, agriculture and society is absolutely essential for any modification in the management of agriculture in the Tagus Basin.

The potential adoption of strategic measures to avoid or mitigate the impacts of climate change in agriculture is necessary. One of the main difficulties in adaptation planning is the lack of previous experiences in similar conditions and the insufficient data records to foresee the potential results of such adaptation measures.The case study will address to two main adaptation questions:

- How can current knwoledge contribute to the design of adaptation practices?
- How can farmers contribute to adaptation?

Methodology

The first question will be addressed with a technical review of the adaptation practices and the opportunities to establish policy linkages with the Common Agricultural Policy. The information will be based in a semi-quantitative analysis of the adaptation practices, their potential effort to benefit ratio and the possible policy instruments to implement them.

The second question will be addressed by semi-structured interview with relevant stakeholders. Additionally a questionnaire-based survey (data collection) – that would investigate farmers perceptions to climate change, current adaptation measures. The results may be analysed with the PRIMATE model.

2.2 Biodiversity and Ecosystems Services

Overview of Impacts and Adaptation Challenges

By Eliska Lorencova

Anthropogenic climate change is one of our greatest environmental, social and economic threats (Stern, 2007). Moreover, climate change is a significant driver in the natural ecosystems distribution and functioning (Parmesan and Yohe, 2003). Current projections show that if global mean temperature rise beyond 2 to 3°C above pre-industrial levels, between one fifth and one third of European species could be at increased risk of extinction (Lovejoy and Hannah, 2005; IPCC, 2007). Therefore, maintenance and enhancement of healthy ecosystems plays important role in climate change mitigation and adaptation (EEA, 2008). This section reviews preliminary results from BASE case studies in this group.

Within the Ecosystem services and biodiversity sub-group, there are two case studies focusing on climate change adaptation – Green Roof case study in the Czech Republic and Dartmoor case study in the UK. Both case studies are located in national parks that provide a wide range of ecosystem services and substantially contribute to human well-being. Case studies investigate different aspects of Ecosystem Based Adaptation in Europe.

The two case studies are at different stages of climate change adaptation. In case of Dartmoor National Park, a climate adaptation strategy has been developed in 2011. Dartmoor case study aims to understand the current climate change adaption plan and its development process, by identifying the positions of several actor groups, barrier and opportunities to adaptation as well as risks and vulnerabilities.

On the other hand, in case of Šumava National Park (Green Roof) the adaptation strategy has not been yet approved even at national level, and therefore the debate on climate change adaptation is emerging slowly, although the impacts are already happening. The main aim of Green Roof case study is to analyse current adaptation action, assess potential future impacts, propose adaptation measures and analyse their feasibility. Engagement with local stakeholders and participatory development of adaptive scenarios is integral part of this research.

2.2.1 Green Roofs Case Study

By Eliska Lorencova

Green roof case study is focusing on ecosystem services and biodiversity in a Central-European mountainous forested range Šumava (Black Forest, Bohemian Forest). The area is one of the most extensive forest landscapes in central Europe located in the southern part of the Czech Republic. The area of National Park Šumava is 68,064 ha, protected landscape area has 99,624 ha. Together with the neighbouring Bavarian Forest National Park in southeast Germany, the Šumava National Park covers one of the largest forest areas in central Europe, also called the Green Roof.

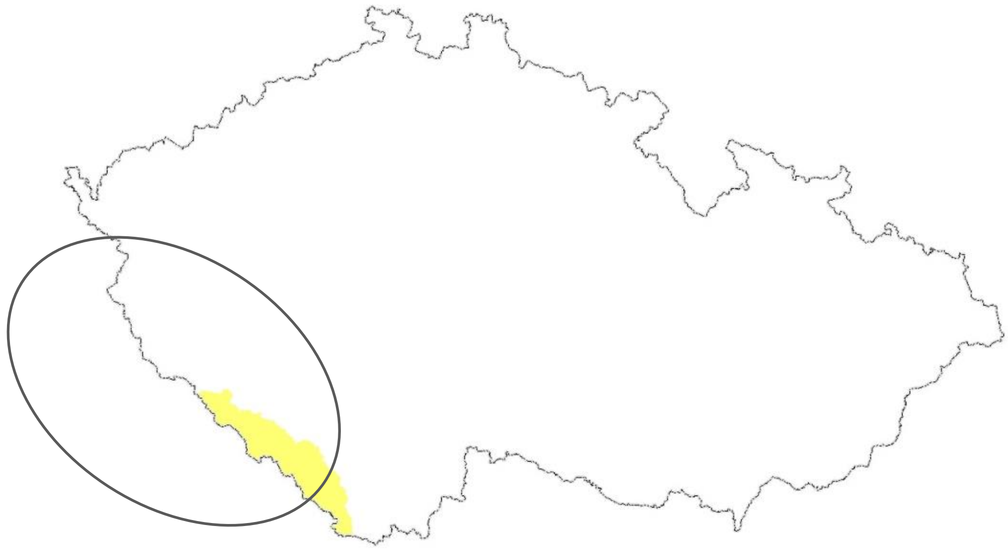


Figure 2.3.1: Location of Šumava in the Czech Republic

Impacts

Climate change threatens the Šumava region by declining precipitation, increasing storms (e.g. storm Kyrill in 2007, another storm in 2011) and periods of droughts. The Šumava NP has been impacted by acid deposition and bark beetle calamites which lead to deterioration of more than 50% of the forest canopy. Therefore, the regeneration of forest in the light of climate change is an important aspect of cultural ecosystem services (e.g. recreation and aesthetic perception of ecosystems).

Case study research and adaptation

The provision of ecosystem services in Šumava is highly dependent on its land use and land cover (LULC). However, Šumava has been undergoing a considerable LULC change recently and conflicts about the desirable proportion of various LULC types have arisen, with recreational landscape being growingly pronounced at the expense of forested area. This trend is enhanced also by climate change and natural disturbances, e.g. bark beetle outbreaks or windstorms. Therefore, the assessment of changes in ecosystem service levels, caused by developing LULC, is of increasing interest from both the scientific and governmental point of view. The present case study brings an opportunity to utilize various models (e.g. InVEST) to evaluate based on the scenarios (that also include ecosystem-based adaptation measures) the delivery of ecosystem services in the study area, with an emphasis on regulating and provisioning services, such as carbon sequestration, nutrient retention, sediment retention and timber production. The results will contribute to the current debate and will bring valuable knowledge on the interaction between climate change and ecosystem services.

Our core objective is to understand potential climate change impacts on biodiversity and the ecosystem services sector (together with tourism and forestry sector), with the aim to propose integrated adaptation measures that would support climate change adaptation in the region from an ecosystem services perspective. The main aim is to analyze current adaptation action, assess potential future impacts, propose adaptation measures and analyze their feasibility. Engagement with local stakeholders and participatory development of adaptive scenarios is integral part of this research.

Main research questions:

a) Analysis of current status of the study area of Šumava regarding existing adaptation measures and potential future climate change impacts:

- What current adaptation measures are employed in Šumava? Was the primary motivation of their adoption climate change impacts?
- How is climate change adaptation represented in local sectors (e.g. tourism, forestry) and strategic documents?
- What are the potential climate change impacts with regard to ecological and socio-economic indicators?

b) Specification of adaptation measures (short-, medium-, long-term) with respect to expected climate change impacts based on scenario workshop.

- What adaptation measures are proposed by relevant stakeholders?
- What scenarios and adaptation measures are not well accepted by the stakeholders?

c) Assessment of proposed adaptation measures and actions, costs and benefits (CBA)

- What is the impact of proposed adaptation measures on biodiversity and ecosystem services?

d) Analysis of proposed adaptation measures and actions implementation potential, barriers and opportunities.

- What are the barriers and opportunities of proposed adaptation measures?

2.2.2 Dartmor case study

By Roos Den Uyl, Eliska Lorencova

Dartmoor National Park is an upland located nature conservation area (with several peaks rising up to 600 meters) in the South West of England covering about 954km. A wide range of ecosystem services is provided by the Dartmoor area including: provisioning services such as food provision and fresh water availability; regulating services such as regulating soil erosion and regulating water flow; and cultural services such as sense of place/inspiration, tranquility and recreation (Natural England, 2014).

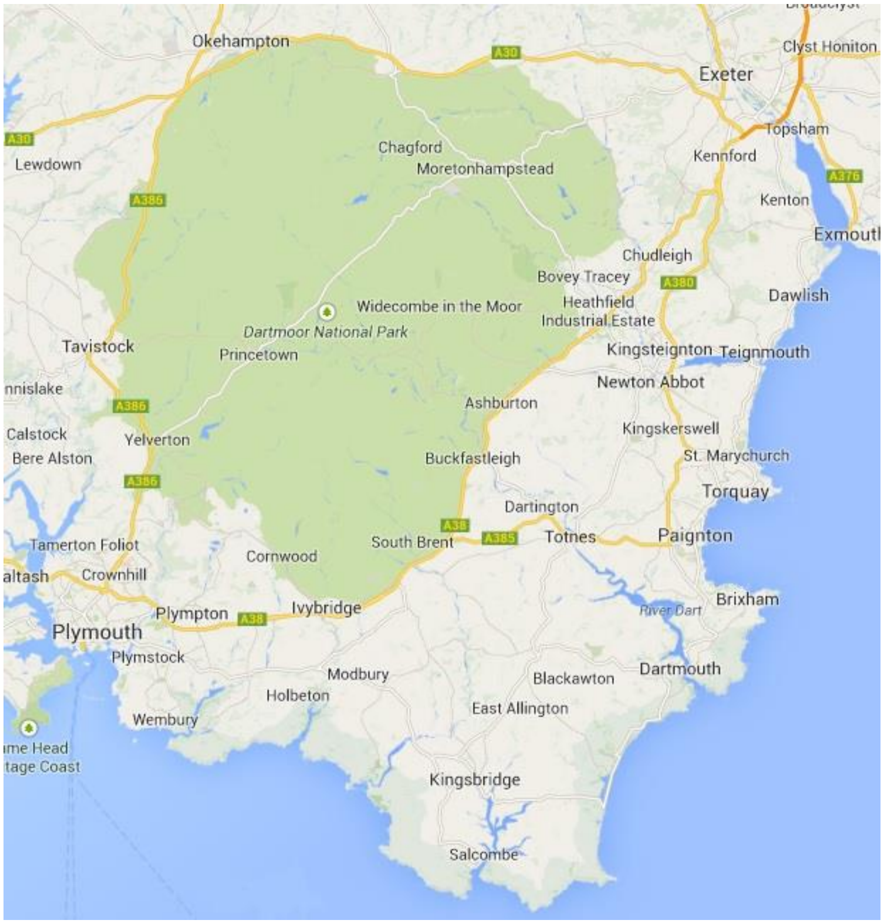


Figure 2.3.2: Location of Dartmoor National Park (source: Google maps)

Impacts

The Dartmoor National Park Authority states that: "Between 1961 and 2006, average daily temperature in the South West increased by 1.37°C, the number of days of air frost decreased by 20.9 days. Annual precipitation also increased between 1961 and 2006, with the largest increase seen in autumn (28.6%). Conversely, there was a small decrease in summer rain (8.8%)" (DNPA, 2011, p. 5). The Dartmoor National Park Authority expects climate change impacts to continue in future, and states that adaptation actions are needed in Dartmoor to prepare for further climate change impacts. Natural England (2014) also expects climate change to impact Dartmoor, and identifies several climate change pressures in particular on Dartmoor's ecosystem services:

- An increased frequency of drought in the summer months might result in dry out of specific plant species affecting their functions for water and carbon storage. The drought periods might also lead to more frequent and intensive moorland fires and erosion.
- Increased autumn and winter precipitation levels could lead to higher water levels in upland streams, resulting in more frequent downstream flooding.
- Climate change could lead to an extended growing season and enhanced growth rates of vegetation.

- Increased pressure to expand coniferous plantation and woodland (impacting on open character) might occur. The coniferous plantations are planted to enhance water filtering, minimise downstream flooding, storing and sequestering carbon dioxide and providing low-carbon fuel sources (through coppice management).
- Increase in the occurrence of pests and diseases and spread of non-native and alien species might occur due to climate change.
- Climate change may result in increased demand for renewable energy sources, such as turbines within the open landscapes and hydroelectric schemes at Dartmoor's fast-flowing rivers.
- Increase in extreme weather events may change farming and woodland practices, which consequently may have an impact on the character of the landscape.

Case study research and adaptation

Our core objective is to understand how planning processes takes place oriented at adapting to climate change impacts on ecosystem services and reducing vulnerability of an area's ecosystem services to climate change. In this case study, we will:

- analyse (retrospectively) how the climate change adaptation strategy for this area (coordinated by the Dartmoor National Park Authority, published in 2011) was developed;
- identify how the implementation process is taking place;
- assess whether there are potential future risks which are not yet being addressed by the current strategy;
- and whether the strategy would allow for additional or alternative adaption actions which may contribute to reducing vulnerability of Dartmoor's ecosystem services to climate change impacts.

Our case study research shows the complex institutional setting for Dartmoor, and analyses how this climate change adaptation strategy was developed within this setting, and how the setting has shaped the implementation process. The case study includes engagement with local stakeholders to identify barriers and enablers encountered in the implementation process, to assess possible risks and vulnerabilities not yet addressed by the current strategy, and to identify possible additional or alternative adaption actions. An array of public organizations is involved the management of Dartmoor's ecosystem services. The most prominent actor is the Dartmoor National Park Authority, which is referred to as a special purpose, freestanding local authority created under the Environment Act 1995, and is governed by 22 appointed members.

Other public actors involved the management of Dartmoor's ecosystem services include:

- the Environment Agency, a governmental agency involved in developing and implementing a flood risk plan for South Devon;
- the Devon County Council, the regional government under which Dartmoor resides;

- the Natural Devon/Devon Local Nature Partnership, which is an umbrella body which brings together and includes everyone with an interest in securing the benefits of our natural environment, affiliated and supported by the Devon County Council;
- the Ministry of Defense, who uses several areas in Dartmoor for military practice, and leases lands from the Duchy Foundation;
- the Dartmoor Commoners Council, which comprises commoners of most commons or groups of common, and a complex representation structure, and which makes regulations about most matters, which is concerned with the management of the commons, the welfare of the stock de-pastured there and arbitrates in disputes between commoners;
- DEFRA, UK's national ministry of Environment, Food & Rural Affairs;
- and Natural England, who is the government's advisor on the natural environment and who also gives advice on Dartmoor.

Furthermore, several semi-public organisations are involved in the management of Dartmoor's ecosystem services, including:

- Dartmoor Farming Futures, which is referred to as an initiative to improve agri-environment delivery on common land and to reflect a wider range of ecosystem services. It is led by the Dartmoor National Park Authority, the Dartmoor Commoners' Council and Natural England. The work seeks to overcome concerns over the appropriateness of some Higher Level Stewardship agreements to address the full suite of ecosystem services and the lack of ownership of their agreements by commoners;
- and the Dartmoor Access Forum, which is referred to as an independent advisory body which was established by the Dartmoor National Park Authority; its purpose being to give advice to the National Park Authority and other organizations, on how to make the countryside of Dartmoor more accessible and enjoyable for recreation (taking into account environmental, social and economic interests).

And several private organisations are involved in the management of Dartmoor's ecosystem services, including:

- the Duchy of Cornwall, a private organization from the Prince of Wales, which owns about 27300 hectares in Dartmoor, which is about a small third of the park;
- the Southwest regional office of National Farmers Union, which represents farmer's interests;
- and various other local agricultural groups, such as Dartmoor Livestock Protection Society and South West Uplands Federation.

Our case study further analyses the role and contributions of experts and expertise in the development of the climate change adaptation strategy, in its current implementation process, and in the assessment of possible risks and vulnerabilities for Dartmoor National Park. The Dartmoor adaptation strategy appears to have been developed on the back of expert advice and a strong evidence base. The case study investigates which type of knowledge was used and in which way in the development of this strategy, and which knowledge needs are currently articulated and why (to adapt and/or reduce vulnerability of Dartmoor's ecosystem services to climate change impacts). In particular, this study includes an analysis of how the Adaptation Strategy from the European Commission and the UK National Adaptation Strategy facilitate knowledge use and needs in more localised settings. In that way, this case study contributes to our understanding of context-specific knowledge usage needs in local responses to climate change, and why higher-level adaptation strategies assist or not in such context-specific knowledge needs.

Finally, our case study examines the dynamics in the relationship between the UK National Adaptation Strategy and the EU Adaptation Strategy, and the local Dartmoor adaptation strategy. At the local level, specific environmental, economic, social and political contexts present a variety of climate change challenges and institutional responses. The case study investigates how the higher level strategies assist in local institutional responses to climate change, which synergies and tensions can be observed between (supra-) national and local institutional responses to climate change, and what may explain these synergies and tensions. Thus, this case study also contributes to enhancing our understanding of synergies and tensions between local and (supra-) national responses to climate change, in particular to reduce vulnerability of ecosystem services to climate change impacts.

This case study is in a relatively early stage, further results will be provided with deliverables 5.2 and 5.3.

2.3 Coastal Zones

Overview of impacts and adaptation challenges
By Inês Campos

The coastal group includes four case studies: Aveiro Coast (Portugal); Timmendorfer (Germany); South Devon Coast (UK) and Kalundborg (Denmark).

Direct impacts as stated in D.4.1 are: "**sea level rise and storm surges**. Sea level rise estimated by IPCC (2007b) for this century ranges from 20 up to 59 cm in a global average." (section 2.2.1).

The following reports from each case study and their preliminary findings, highlight several indirect impacts such as: increased vulnerability of coastal communities to flooding and extreme events; severe impacts on economic activities (such as tourism, agriculture and fishing and sea farming activities); losses of biodiversity; and even the relocation of vulnerable populations.

What the four cases have most in common is their expected impacts, but their geographies, socio-political and economic landscapes, as well as local responses to adaptation impacts differ in various ways. Though the coastal group has been working together to integrate similar methodologies – i.e. Scenario Workshop; Adaptation Pathways; Interviews; Economic Assessment of Costs and Benefits - , comparability will be higher between some case studies.

Both in the Aveiro Coast and South Devon Coast cases, adaptation is strongly linked to social, institutional and governance conditionings. In these prospective case studies the potential for comparability is significant, even more so since both are using the Scenario Workshop method to design adaptation plans and promote their implementation, but are also concerned with multilevel governances processes that contribute to building up local adaptive capacity. Timmendorfen and the Kalundborg case studies are retrospective and ongoing: both have adaptation plans, which resulted from participatory decision making processes, and which have been or are being implemented. The Kalundborg case study has also used Scenario Workshop and will provide interesting comparisions to Aveiro and South Devon.

Moreover, comparative analysis of the Aveiro Coast, South Devon and Kalundborg case studies may provide interesting insights on how levels of public participation in decision-making influence adaptation preferences and planning at the local level. Thus, potential for comparing future research findings is significant, either due to similarities between the four cases, or due to their differences.

In the subsections below case study impacts and adaptation strategies are described for each case.

2.3.1 Aveiro Coast: From Barra Beach to Areão
By Inês Campos and André Vizinho

The case study area is a dune barriere located at the Southern Aveiro district coast of Portugal, namely from "Barra" to "Areão" Beach. The area extends from the South of Aveiro Harbour, along a coastal stretch of nearly 20 km, between the sea and the "Ria de Aveiro". In this territory, three different coastal urban settlements were developed, each with a distinct history and social composition: Barra; Costa Nova and Vagueira. Barra, right next to the main city of Aveiro (district capital) is mostly composed by permanent residences. To the South, Costa Nova is the most ancient settlement, traditionally occupied by a mix of fishermen and tourists (high social classes from the inland regions), whereas Vagueira was only a small fishermen village until the late 80s.

Image 2.4.1 - Barra Beach and access channel to Ria de Aveiro

Image 2.4.2 - Costa Nova Beach

The sediment balance in Barra, Costa Nova and Vagueira has been strongly affected by harbour infrastructures built since the early 1800s; and by numerous dams build upstream the Douro and Vouga Rivers (Vouga flows to the Aveiro Lagoon), which have prevented sediments from flowing downriver to the feed sand reposition of the Atlantic beaches.

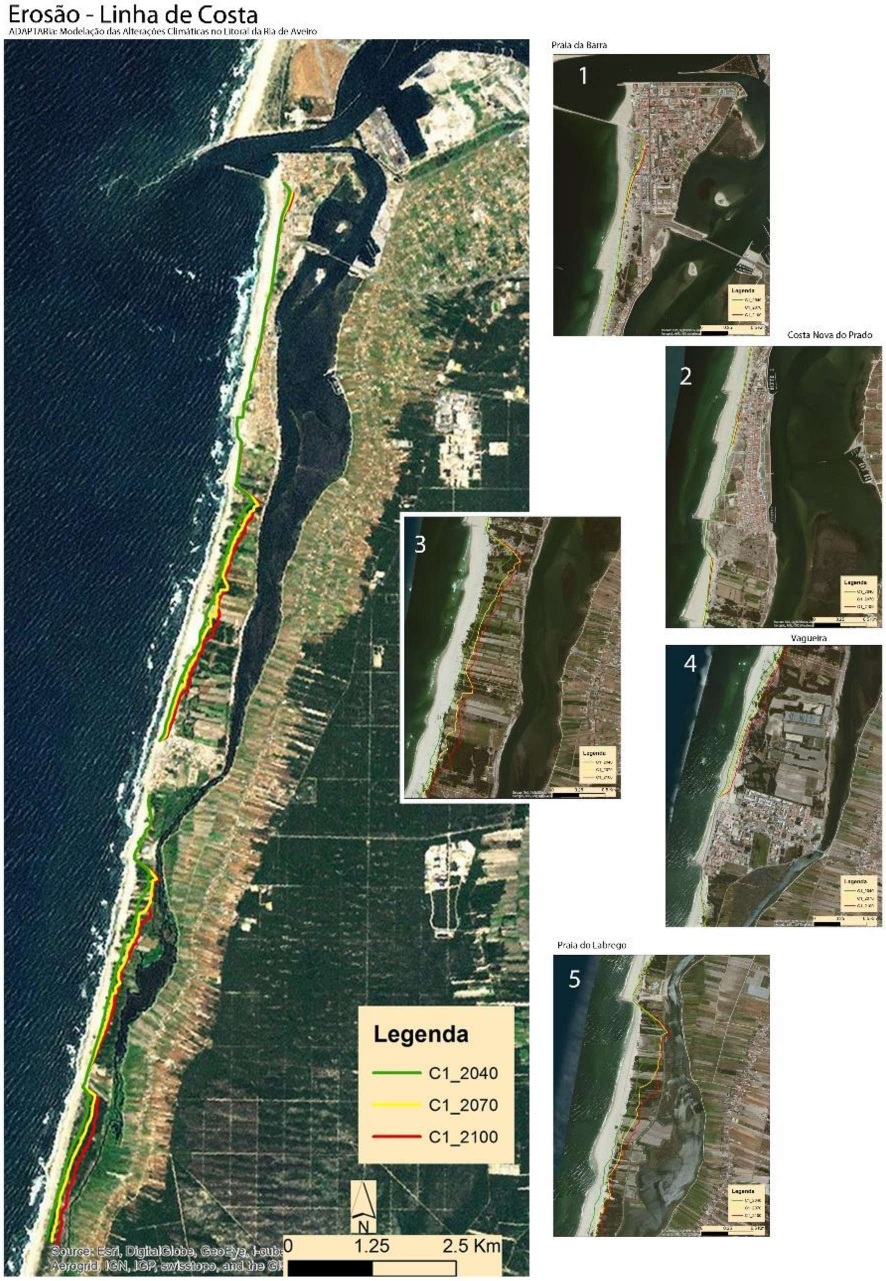

Image 2.4.3 - Vagueira Beach

Impacts

Currently, the coastline is retreating very vast due to coastal erosion and sea level rise. It has been recognized as one of the most vulnerable low-lying coasts in Europe when it comes to storm surges and flood risks (Shmidt et al, 2012). According to recent studies, sea level may rise up to a meter in 2100 and it is expected an increase in extreme events, particularly storm surges, which are already frequent in the region during the winter months (Shmidt et al, 2012). Climate indirect impacts include aggravated coastal erosion and loss of beach sand; recurrent flooding; loss of revenues in tourism and water sports; destruction of urban infrastructures, and devaluation or destruction of residential areas.

Existing flood risk models (adapted by BASE) from the AdaptaRia project of Aveiro University and Project CHANGE point to an unavoidable dislocation of some populated areas (**see Map 2.4.1 - Costal Erosion until 2100; and Map 2.4.2 - Flood Risk until 2100**), as well as changes in economic activities, namely agriculture and fisheries, and touristic activities.

Map 2.4.1- Coastal Erosion until 2100 from Barra to Areão Beach



Map 2.4.1- Coastal Erosion. Areas:

1 - Barra beach and urban settlements

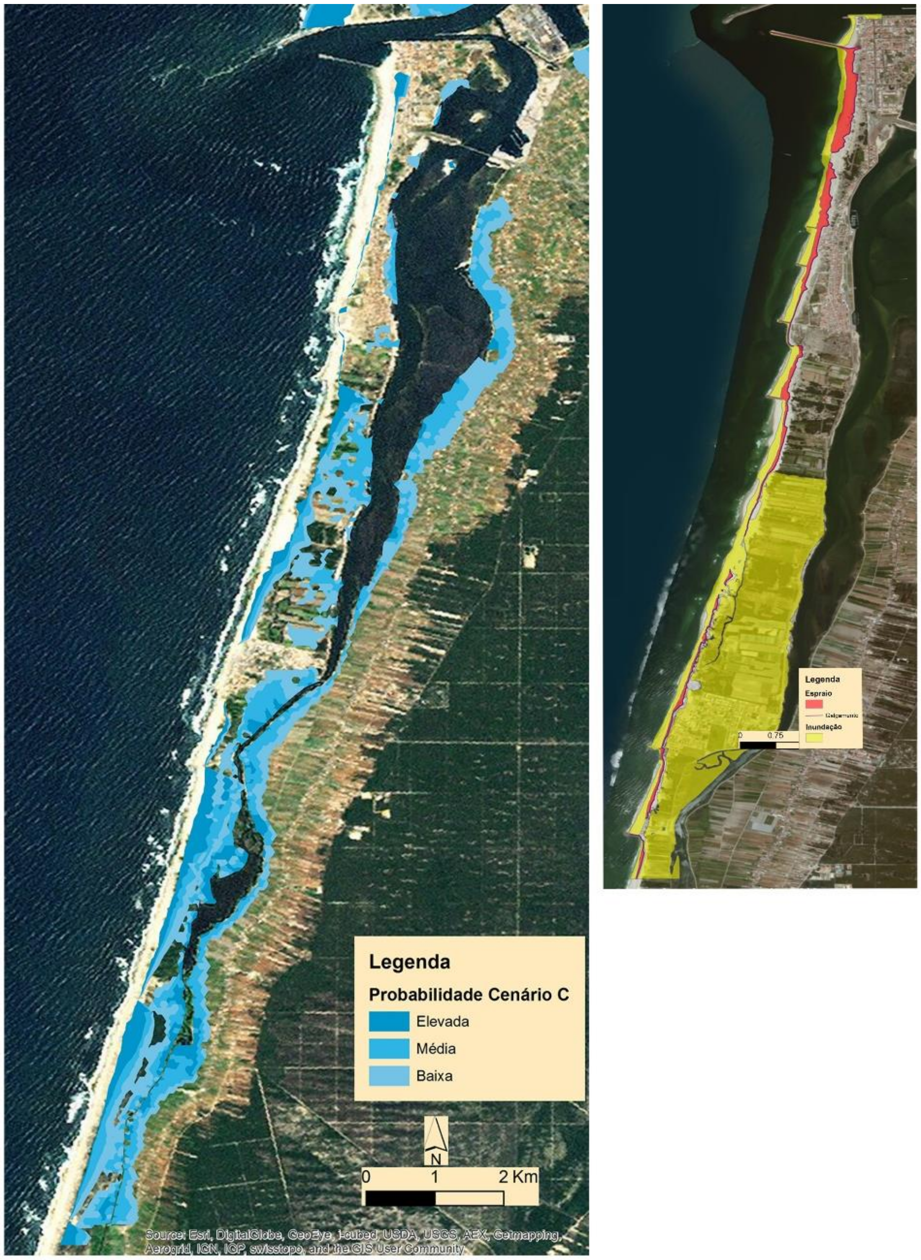
2 – Costa Nova Beach and urban settlements

3 – Between Costa Nova Beach and Vagueira (farming fields)

4 - Vagueira Beach and urban settlements

5 – South of Vagueira and Areão beach (farming fields)

Map 2.4.2 - Flood Risk until 2100



Case study research and adaptation

We found the success of this case study depended on the close engagement of local stakeholders throughout the implementation of the chosen methodologies.

Locally, adaptation planning to date has been based on piecemeal disconnected solutions, often responding to emergency situations. Long-term planning is difficult to put in practice given the myriad of institutional bodies involved, and a non-existent culture of public participation (see Shmidt et al, 2012) to support decision making.

The objective of BASE research has been to bring together a group of relevant stakeholders to promote institutional dialogue and the co-design of an adaptation plan for the area. There is, however, a national adaptation strategy for Portugal – ENNAC though it is still at the beginning stages of implementation. Additionally, last winter's events (storm surges which threatened several coastal zones in Portugal), lead the Portuguese Ministry of Environment to create a working group for costal adaptive management. The group is currently gathering data to advice on a plan for adapting the Portuguese coastline to both climate change impacts and coastal erosion.

Locally, political agendas are concerned with maintaining the functioning of the beaches during summer season, thus protecting investments and business in the tourism sector, but also in deterring the devaluation of real-estate investments.

The problem of this coast continues South to the district of Mira and Figueira da Foz, as well as North to Ovar; and an association of the municipalities that surround the Aveiro delta (CIRA) have created a joint strategy to supports implementation and fundraising strategies, which includes coastal adaptation and protection as part of its agenda. Thus, planning coastal adaptation in this smaller section of the affected territory can be an important pilot experiment for other regions to the North and South.

We began by presenting to stakeholders, individually, our methodological proposal based on the Scenario Workshop (Rasmussen, 2003) and the Adaptation Pathways and Tipping Points methods (Hassnoot et al, 2013) supported by a Multicriteria Analysis. The use of the Adaptation Pathways and Tipping Points method in a participatory context had, to our knowledge, not been done before. We complemented the workshops with follow-up individual interviews where we asked participants to assess their experience, as well as their views on local barriers, uncertainties and perceptions regarding climate adaptation. Finally, adaptation actions selected by local stakeholders are currently being economically assessed through a Cost-Benefit Analysis.

Stakeholders included in the scenario workshop were representative of the following groups: national environmental agencies; Aveiro Harbor; environmental NGOs; local authorities – municipalities and parishes; association of the region's municipalities; local business association; local residents associations.

To prepare stakeholders for the scenario workshops, we began by having informal meetings (from November, 2013 to February of 2014) with various individuals with the objective of choosing a representative group with a maximum of 30 people to participate in the Scenario Workshops (including local, regional and national political and administrative bodies, farmers, fisherman, business owners, and residents). Still during the preparation stage, we opted by providing a strong knowledge base to local stakeholders on the topic of coastal adaptation to erosion and sea level rise, in order to level the knowledge of all potential participants in the planning process. To do this, we partnered up with the Aveiro Order of Engineers and organized two seminars, which provided a review of the existent knowledge on coastal erosion and climate change impacts for the region. For one of the seminars, a collegue from Deltares (Ad Jeuken) came to Aveiro to present adaptation options that have been used in similar contexts in the Netherlands. An average of 70 people attended the seminars.

Our team used the vulnerability maps, based on results from projects AdaptaRia (Aveiro University) and CHANGE (CCIAM and Institute of Social Sciences) to support the design an adaption plan in the Scenario Workshop. (see **Maps 1 and 2)**. The workshop was structured over two days.

The first session day took place on April 10th. In this session participants reached a consensus on their shared goals for the region and on the potential measures needed to realize such goals. They concluded that there would be a need to invest on a number of adaptation actions to meet the shared goals of protecting human settlements and the integrity of the dune cord (see **Table 2.4.1**).

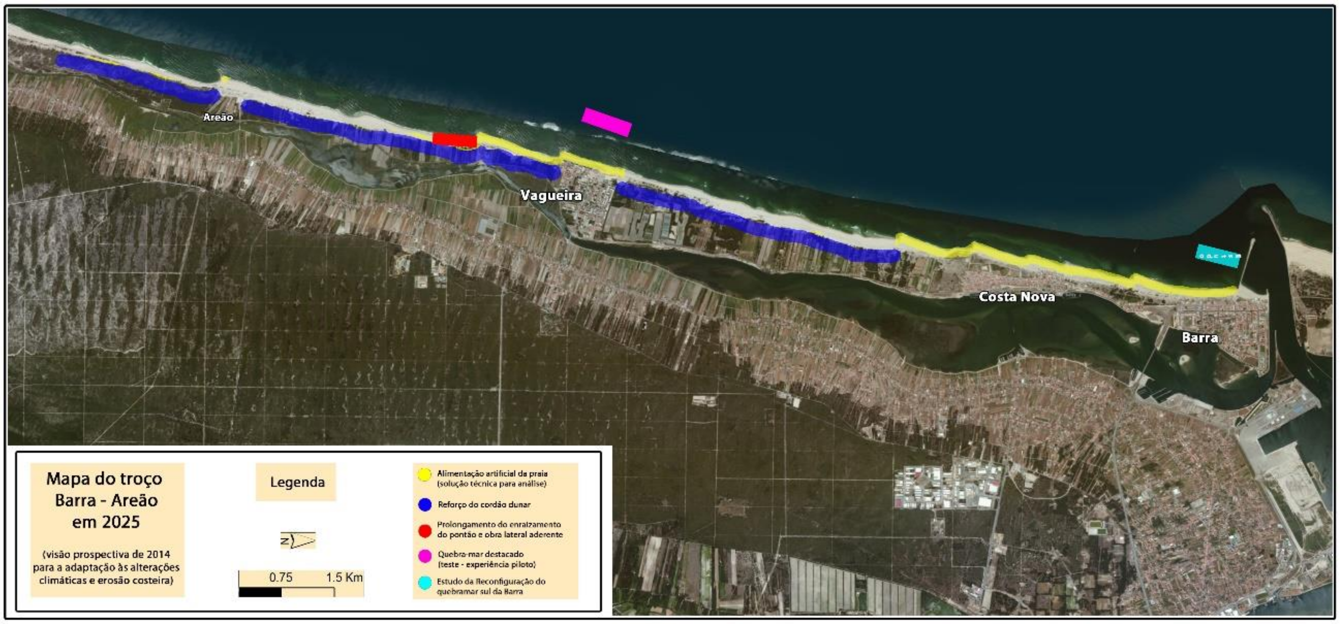
In the week after the first workshop participants received the recordings of the workshop and a summary of the decisions made. They were reminded that before the following workshop they would receive some information on the multi-criteria analysis that was being prepared, based on the consensual adaptation solutions that had resulted from the first session.

Solutions considered were mostly “hard measures”, such as building a sand dike or an underwater artificial reef. There has been an effort to consider multifunctional solutions – such an artificial reef with a surf wave. But this was not central to the discussion during the Scenario Workshop. Throughout the BASE scenario workshop, the aim was to reach common consensual solutions (see **Table 2.4.1**). This has been a good added value of BASE case study research in the South Aveiro coast – getting stakeholders to reach consensual solutions and come up with a common action plan.

Table 2.4.1. Synthesis of Consensual Visions (Scenario Workshop, day 1)

Consensus
Protect populated areas and the dune cord
Maintain existing coastal defence infrastructures
Beach sand replacement
Strengthen the dune cord (technical solutions need further analysis. Possible options are using dredging materials from the Porto of Aveiro maintenance works; and/or expropriate lands in non-urban areas to build a sand dike in the most vulnerable zones.
Dredging the River (use sediments to reinforce the dune cord)
Reinforcing the existing structures along the southern part of the lagoon (two small sized sand dikes)
Breakwater Structure: underwater reef (needs to be tested, a pilot-experience)

At the end of the 1st session participants had not only reached a consensus on their shared goals for the region, but also the potential measures needed to realize such goals (see **Map 2.4.3 – Map of Consensus**)



Map 2.4.3 - Consensual adaptation measures related to:

- Beach sand replacement;
- Reinforcing the dune system (by building sand dikes, and relocate farming fields); maintain existing structures (groynes);
- Build a longitudinal adherent construction on the existing groyne South of Vagueira Beach;
- Re-align the direction of the Aveiro Harbour's Southern groyne;
- Build an artificial reef in front of either Barra or Vagueira beach (or both).

On the second day of the Scenario Workshop (May 15th, 2014), which was dedicated to designing an adaptation plan until 2100, we began by presented potential adaptation pathways. The task of designing adaptation pathways had to be supported by information on the costs, efficiency, uncertainty and secondary effects of potential adaptation actions. Therefore, we prepared and presented a multi-criteria analysis to support the participants' decisions. Afterwards, we asked stakeholders to consider the possible adaptation pathways presented by us and design their preferred pathways for adapting the coast to climate change impacts and coastal erosion over the next 100 years, choosing actions according to tipping points (rising sea level and erosive forcing).

Participants were also asked to refer who they thought would be responsible for financing and implementing the suggested adaptation measures selected until 2025. For the purposes of this exercise, we asked that the group considered a shorter term period, though they had selected adataption pathways for the next 100 years. Our intention was to promote short-term planning, guided by a long-term planning direction.

For all adaptation measures until 2025, participants referred there should be a joint financial plan (70% to 80% the EU; and 30% to 20% Government agencies and local authorities). Overall, responsibility for financing resilience has been attributed to public investment, namely the

European Union, central government and local authorities. Yet, concerns with budget limitations left the debate open to explore alternative financial mechanisms. It was suggested that an increase in local taxes or introducing new tariffs locally could be possible solutions, though this was not agreed by all the participants. It was also suggested that small soft measures (such as planting vegetation to support dune structures) could be carried out by local volunteers, mobilized by local and national environmental NGOs.

The main barriers identified by the participants for the implementation of the adaptation plan have been the current budget limitations of public funding and the lack of institutional dialogue, which participants considered to affect institutional colaborations. Regarding possible funding from the private sector, more research would be needed to determine how social responsibility and sustainability budgets contemplate integrating climate change adaptation.

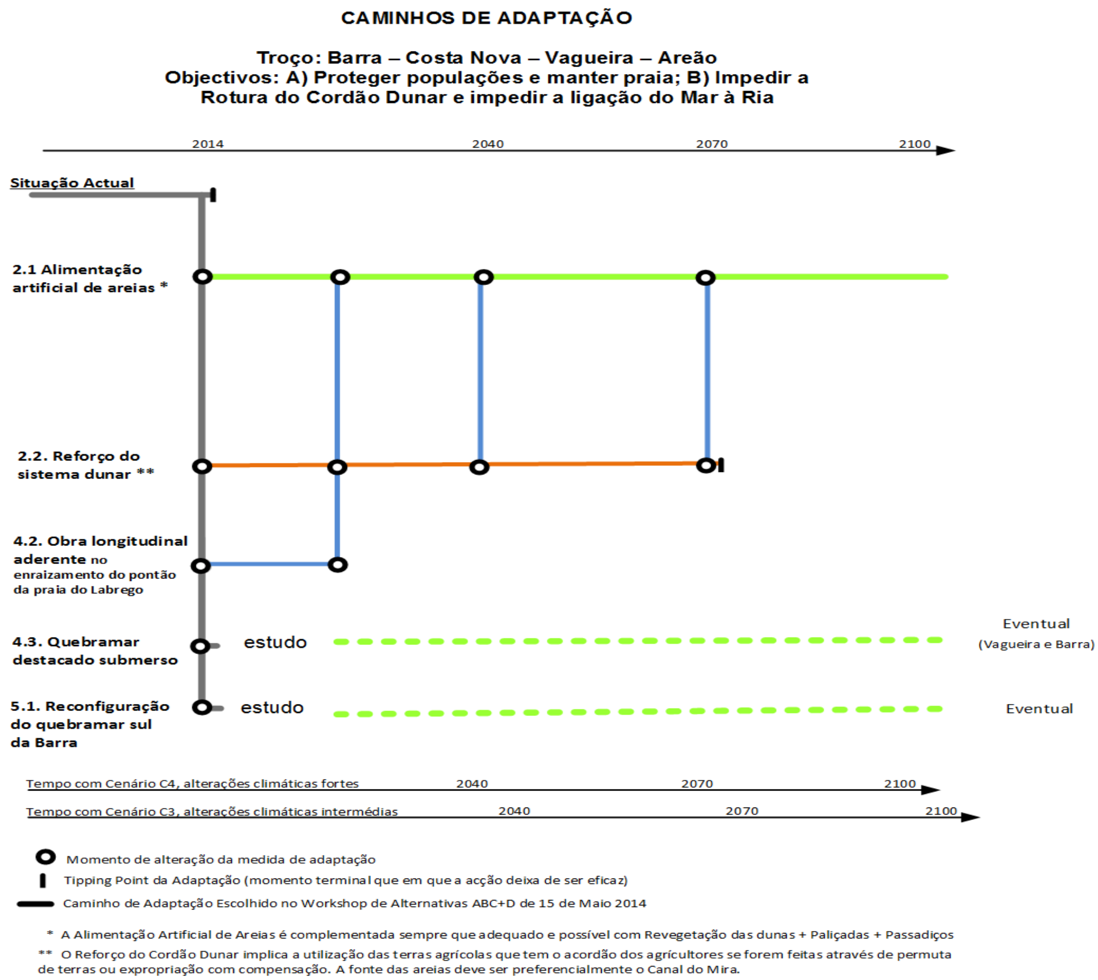


Image 2.4.4: Final Adaptation Pathways

Currently, only a qualitative and exploratory multicriteria analysis has been done to support the discussion of the second workshop day and the design of adaptation pathways. This analysis considered higher costs of different technical options for the same measures, as well as cost variations between measures. The artificial reef, the sand dike and the sand nourishment operations were considered the most expensive.

Based on the adaptation actions that resulted from the Scenario Workshop/adaptation pathways methodology, a Cost Benefit Analysis of the measures is being conducted. Results will be available by October, 2014. Social and environmental risks are also being be assessed through follow-up interviews.

We would like that the adaptation plan created through the scenario workshop and its follow-up research steps (i.e. interviews; CBA) would be entering its implementation stages over the next couple of years. We also understand that planning adaptation is merely the tip of an iceberg. Dominant societal practices, rules, cultures and structures need to fundamentally change to meet the challenges of this century. By promoting a collaborative planning we hope to influence this societal transition towards a more sustainable direction.

2.3.2 Timmendorfer: Adaptation to climate change in coastal regions of Schleswig-Holstein

By Jenny Troeltzsch

With respect to climate change, the coast of Schleswig-Holstein (northern Germany) is mainly threatened from impacts such as sea level rise, storm floods or coastal erosion. Therefore, coastal defense is one major aspect of adaption to climate change.

Impacts

From the perspective of coastal defense, changes in mean and maximum water levels and sea condition caused by climate change are predominately relevant. Both parameters (water level and sea conditions) are essential basis for the dimensioning of the coastal flood defenses. This aspect is acknowledged in the 2012 update of the state's master plan for coastal protection by the Ministry of Energy, Agriculture, the Environment and Rural Areas (MELUR 2012). As a major technical adjustment, a new dike profile was developed, including a "climate add-on" of 50 centimeters and "construction-buffer" for future further increases of the dike.

Case study research and adaptation

The first dike following this approach is built at the North Sea coast at Nordstrand. On a stretch of 2.5 kilometers the dike is raised to 8.7 meters above mean sea level with a more shallow profile and a broadened top of the dike from 2.50 meters to five meters. This allows future generations to increase the dike without great effort, should the sea level rise more than previously expected. This widening of the top of the dike will be used to arrange a promenade with relaxation areas to increase the attractiveness of the area for tourists. The construction costs of around 21 million Euros are financed with federal and state funds. The dike protects 612 hectares of lowland area with around 370 inhabitants.

Looking at the Baltic Sea, the case of Timmendorfer Strand is an example of a good practice of a participatory coastal defense planning. The ministry (MELUR, then MLR) stepped in 1999 and initiated a pilot of participatory coastal defense planning. In addition, the *Beirat Integriertes*

Küstenmanagement (advisory board integrated coastal management) was installed in 1999 to facilitate information and communication in coastal planning (Hofstede, 2004: 236). The project followed three steps: assessment of socio-economic values, sensitivity analysis, and ideas competition. All of these steps were unprecedented in coastal defence planning (Hofstede, 2004: 236). At first, an assessment of economic values in the community was conducted (see Reese 2003). It showed the damage potential in case of a flooding. This highlighted the need for coastal protection.

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 (Hofstede, 2004: 237). Based on the outcomes of the first exercise, scenarios for various measures of coastal defence were discussed in further focus groups. Altogether nine of these focus groups were held with over 50 participants. For example, these participants were stakeholders from the coastal protection authority, fishermen, tourism representatives, local residents and community authorities. It was agreed, that the potential measure should integrate coastal protection and erosion control measures and additionally acknowledge tourism interests via landscape planning.

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 (Hofstede, 2004: 240). Special elements, like flexible revetments and glazed/mobile retention walls were located at local spots. This particular design also meant additional expenses, which the community has had to cover. The execution on site started in 2006.

Overall, the total cost was € 30 million. While the pure sea defence cost € 18 million (of which the community had to take € 3.5 million), the cost of architectural and landscaping activities amounted to € 12 million. Of these, the community had to cover a share of 50% (Lehners 2011: 19). A crucial aspect of the implementation was the early financial backing of the project. With the help of EU funding, the community was able to afford the additional costs of the measure.

Another important factor for success was an exchange between all stakeholders throughout the whole period. Through information in newspapers and especially by information on site, for example by the mayor of Timmendorfer Strand, the acceptance of the stakeholders was maintained. In 2011, final measures were executed.

In summary, the following key elements can be identified which contributed to the success of this measure:

First, the economic analysis of the potentially damages of the community have been set in relation to the costs of coastal protection. With the participatory approach chosen, stakeholders were involved successfully in the process and their wishes concerning the coastal defence measure were acknowledged by the community. This was possible because the community could assure funding for the more costly measures from the beginning of the project. Finally, the identity of the community has historically been determined by tourism and the material standards have helped to achieve. The substantial investments and the choice of an expensive adaptation strategy can thus be understood as a strategy designed to protect the community’s primary material values and future development options. In Timmendorfer Strand, tourism and the associated consumerist values (such as gain orientation, individualist entrepreneurial thinking, and protection of the high standard of living) can therefore be understood as the primary drivers of coastal protection measures.

2.3.3 South Devon Coast

By Roos Den Uyl and Duncan Russel

The South Devon Coast, located in the South West of England, is an important area for tourism; it includes sites with heritage and nature conservation, and it provides some sites with exclusive housing/residential areas. In addition, it includes some important infrastructure connecting the South West of England to larger cities such as London.

This study focuses at the coastal area stretching from the town of Teignmouth (at the relative southwest), including the town of Dawlish, through Dawlish Warren (at the relative northwest); covering a length of about 10km. Provision of housing/residential areas, infrastructure and tourism, and heritage and nature conservation are already under pressure from coastal erosion and sea and river flooding (e.g. the town of Teignmouth is located at the mouth of the river Teign), a situation which will be exacerbated by climate change.

The recent extreme events at the coast at Dawlish (February 2014), which severely damaged the sea wall and the railway, increased the risk of flooding for the houses behind the sea wall, and disconnected the railway connection of the southwest of England to the rest of the country, demonstrate these pressures. Moreover, due to the geomorphological setting of rocky/cliff shores at the South Devon coast, options for managed flood plains, or for example dikes, or managed realignment of the coast are limited which presents further challenges when considering and developing climate change adaptation pathways.

Climate change adaptation at the Dawlish coast has been topic of discussion. As adaptation it is a very complex issue at this location, several groups have formally and informally attempted to outline the main issues and several options. But a formal adaptation strategy has so far been absent. In general, after the recent extreme events at the Dawlish coast, we can diagnose that – as far as there have adaptation actions – these have been clearly insufficient to prevent severe disruptions such as severe flood risks and infrastructure disconnections.

In order to increase our understanding of barriers and enablers to climate change adaption, we will study two local case studies of climate change adaption in Southwest England. In one of our two case studies, i.e. Dartmoor National Park, a climate change strategy has been developed in 2011. In the other case study, i.e. the South Devon Coast from Dawlish Warren to Teignmouth, this has not been done yet. This study focuses on identifying current discussions on climate change adaptation in this area, identifying who is involved in which way, identifying which potential risks and vulnerabilities are discussed and which not yet, and who is and/or will be in charge for which type of adaptations.

We will focus on the understanding of barriers and enablers in:

- the relationship/dynamics between local initiatives and higher level policy frameworks;
- the relationship with other relevant policy fields (e.g. is climate change adaption integrated in other relevant policy topics such as nature conservation, agriculture and infrastructure, and if so, how?);
- the role of participation (i.e. of local/regional non-state actors in policy making for collective goals);
- the role of knowledge use (e.g. to deal with uncertainties due to variability or due to lack of knowledge).

Also included in our study are evaluating the role/relevance of economic assessments (e.g. does insight in cost-benefit analysis help in decision-making on climate change adaption?), and the role/relevance of adaption pathways (e.g. does insight in adaption choices help in decision-making on climate change adaption?).

The main climate changes for the region are forecast to be longer, warmer summers (with a longer tourist season), and milder winters (CSW 2010). However, the region is also predicted to be more susceptible to episodes of extreme weather events from longer and more frequent periods of drought, to more intense precipitation events associated with more intense winter storms, and longer and hotter heat wave events (Devon County Council, 2005). Modelling suggests 1 in 100 year storm surges events on parts of the South Devon coast could increase to a 1 in 20 year probability by the latter half of this century, due to rising sea levels and predicted increases in winter storm intensity (Devon County Council, 2005).

According to Climate South West (2010) there is already some evidence of climate change in the region. Between 1961 and 2006, for example, average daily temperatures increased by 1.37°C, with the number of days of air frost decreasing by 20.9 days. Over the last couple of decades there have also been several episodes of extreme high temperatures. In addition there has been a small reduction in total summer precipitation of 8.8% in the same period. Further changes include a 5% increase in total winter precipitation stemming from heavy precipitation events, and increased frequency of floods and droughts. Finally sea level in the region (corrected for land movement) has risen by around 1 mm/yr over the 20th century, with some indications that the rate of increase has become more pronounced since the1990s. The isostatic sinking of the South West land mass (where land levels are generally getting lower through time) is likely to exacerbate the effects of a rising sea level.

Climate impacts

The coastal line if the South West is a vital asset to the region. It helps to attract over 21 million tourists a year to the region, comprising as it does of approximately half of the UK's designated bathing beaches. Tourism is a main pillar of the region's economy, with visitors spending over spending over £9 Billion a year and supporting about 200,000 full-time jobs in the South West (CSW 2010). A survey of tourism businesses in the South West found that 56% had been affected by extreme weather events in the past (CSW 2010).

According to Climate South West (2010) and Devon County Council (2005) key projected climate impacts on the coast are:

- Rising sea levels, and changes to coastal dynamics with the potential for increased wave heights which will increase coastal erosion and damage coastal amenities.
- Natural assets such as beaches, wetlands, mudflats, salt marshes and dunes will be more vulnerable to loss and damage including associated flora and fauna.
- Protecting or relocating coastal assets may be too costly. However, due to the hard geology and steep topology of the coast, there are few opportunities for managed retreat.
- Heavy rainfall can mean that harmful organisms and chemicals can be rapidly washed into the sea which may impact upon bathing water quality.
- Predicted extreme high temperatures in Mediterranean and other overseas tourism destination could boast domestic and international tourism to the South West as visitors look

for a more comfortable climate for their holidays. While providing a positive boast to the local economy, the extra visitor numbers will increase pressures on the natural environment, attractions, services and utilities

- A formal climate change adaptation strategy to deal with the issues at the South Devon Coast has so far been absent. In general, after the recent extreme events at the Dawlish coast (in February 2014 – see below), we can diagnose that – as far as there have adaptation actions – these have been clearly insufficient to prevent severe disruptions such as severe flood risks and infrastructure disconnections.
- Adaptation at the South Devon Coast is currently (i.e. February-March 2014) a hot topic of dicussion, though not under the heading of climate change adaptation, rather under the discourse of responding to coastal dynamics.

Overal, the current discussion mostly focuses on advantages and disadvantages of options to reroute the railway, which links the South West of England to London and which currently runs along the cliff base. Flood risk management appears to be a minor issue in the current discussion in comparison to the attention that is given to the infrastructure connection. Although flood risk management is not a hot topic in the current discussion about this part of the coast, there are several management plans that address the flood risks in the area of our case study. In terms of addressing issues under the heading of climate change adaptation, a strategy was developed for the county of Devon in 2005 by the Devon County Council. In principle, this climate change adaptation strategy includes the coastal area between Dawlish Warren and Teignmouth, but this strategy is proposed in general terms for the whole county of Devon, and not specified to different locations.

Railway connection

The railway line along the coast at Dawlish provides an important infrastructure connection between Cornwall and the west of Devon, and London and the rest of England. It's usual that the railway is closed every year in winter for a short while to repair damages due to high and strong waves, and the discussion of how to adapt this part of the railway has been ongoing for several years and focuses on options of rerouting and/or maintaining the current train line.

However, this years' storms (in February 2014) have led to very heavy damage to the railway rendering it unusable, with repairs expected to take more than two months (until Easter 2014). The vulnerability of this part of the railway has been exposed as the Achilles's heel in the connection between Cornwall and London. A BBC news item mentions that according to the Chambers of Commerce in the region, "*the South West Economy is losing £20m a day as a result of the track being destroyed*" (http://www.bbc.co.uk/news/uk-england-26349928).

This years' severe damage to the railway has sparked the discussion again on the long term viability of the railway. The current discussion does not relate the impacts or the options to climate change, or connect it to flood risk management, despite the obvious connections. The Department for Transport, Network Rail (the government owned company in charge of managing the UK's railway infrastructure), various transport experts and the Devon County Council play an important role in the current discussion.

A news item from 2 March 2014 from the BBC mentions that the Department for Transport has asked Network Rail "*to look at options for Dawlish including a review for securing the coastal line* *and the feasibility of alternative routes*" (http://www.bbc.co.uk/news/uk-england-26407806). Network Rail is expected to report back a first proposal around June/July 2014, and formally in autumn 2014. On 19 February 2014, Network Rail preliminary/tentatively identified the following options:

a) "Reinstate the Okehampton line (between Plymouth-Exeter, via Okehampton), which closed in 1967

b) Create a new line connecting existing freight lines from Alphington (near Exeter) and Heathfield (near Newton Abbot)

c) Options between Newton Abbot and Exeter (with new tunnels) – but current level of trains via Dawlish route could be maintained

i) Exminster – Newton Abbot

ii) Starcross – Newton Abbot

iii) Dawlish Warren – Newton Abbot

d) Make the coastal railway more resilient"

(http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/26_02_14_dawlish_jmo.pdf)

The two figures below are used in the discussion of the future of the Dawlish railway line and sketch the different options (the pictures below are taken form this BBC website, original sources unknown: http://www.bbc.co.uk/news/uk-england-26349928).

Figure 2.4.5

Alternative south-west rail routes

Figure 2.4.6

Floodrisk management

A "Shoreline Management Plan 2" should be in place for the coast from Durlston Head in Dorset through Rame Head in Devon, which includes the piece of coast between Dawlish Warren through Teignmouth. The Environment Agency is the responsable authority for the Shoreline Management Plans. A draft of this Shoreline Management Plan 2 (the Shoreline Management Plans 2 are updates of the Shoreline Management Plans 1) has been proposed in September 2010. The current status of this Shoreline Management Plan 2 is not entirely clear. In the draft from 2010, 2 types of action are proposed for the area between Dawlish Warren and Teignmouth, whereby proposed types of action may change over three time periods, i.e. short term to 2025, medium term to 2055, and long term to 2105 (SDCADCAG, 2010, pp. 21-22):

- "Hold the existing defence", i.e. maintain or change the level of protection provided by defences in their present location.
- "Managed realignment", i.e. allowing the shoreline position to move backwards (or forwards) with management to control or limit movement.

For most of the locations between Dawlish Warren and Teignmouth, the action of "hold the defence line" is proposed in this plan (i.e. "policy unit 6b20" through "policy unit 6b30"). For 3 sites at Dawlish Warren (policy units 6b20, 6b21 and 6b22), and 1 site in Teignmouth (policy unit 6b29) "hold the defence line" or "managed realignment" are proposed for the medium and long term time periods.

The options of "Advance the existing defence, i.e. build new defences on the seaward side of the existing defence line to reclaim land" and "No active intervention, i.e. a decision not to invest in providing or maintaining defences" are not proposed for the area between Dawlish Warren and Teignmouth.

Two river basin flood risk plans address parts of our case study. The first is a flood risk management plan for the "South Devon Catchment" that has been issued by the Environment Agency (issued in December 2009). This flood risk plan proposes preferred policies for several sub-areas; in one of the sub-area the town of Teignmouth is included (which is the western tip of the stretch of coast we study). Concerning the area which covers Teignmouth, this plan refers to the need to adapt to anticipate climate change impacts, which is expected to lead to sea level rise and increasing frequency and depth of future flooding (Environment Agency, 2009). It also refers to the Shoreline Management Plan to reduce flood risk overall. For the area which includes Teignmouth, the plan proposes the following "...actions to implement the preferred policy:

- System Asset Management plans and performance specifications will be produced for all our flood risk systems and major assets. These will assess flood risk maintenance with the aim to reduce flood risk in the policy unit and will include environmental constraints and targets.
- „We (EA) will investigate options to reduce flood risk to settlements around the estuaries. This should include habitat creation or enhancement to contribute to Devon's Biodiversity Action Plan targets. We will identify locations where tidelocking of tributaries is causing problems. We will investigate, and where appropriate implement solutions (for example at Bitton and Brimley Brooks in Teignmouth). Produce community flood action plans in Dartmouth and Kingsbridge to reduce flood risk through engagement of the local community." (Environment Agency, 2009, p. 21).

The second is a flood risk management plan for the Exe Estuary that has been proposed by a consortium of partners including the Environment Agency (drafted in August 2013). This plan proposes flood risk strategies for several sub-areas, including Dawlish Warren and the town of Dawlish (which are located at the eastern part of our case study area). For the sub-area of Dawlish Warren, the plan proposes: "Continued maintenance of the coastal revetment and wave wall at the near end. Groyne maintenance, local ground raising and removal of some existing gabions are alsoecommended in the period up to 2030. This will provide protection for Dawlish Warren village and for the tourist and environmental interests. Beach recharge and recycling will improve the quality of the beach and help it to act as a natural wave barrier into the medium term (towards 2060). Between 2030-2110 the coastal revetment will need to be maintained and improved, with the sand spit being allowed to evolve naturally." (Environment Agency, 2013, 15). It also includes the following consideration: "It is predicted that that towards 2060 continued engineered control of the sand spit will become too difficult and costly. We also then expect the sand spit will partly lose its sheltering function, requiring further defence improvements within the estuary. Some of this work will require local partnership funding." (Environment Agency, 2013, p. 15). And it also refers to coordination with the Shoreline Management Plan: "The Strategy agrees with the South Devon and Dorset Shoreline Management Plan 2 policy for Policy Units 6b19 in the short term and extends it to the medium and long terms. For Policy Units 6b20 and 6b21 the Strategy changes the policy from Hold the Line in the short term to Managed Realignment. The policies for the medium and long terms are now Managed Realignment and No Active Intervention respectively. (Note that policies for Dawlish Warren sand spit for the medium and long terms were not previously determined)." (Environment Agency, 2013, p.15).

For the sub-area that covers the town of Dawlish, this flood risk plan proposes: "Improvements to the mainline railway revetment in the short term. Network Rail is carrying out its own studies to develop the approach to this, which the Strategy supports. Resilience works for local properties, adjacent to where Dawlish Water discharges to the sea, will be required between 2030-2110 to keep pace with climate change. The improvement works would improve protection and reduce operational impacts on the mainline railway, and limit tidal flood risk to property into the future." (Environment Agency, 2013, p. 16). It also gives a consideration: "The drainage of low-lying areas, particularly during tide-lock, and the flood risk to properties due to groundwater are also of concern, and the Strategy recommends further detailed studies on these." (Environment Agency, 2013, p. 16). And as coordination to the Shoreline Management Plan, it says: "The Strategy agrees with the South Devon and Dorset Shoreline Management Plan 2 policy in the short to long term of Hold the Line for Policy Units 6b22 to 6b23." (Environment Agency, 2013, p. 16).

The climate change adaptation strategy for the county of Devon included objectives such as: to undertake a climate impact assessment for Devon for the short and medium term; to review and update the Council's emergency/contingency plans for all vulnerable locations in the light of recently experienced weather-related hazards; to ensure that when unexpected, unusual or extreme weather events cause problems the post hoc restoration is climate-proofed for the next 50 years against potentially more extreme events and the lessons learned are applied where practicable to similar locations countywide; and, to climate-proof strategies, policies, programmes and plans that come up for review, infrastructure upgrades, maintenance regimes and new fixed infrastructure that has a life of 20 years or more against projected changes in climate over the next 50 years (Devon County Council, 2005, p. 80). It further proposed 5 adaptation principles (Devon County Council, 2005, p. A5-6): 1. adaptation should focus on seasonal extremes and short duration hazards for the period to 2040; 2. climate events of the recent past should be used to identify potential adaptations required over the next 20 years; 3. all adaptation measures should be climate-proofed for a minimum of 50 years; 4. long-term business/investment decisions (i.e. + 30 years) must take into account changes in mean climate; and 5. the business case for long term adaptations must use the precautionary principle as the basis for action.

Noticeable is that it states about storm surge events: "There is no evidence for a long-term change in UK storm surge statistics." (Devon County Council, 2005, p. 23) as well as "Whilst the tidal range will continue to be highest on the north coast, higher storm surges are likely to occur on the south coast increasing in height in an easterly direction. For Start Bay a current 1 in 200 year extreme storm surge event will become a 1 in 20 year probability by the end of the century." (Devon County Council, 2005, p. 50). And that it expects relative more sea level rise at the coast: "For the South West the present rate of subsidence is estimated at between 0.1 and 1.4 mm/year. Therefore, it is likely that relative sea level rise along the coasts of Devon has been greater than the average sea level rise around the coast of Britain over the 20th century i.e. +0.1 metre." (Devon County Council, 2005, p. 31).

The Environment Agency in Exeter hosts and facilitates an initiative on climate change adaptation called 'Climate SouthWest' (started in early 2010, which succceeded the South West Climate Change Impacts Partnership whihc started in 2001). Climate SouthWest aims: "to raise awareness of the impacts of climate change, inform and advise on the challenges and opportunities of climate change in SW England, and develop practical adaptation responses. Our focus is to look at the effects and impacts of climate change in the South West and develop adaptation responses across a number of priority sectors. We influence the strategies and plans of key partners and work with stakeholders to enhance the region's resilience to the impacts of climate change." (quote from their website http://climatesouthwest.org/about). They identify that coastal change is one of the five key themes in climate change impacts in the region, and state that coastal change is expected in terms of "sea level rise and erosion impacting on business, people, property, transport (e.g. coastal railway at Dawlish) and wildlife" (quoted from: http://climatesouthwest.org/impact-on-the-south-west). Though, as far as their website informs, they don't run or plan to run a coastal project.

In summary, climate change adaptation of this coastal area is addressed in a fragmented way. The current discussion about how to adapt this coastal area to current and expected challenges focuses on adaptation of the railway connection, and does not link it climate change and flood risk management. Several options to adapt the railway are currently being considered and a decision about it has not yet been made. Although not part of the current discussion, flood risk management is being addressed by several flood risk management in this area plans developed by the Environment Agency, such as the flood risk plans for the Exe Estuary, the South Devon Catchment and a Shoreline Management Plan. Furthermore, two policy initiatives (one by the Devon County Council and one by the Environment Agency) address climate change adaptation in the Devon area, and mention coastal issues, but are not specified to adaptation around the Dawlish coastal area.

2.3.4 Kalundborg

By Andreas Hastrup Clemmensen and Søren Gram

Cimate adaptation plans for municiplies were not compulsory in Denmark in 2009. Nevertheless, the municipality of Kalundborg already considered making a climate adaptation strategy. However, they did not plan to produce a very detailed one.

On this background, The Municipality of Kalundborg joined the EU-Interreg project 'BaltCiCA' [Read more about the project here: http://www.baltcica.org/index.html from 2009-2012. The aim oft he BaltCICA project was to find ways of dealing with climate changes in the Baltic Sea Region. Through the use of climate change adaptation scenarios, measures were developed in corporation between planning authorities (e.g municipalities) and relevant stakeholders. Kalundborg thus joined BaltCICA with the purpose of taking a close look at an area located in the south-western part of the municipality. BaltCICA was considered to be one of several ways to gain the required knowledge to draw up a climate adaptation strategy for that particular area, and possibly to provide inspiration for such a strategy covering the entire municipality. In the Kalundborg case this was done by carrying out a scenario workshop with relevant stakeholders and later a citizen summit where ordinary citizens were consulted on the results of the scenario workshop.

The workshops were carried out in cooperation between the municipality and DBT. The scenarios used in the scenario workshop were developed from calculations of the future precipitation patterns and sea level rise in the case area by GEUSi. The goal was to clarify different and potentially conflicting interests of citizens and stakeholders in the particular area to be used in the later development of a climate adaptation strategy for the whole area of Kalundborg. In 2011, the results were analysed, debated by the politicians, and the administration started drafting up an adaptation strategy, based partly on the results from the citizen summit, partly on further assessments of climate impacts in the municipality, and partly on fairly general guidelines from government agencies and ministries. The final climate adaptation plan has not yet been amended, but because of requirements from the Danish government, a draft version was completed in 2013.

The municipality of Kalundborg is situated on the west corner shoreline of Zealand, Denmark. Like many municipalities along the Danish coast, they have only recently started to consider the need to develop adaptation strategies. Municipalities on the west coast of Jutland are used to dealing with storm surges from the North Sea, but coastal areas in the rest of Denmark are better protected from such surges and have dealt with them on a much less regular basis. This is however anticipated to change because of climate change. The study area (14.000 hectare) includes, as shown on the map, a peninsula (Reersø), a large lake Tissø (1233 hectare), a large near-shore and low-lying summer cottage area and also permanent habitation, large agricultural areas, nature resorts, ground- and surfacewater interests, tourist and cultural assets.

The land behind the coastline has delta-like characters which makes the area vulnerable to extreme weather conditions. Also the area includes infrastructures such as roads, sewerages, water supply and draining assets. The case study area has a coastline and lowland, which are threaten by rising of the sea level and changes in precipitation. Flooding is already an issue in this area, as it occasionally affects farmers and summer cottage owners.

Climate impacts

The case study area around Reersø and Tissø is an average Danish rural coastal area. It is dominated by farmland and to a lesser extent by protected nature areas, scattered settlements and summer cottage areas. It is inhabited by approximately 12,000 residents (out of which 321 live all year round in their summer cottages), including 6,839 in the hamlets of Gørlev and Høng, two areas that are not, however, expected to be seriously affected by future floods.

The summer cottages in the low-lying areas by Ornum Strand, Bjerge Sydstrand, Bjerge Nordstrand and on the peninsula of Reersø are expected to get most seriously affected by future floods. Altogether, there are 3,036 summer cottages in the area. Equally exposed are some permanent residences, large farmland areas and internationally protected nature areas with meadows, bogs, streams and lakes. The area around Flasken and Vejlen is in particular vulnerable, at the mouth of the stream called Nedre Halleby Å, currently almost unregulated and with a delta and lagoon-like character.

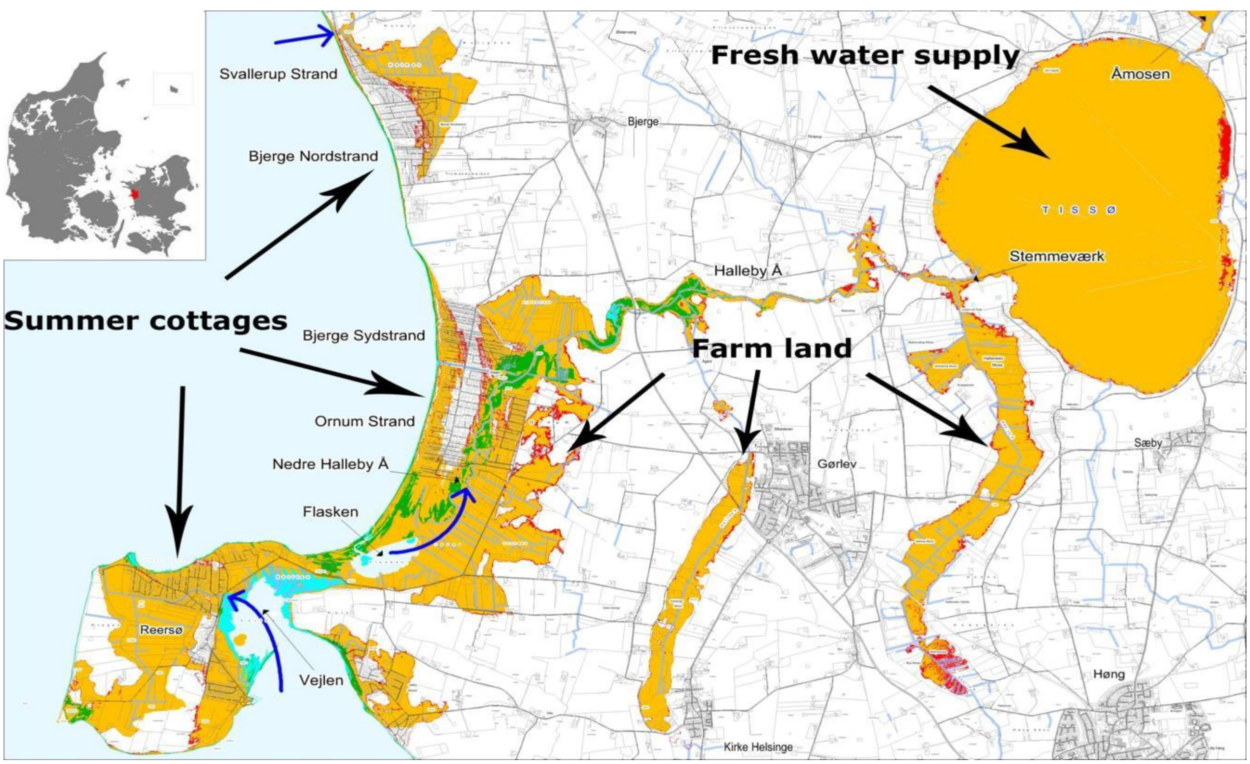


Figure 2.4.7

The infrastructure in the area holds public roads, sewage systems, electrical supply, water supply and drainage. It holds groundwater supplies for drinking water and fresh water from Tissø Lake (the source of Nedre Halleby Å) is used for industrial purposes in Kalundborg. The area is somewhat important for tourism in the municipality of Kalundborg and includes several locations of interest with regards to cultural heritage. A large part of the rain falling on the middle and western parts of Zealand flows through this area before reaching the sea.

Especially residences in the town of Reersø and summer cottages on the peninsula of Reersø, Ornum Strand, Bjerge Nordstrand and Bjerge Sydstrand are exposed to future floods (see map included above). In a situation of flooding from the sea combined with heavy precipitation, low-lying summer cottages at Bjerge Sydstrand will be particularly exposed, because rain water from a large catchment area in the hinterland will flow in that direction and meet salt water from the flooding.

Case study research and adaptation

In relation to the participatory exercise in Kalundborg, three adaptation scenarios were developed on the basis of the IPCC A2 emission scenario, in order to illustrate options and degrees of adaptation to future climate impacts. In practical terms this means impacts of sea-level rise between 80 and 230cm, an increase of winter precipitation of 43%, reduced summer precipitation of 15% and a 20% increase of larger cloudbursts in 2090. The adaptation scenarios for Kalundborg were used to exemplify future adaptive actions to the involved stakeholders and citizens at a scenario workshop in 2009.

- 0-scenario or a “laissez-faire” scenario – nothing specially is done to mitigate the impacts of sea-level rise, adaptation is understood here as a gradual response to climatic changes.
- Adaptation scenario – Attempting to adapt to future climate impacts through planned adaptation measures.
- Protection scenario – protection of business interest and housing in the area to the highest degree possible

The Kalundborg adaptation history

Because of the participation in the BaltCICA project, the Municipaity of Kalundborg has already taken steps towards defining the goals and priorities of adaptation to climate change. This has, as earlier mentioned, 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 citizen summit (based on the results from the scenario workshop and further technical analyses discussed in the municipality) were received and discussed by city council members and has been taken into account in the preparation of the adaptation strategy for Kalundborg Municipality.

National climate strategy

Denmark has adopted both a national strategy for climate change (2013) and a national strategy for climate change adaptation (2008), these strategies does however 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. This situation changed somewhat, when a new center-left government won the general election of September 2011. The new minister of the

Environment announced in autumn 2011 that all municipalities have to make a climate adaptation strategy within the next two years (by the 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. The climate adaptation strategy is required to be implemented in the overall strategy for the municipality (kommuneplanen) or as an appendix to the overall strategy for the municipality. In the Municipality of Kalundborg, the climate adaptation strategy for the municipality will be made as an appendix to the overall strategy for the municipality [Kalundborg Kommune 2013:10 - udkast til klimaplan Kalundborg].

The Danish state will provide data and maps for the municipalities to use in the mapping of risks [Regeringen & KL 2012:7 (aftale om kommunernes økonomi)]. In addition the Government has published a guide for the municipalities on how to make climate adaptation strategies in practice.

Regional (Zealand) climate strategy

The region of Zealand has developed a climate strategy including the 17 municipalities in the region. The plan runs from 2009-2013 and is divided into 8 activity themes. The Municipality of Kalundborg served as part of the steering group in the making of the strategy. The objective of the strategy is to provide an overview of the existing challenges and the available strenghts with which to meet them. In addition the strategy seeks to contribute toward a further strenghtening and coordination of the municipal and regional climate efforts. The strategy is reaching for a minimum of a 20% reduction in CO_2 emmisions and to reach at least 20% of energy from renewable ressources in 2020 in accordance with EU's climate goals. The regional climate strategy is non-binding for the municipalities involved, but calls for cooporation in the region on the climate area.

Municipal (Kalundborg) climate change adaptation strategy

Impact/Inputs from the participatory process will be analysed once the strategy is completed.

The case study will focus on how the municipality can incorporate local knowledge, needs and suggestions into their short and long term adaptation planning. And whether such involvement will strengthen the adaptation effort and how will the political level priorities such local input and how can local stakeholders lobby to make politicians stand by their promises? As the case of Kalundborg has included a thorough and path-breaking participatory approach special focus will be on the experience gained from the different elements is this decision making process and on the interaction between these elements leading up to the climate change adaptation plan.

Local stakeholders and citizen's assessment of the adaptation strategy results, considering the participatory process they were involved in. More paticularly we will examine:

- Tangible impact of the participatory process in the adaptation strategy?
- Where in the adaptation strategy did participation have an impact?
- Where/what are the barriers in the adaptation policy process to incorporate results from participatory processes?
- How can the policy/political process be optimised to better include input, views and knowledge from local stakeholders and citizens

- How were the economic assessments utilised in the process of making the adaptation strategy: How were they used in the participatory process; what costs and benefits were highlighted; who determined the criteria for cost/benefits?

  Stakeholder categories:

  - Local politicians
  - Local officials in the municipality
  - Dike and pump associations
  - Farmers
  - Home owners associations
  - Nature- and environmental organisations
  - Harbour authorities
  - Tourist and business committee

2.4 Cities and Infrastructures

Overview of impacts and adaptation challenges

By Ad Jenken

The urban cluster consists of 7 case studies in which a diversity of impacts is expected and in some cases already experienced. The urban cases comprise of small cities Cascais (Portugal) and Jena (Germany), middle size cities like Venice (Italy), Rotterdam (Netherlands) and Leeds (UK) and large cities Copenhagen (Denmark) and Prague (Czech Republic). With 7 case studies the city cluster is the largest cluster within BASE. A first analysis of the case study descriptions yields the following overview.

The city cases comprise at least 3 different climatic zones within Europe: Southern Europe (mainly dryer summers, heat waves), North/West Europe (mainly wetter winters), Central Europe (heat waves, increase of thunder storms in summer). There are 4 coastal cities involved that also have to deal with sea level rise. Two of them, Venice and Rotterdam, experience significant subsidence in addition.

The main impacts considered are:

- Increase of riverine flood risks (Rotterdam, Prague, Jena, Leeds)
- Increase of pluvial flood risks and insufficient drainage capacity (Copenhagen, Leeds, Jena, Rotterdam)
- Increase of flood risks due to storm surge (Venice, Copenhagen, Rotterdam)
- Decrease of fresh water availability for different sectors (Cascais)
- Urban heat Island effect (Cascais, Jena, Rotterdam)

Some trends and projected changes are more clear and persistent (Sea level rise, temperature, droughts in SE, rainfall in the UK) than others (rainfall patterns in CE). It is not clear in most cases yet what the current variability is the city should be able to cope with.

In dealing with *coastal and riverine flood* risks the cities consider similar strategies, which will make intercomparison interesting:

- Flood control through defences and barriers (Venice, Rotterdam, Prague)
- Early warning systems (Venice, Rotterdam)
- Flood proofing building and infrastructure (Venice, Copenhagen, Rotterdam, Leeds)
- Retention / room for rivers (Rotterdam, Leeds, Prague)

Reducing *heat stress* is also a common challenge among a number of cases by introducing a number of green and blue adaptation solutions (Jena, Leeds, Cascais, Rotterdam).

These strategies do also match well with strategies to cope with *intense rain events* also common in most of the cases. In addition to creating blue and green spaces, the design of more sustainable drainage systems is considered in a number of cases to adapt to increasing heavy precipitation events (Leeds, Copenhagen).

Cascais is the only City case concentrating on *fresh water availability*, approaching it from 2-sides: increasing supply by improving the supply system, creating buffers and improving quality and decreasing demand by stimulating low water use. With respect to this impact it could better connect to other cases in other clusters. Cases vary from analysing strong private contributions to adapation (Venice) to fully public initiatives (Rotterdam, Prague)

There are a number of reasons given for the proposed adaptation strategies. In only few cases Climate change is the only driver for change. In addition:

- Autonomous subsidence and SLR
- Replacement of old drainage system
- Necessary maintance/renewal of flood defence system
- Necessary maintenance and renewal of the water supply system
- Retrofitting of infrastructure, built areas and buildings
- Increased demand for fresh water from increased tourism sector
- Increased asset values exposed to floods
- Better insight in current variability (1/500 flood Prague)

Also without climate change these ‘drivers’ would lead to necessary investments and costs. Investements that are (or should be) already part of sectoral investments agendas. Taking into account the projected climate effects in the design will in some cases increase the costs of adaptation (higher defences). In some cases smart design may have co-benefits that outweigh the extra costs.

All the cases involved are going to deliver some sort of cost benefit analysis for a large part expanding on existing studies and thus not necessarily using the new range of scenarios prescribed by BASE. Upcoming deliverable D5.2 will provide a better insight. Leeds, Rotterdam, Copenhagen cases will also apply IO-modelling for economy wide effects. All cases are part of a formal adaptation policy process mostly in the planning phase with some also looking at already implemented adaptation policies and its successes (Prague, Venice, Cascais).

2.4.1 Cascais

By Filipe Alves and Inês Campos

The Municipality of Cascais is located on Europe’s West coast, Portugal, 25 km West from Lisbon and facing the Atlantic Ocean. The Municipality has an area of approximate 30 sq Km and is bounded by the Atlantic Ocean and the Sintra-Cascais Natural Park.

Since the 19th Century, the economy of Cascais has been growing exponentially, not due to industry or agriculture but mainly due to the Tourism sector, namely an elite tourism for the Royal families of Europe. Today, Tourism is still the dominating sector, although it diversified in its nature and spectrum in order to accommodate a growing number of international events – for example Sea-related events such as Sailing, Surfing, Kitesurfing events – and Business Tourism, which accounts for almost 1/3 of all revenues.

Impacts

Due to its Tourim-based economy, Cascais in highly dependent on its overall Climatic conditions, and highly vulnerable to Climate Change impacts, namely on its natural capital. In the history of the Municipality, two types of Climatic Events stand-out, due to their regularity, impact and importance for the region: floods and fires.

The latest EEA Report (03/2013) states that Cascais, as well as the rest of the Mediterranean Region in Europe, will be facing in the upcoming decades, a temperature increase, a decrease in annual precipitation and annual river flows, as well as in the productivity of crop yields and of hydropower potential, and an increase in the risk of biodiversity loss and desertification.

More location-specific scenarios can be found in the Strategic Plan for Climate Change in Cascais (PECAC), which was elaborated in 2009/2010 and the report (only available in Portuguese) can be download here - http://www.siam.fc.ul.pt/PECAC/index.php. The plan was elaborated using the IPCC 2007 Scenarios, and it concluded that for Cascais it is estimated that until mid-century the average annual temperature will rise between 1,7 °- 3,2 °C , with a stronger emphasis during the summer period (2,8 - 5,0 °C) than winter time (0,9 - 1,8 °C). Monthly minimum temperatures in the winter will rise around 1 - 2°C till mid-century, 1 - 3°C towards the end of the century. Heat waves, still rare these days due to the presence of the Atlantic Ocean, will become more frequent and long lasting, occurring even during Spring and Autumn.

Concerning Precipitation, scenarios point towards a decrease in the accumulated annual value from the current 630 mm for 530 – 600 mm until mid-century, and 420 - 580 mm till the end of the century.

As mentioned before, the Tourism sector is crucial for Cascais, while Agriculture and Energy production play a minor role in the socio-economics of the Municipality. Thus, our focus has been in two sectorial areas - Tourism and Health. In terms of impacts our focus will be on floods and heat waves. Though these are the core topics of our analysis, the case study has been integrated in the cities and infrastructures subgroup (and not in the health group) because analysis is based on the implementation of specific measures that are interrelated with physical urban structures and that will act as mechanisms that may potentially increased local resilience and adaptative capacity to negative impacts on health and tourism.

Case Study Research and Adaptation

Cascais became one of the only 2 municipalities in Portugal to have a Strategic Plan for Climate Change in 2010. The Strategic Plan identified a key number of sectors and impacts to be addressed and 15 Adaptation Measures were proposed and prioritized against the vulnerability and risk assessment maps, as well as potential costs & benefits. The PECAC project involved a Participatory Workshop with scientific experts which ranked the 15 Adaptation Measures according to their importance, urgency, no-regret, co-benefits and Mitigation.

Our challenge within BASE has been to review the Cascais Strategic Plan according to the new IPCC Climate and Socio-Economic Scenarios, as well as monitor and evaluate the implementation phase of the proposed adaptation measures, and if necessary, suggest complementary actions.

The main stakeholders involved have been the Cascais Municipality; Local agencies and civil protection, as well as local residents.

Our methodological approach has been quantitative and qualitative. The qualitive analysis was conducted over a series of participatory workshops with the municipality and its sister agencies, as well as civil protection, but also with local residents. The quantitative analysis included two surveys. We will describe this two research levels below.

Qualitative research

This qualitative research included a series of workshops; which we will now describe.

PECAC 2.0 workshop

The kick-off workshop (PECAC2.0) took place on 26th July of 2013, at the DNA Auditory (Cascais), gathering 20 key actors in the Planning and Action for Climate Change in this Municipality. This included not only the technical body from different departments of the Municipality, but also Civil Protection and Municipal Police representatives. The working day was focused on a conscious attempt to: i) map the participants knowledge and practical experience exchanges; ii) create a space for critical reflection about the concrete implementation of the measures presented in the PECAC; iii) allow for the participatory re-prioritization of those measures, taking into account the more recent IPCC scenarios and socio-economic reality(see chaper 1 of this deliverable), a better definition of 'who does what and how' between different actors; v) and finally identify opportunities and barriers for cooperation between them.

Main results were:

i. From the 15 Adaptation Measures which were Top Priority in the PECAC 2010 – Annex I -, **50,1%** were considered as already implemented (V) or in implementation (IV).

ii. Participants responses highlight that: New Forests' – Adaptation Measure is considered implemented or in implementation by 90,5% of all participants; 'Reflorestation with endogenous species' – Adaptation Measure considered implemented or in implementation by 90% of all participants; and, 'Create alternatives to the supply of fresh water (ex: rain water harvesting)' – Adaptation Measure considered '0 – Nothing done' by 73% of all participants.

iii. All the different working groups, when given the opportunity, made profound changes to the Top priority ranking list elaborated by the scientific experts three years earlier, having in mind that between the three groups there was coherence and consistence in the re-prioritization, namely for the first two and last three (TOP 15 PECAC 2013):

    1ª Awareness raising for all actors;

    2ª Water Efficiency Programs Design;

    13ª Guarantee the reduction of diffused discharges of pollutants in the water

    14ª Guarantee the reduction of punctual discharges of pollutants in the water

    15ª Prevent the construction on the lands adjacent to sand rock cliffs.

iv. Given the possibility of reviewing the list of adaptation measures in the PECAC and include new measures, there was a clear and straightforward inclination for the inclusion of new measures. Six gained particular relevance: Sustainable School (from the Adaptation Inspiration Book); Green Corridors in Cities (from the Adaptation Inspiration Book); Information, Dissemination and Training Campaigns (from UNFCCC); Integrated Planning and Management of Water and Soil use (from UNFCCC); Construction legislation that includes water consumption savings (from UNFCCC); and, Management of the Natural Capital (from UNFCCC)

v. Lastly, the workshop included a “budget exercise”. Each participant was asked how they would choose to allocate their adaptation budget, if they had 1M€ each year, for three years, to finance the implementation of the TOP 20 Adaptation Measures, that they identified in the previous exercise. Results from this “budget exercise” showed the water sector as the one where consensus was clear regarding investment needs, representing 40 - 43% from total investment. The water sector was followed by a cluster of measures regarding Biodiversity, gathering 17% and Education/Awareness raising with 13% of total budget.

Workshop Greenfest – Tourism and Climate Change

Following the preliminary results from the first workshop and having the GREENFESTIVAL at the Estoril Conference Center as our hosting venue, FCCUL and Cascais Mayor’s Office (CMO) co-organized a second workshop with the objective of exploring the Tourism sector, one of two sectors identified by the Municipality as key to be properly studied under BASE. This workshop had 45 participants, representing a wide variety of local and regional stakeholders, namely from the Tourism Regional Association. The specific purpose of this follow-up workshop was to analyze, prioritize and evaluate sector-specific adaptation measures.

Awareness raising; Green corridors, and the Improving an efficient use of water and reduce waste, were consistently considered as the Adaptation Measures with the highest potential to contribute positively to a greater resilience, innovation and sustainability of the Tourism sector in Cascais. As such, these three measures were considered to be top priority by stakeholders who analyzed and evaluated 15 different adaptation measures listed in the Cascais Strategic Plan.

It is important to notice that measures, such as Heat and UV Alert Systems; Food Productions and Improve Weather Forecast information, were ranked as ‘non-priority’. Moreover, FFCUL took the opportunity to test the SPCBA- a tool presented by the Climate Resilience Network. This simple-to-use tool develop by the CRN, weights the costs and benefits (social, environmental and economic) of different adaptation and allows for non-economists to name and value them within a group, using a scale (1 to 5) in order to reach a non-monetary Benefit/Cost ratio.

Workshop Biodiversity

On the 5th of November 2013, our third participatory workshop took place in Cascais, with ten key stakeholders of the region regarding Biodiversity and Coastal Zones. These included representatives from the Municipalities’ departments, dealing with Biodiversity, as well as the Municipality’ harbor authorities. As with the Tourism workshop, specific adaptation measures taken from the PECAC, were analyzed, prioritized and evaluated, namely regarding their scale of implementation, level of complexity (Technical, Institutional and Social) and order of relevance (Urgency, Importance and No-Regrets). This multicriteria analysis was done in order to keep scientific coherence with the process initiated in 2010 and allow for comparison. From the analysis of the participants and aggregating the different variables, 3 adaptation measures clearly stand out as the most important:

1º Plan for the management of invading species

2º Reflorestation / New forests

3º Urban farming

For each one of them we invited the participants to design an Action Plan which contemplates the fundamental questions: Who? What? When? How much?

In this workshop we also decided to introduce a “discount rate” exercise (Stern, 2006). The objective was use the “discount rate” concept to stimulate a deeper reasoning in the participants and understand how they differentiated short-term impacts versus longer-term impacts and applying a discount rate (see more at STERN 2006). We asked the participant to choose between possible discount rates attributed to future benefits of actions implemented in the present (not that the highest the discount rate, the highest is the importance given to the cost of not adapting). Interestingly, both groups opted for a negative interest rate in their analysis, which indicates that these stakeholders valued the future above the present. This reflects a time-preference towards long term investments/returns rather than present consumption or short-term returns.

Workshop Neighborhood Tutors

In the evening of the 5th of November, the 4th workshop took place at the Center of Environmental Interpretation of Pedra do Sal – CIAPS – with the participation of ten “neighborhood tutors” and two members of Agenda XXI Cascais. As before, several adaptation measures of the PECAC were analyzed and prioritized by the citizens as new measures were taken into consideration. Similarly to other interest groups in earlier workshops, the TOP 15 Adaptation Measures of the PECAC 2010 are perceived by a majority (65,5%) to have been already implemented (V) or in implementation (IV). Participants also agreed in stating that the adaptation measure “create alternatives for the supply of water (rain water)” is a priority, though nothing has been done. The re-prioritization of the TOP 15 Adaptation measures by the three groups was also undisputed; recognizing that the water sector is clearly the most urgent and important for a quick and concrete action. The following adaptation measures were widely considered as priority:

- Improve the water use efficiency and reduce waste
- Reduce the amount of wastewater discharge over the hydric system
- Eliminate the water pollution focal points

Concerning new adaptation measures (see Annex 6), the “neighborhood tutors” identified the most interesting:

- Green corridors
- Sustainable school
- Reforestation

Image 2.5.1

Workshop Water

On the 7th January 2014 at the DNA conference room in Cascais, our 5th participatory workshop took place, having with us 10 key stakeholders regarding water management in Cascais, namely representatives from SANEST and Águas de Cascais (Cascais Water Supply). Continuing the same methodology and program applied in previous workshops, participants were asked to analyze, prioritize and evaluate sector-specific adaptation measures – in this case 8 – bearing in mind that some of them were signaled by other stakeholders in different workshops and considered as urgent, important or a priority. Aggregate analysis from the 10 participants shows the following ranking of importance:

1º Raising awareness for water consumption

2º Reduce waste in water distribution

3º Program Design for water efficient use

4º Eliminate the water pollution focal points

5º Rehabilitation of galeries and water "ribeiras"

6º Water retention bays/lakes/ponds

7º Water legislation which includes water savings codes

8º Rain water harvesting

Regarding the scale of implementation of these adaptation measures, it was considered that the vast majority is currently in a "study phase" (I) or "nothing done" (0). Nevertheless for the adaptation measure"Reduce waste in water distribution" the value of 17% for the year of 2013 was presented, as well as the existing target of 12% until 2016.

Regarding the SPCBA, and contrary to the Biodiversity workshops, both groups opted for a positive discount rate of 1% and both obtained over 1 benefit/costs ratios for the short and the long-term. "Raising awareness" regarding the pollution of waste water was the adaptation measure with the highest ratio (of 2, 77).

Quantitive research

Two surveys were done to receive further inputs regarding the prioritization of measures, local perceptions about climate change impacts, as well as motivations to adapt. Following the current analysis of the survey's data, we will select a group of prioritarized measures in the sectors of Health and Tourism and develop a Cost Benefit Analysis of some measures.

Two 2 surveys where originally designed targeting the Municipalities Technical body and upper management teams with a 100 responses (survey 1), another targeting a representative sample of the population (2060 answers) (survey 2).

Survey 1

Between the 28th of October and the 13th of November of 2013 an online survey was available for the Cascais Municipality middle and upper management technicians. The questionnaire, which was transversal to different departments, aimed at i) understanding the level of knowledge regarding Climate Change impacts, adaptation and mitigation; ii) The influence of strategic documents in policy and decision making; iii) The technicians perceptions regarding this topic and personal motivations to engage in adaptation actions. We aimed also at identifying key barriers and opportunities for Climate Change Adaptation in Cascais, as well as to gain a better picture of various governance levels that were interrelated with adaptation planning in the Municipality.

The questionnaire was developed by the FFCUL team in close collaboration with the team of the Cascais Agenda XXI. We've received 99 valid answers, which represents about 7% of the entire workforce from the Municipality. Overall, results show that although there is a good knowledge regarding global impacts of climate change, at the local level, regarding both mitigation and adaptation measures the level of knowledge is considerably lower. Half of the respondents see Climate Change in Cascais as an "opportunity for reflexion and analysis of our common decisions as a community". Interestingly just 8% recognize the inherent uncertainty of Climate Change and only 23% referred to Climate Change „as a serious and real threat to Cascais which should be a priority now". Therefore we conclude that the issue is not yet considered a priority in this group of stakeholders. It is important to mention that the majority of the respondents (60%) didn't know about the National Adaptation Strategy (2010) or the European Adaptation Strategy recently (April 2013) but 55% did know about the Cascais Strategic Plan for Climate Change, although 93% of them didn't participated in the construction or discussion of it.

As for the crucial factors when considering action regarding Climate Change, the technical body underlined the fundamental importance of having strong political will, as well as a focus on the protection of the existing capital and economic development of the Municipality. Heat waves, sea Level Rise and the increased frequency of extreme weather events are seen as the most expected climate impacts. Results also provide feedback regarding the use of finantial resources for Adaptation, stating that these are inadequate and that having knowledge of the inherent Benefits and Costs for each measure would significantly help in the decision-making process and create a desirable forcing towards implementation.

Regarding perceived Challenges/Barriers and Opportunities that may derive from the implementation of the Strategic Plan of Cascais for CLimate Change, these were considered priorities by respondents:

Challenges//Barriers:

1º – Political will
2º– Lack of funding
3º – Cooperation and Communication inter and intra departements
4º – Legal Framework
5º – Appropriate technology
6º – Uncertainty

Opportunities:

1º - Reduction of Risk and Vulnerability
2º - Participation and Citizen Engagement
3º - Increased Resilience
4º - Cascais becoming a National and International reference
5º - Cooperation and Communication inter and intra departements
6º - New Green Business

Survey 2

This door-to-door survey was conducted in February/March, 2014, to local residents, through a partnership with the Cascais Municipality, who has engaged a group of youth volunteers to do this work. A total of 1980 responses were collected and are presently being analysed.

Currently, we are developing a cost-benefit analysis of the prioritized adaptation measures for Cascais. This analysis will inform the design of adaptation pathways for cascais (Hassnoot et al, 2013) which will be presented and discussed in a citizen summit schedule for October, 2014.

2.4.2 Copenhagen

By Anne Jensen

Copenhagen is located by the Eastern Coast of Denmark, along the Øresund bordering to Sweden. The city is the capital of Denmark and the largest city with app. 1.7 mill residents in Greater Copenhagen and about 1 mill in the city. Administratively, Municipality of Copenhagen covers the inner city and the harbour area with app. 0.5 mill residents. Copenhagen Municipality collaborates and networks with the neighbouring 20 municipalities that jointly cover Greater Copenhagen in a number of policy areas, including climate change and climate adaptation.

The major climate challenge issues for Copenhagen in short and medium term perspective are water related, in particular flooding. In 2010 and 2011 during the summer months, the city experienced severe and costly floodings which have pushed adaptation up the local and national policy agendas.

Impacts

The main impacts in Copenhagen are water related and the main part of the adaptation actions are aimed at managing the risk of flooding. **The main impacts are**:

- Increased precipitation
- Rising sea levels and ground water levels
- Rising temperatures, including urban heat islands

Increased precipitation

The major impact of climate changes in Copenhagen is related to water. In particular, the intensity, extend and frequency of rains will impact on the city and management of the increased water flows are subsequently the major concern in the adaptation strategy for Copenhagen, reflected in the Waste Water Plan and the Cloudburst Plan, and indirectly in the Cloudburst Plan.

The impacts of increased precipitation are anticipated to happen more during the winter/spring and autumn, while the summer will experience less rains. The negative impacts of increased precipitation consist of (Cowi and DMI 2008; Copenhagen Municipality, 2008):

- Increased levels of ground water
- Higher risks of building damages, due to moist buildings
- Increased risks of floodings of basements and buildings
- Increased risks of floodings of infrastructure
- Increased risk of polluted waste water in the sea, waterways and wetlands
- Increased risks of flooded water ways
- Permanent flooding of lower lying areas
- Increased risk for flooding of buildings, infrastructures, nature areas cultural heritage, etc. at high sea water levels

During the summer, the impacts are:

- Desiccation of soils and risks of building damages
- Increase air pollution
- Drying out of parks and other green spaces, more dust
- Decreasing water quality in lakes and streams

Sea levels and ground water

Due to the extensive coast line in Copenhagen and the position in the Baltic Sea, the risk for storm surges is increasing with an increase in temperatures and the subsequent rising sea levels. During situations where higher sea levels are accompanied by storms that press the sea water east into the Baltic Sea, the risk of storm surges in the eastern and especially the southern parts of the city increases. Dikes are constructed or reinforced to protect against the sea levels.

The estimate is that effects on ground water have a medium time perspective. The Danish Meteorological Institute (DMI) developed the projection of water levels during extreme weather events relative to 1990 levels represented in table 1 for Copenhagen under key scenarios as put forward by IPCC (2007). The impacts are:

- Salt water in ground water
- Flooding of buildings, infrastructure and green areas

Table 2.5.1: Water levels in Copenhagen during extreme weather events

Water level 1990 levels for Copenhagne	Middle water levels	1 year event	10 year event	20 year event	50 year event	100 year event
2008	+4 cm to 1990 levels	92 cm	122 cm	131 cm	143 cm	152 cm
2050 A1B scenario	+ app 10 cm	102 cm	132 cm	141 cm	153 cm	162 cm
2100 EU2C scenario	+ app 20 cm	112 cm	142 cm	151 cm	163 cm	172 cm
2100 A2 scenario	+ app 60 cm	152 cm	182 cm	191 cm	203 cm	212 cm

Source: Cowi and DMI, 2008:11, 25

Rising summer temperatures

In the medium perspective, urban heat islands are also expected, however to a limited extend. The rising temperatures are anticipated to have positive as well as negative effects for the city, listed below (based on Cowi and DMI, 2008; Copenhagen Municipality, 2008). Among the benefits are:

- Increased options for outdoor activities
- Increased tourism
- Warmer sea water for swimming and extended annual bathing season
- The risks are:
- Increased risk for skin cancer and sun burns
- Extended season for pollen and increased numbers of allergic people
- Increased water use for watering plants, grass etc.
- Increased temperatures in the water storages with risks of bacteria growth in the distribution system
- Higher risks of food poisoning
- Higher water temperatures in streams and lakes, leading to deteriorating water quality and more algea
- More invasive species
- Warmer summers leading to stronger odours from sewage systems
- Decreasing indoor climate
- Health risks for high risk groups of urban residents
- The change in temperatures furthermore influences the mean temperature during the winters.

- The impact for Copenhagen is anticipated to be:
- Decreased heating
- Decreased need for snow clearance and a fall in car accidents due to icy conditions
- Increased number of nvasive species from Southern Europe
- Higher survival rates for rats, lice, etc.

Increase in storm intensities

The Danish Meteorological Institute estimates that storm activity will increase along the Danish coasts, however to a limited extent. The impacts of increased number of storms is mainly harmed buildings, green infrastructures and transport infrastructure, and cuts in electrical supplies.

Case Study Research and Adaptation

The overall research objective of the Copenhagen case study follows from the overall BASE objectives and is to identify *How Copenhagen responds to which impacts of climate change and why Copenhagen seems to have success with adaptation*?

Based on this objective, we developed three research questions that structure the analysis:

1. How and what are the main policy drivers and triggers of adaptation and of adaptation strategy which aspects are decisive for Copenhagen's capacity to manage the impacts of climate change and how do these influence strategic adaptive actions?
    a. What are the main drivers of implementation
2. Which adaptation options are considered/assessed?
    a. How and what adaptive actions are implemented?
3. What are the costs/benefits of adaptation?
    a. Which costs and benefits are included in the adaptation strategy and which methods for assessing costs and benefits are applied?

The stakeholders involved are primarily local policy makers, politicians and local business, developers, citizens and citizens associations. In the participatory part of the case study, DBT is working closely with the Copenhagen municipality on the process of stakeholder involvement regarding storm-surge planning. Over the course of several thematic workshops and stakeholder involvement processes, a wide array of actors and stakeholders will be involved, including local and national politicians, ministries, authorities in charge of natural and coastal protection, municipalities, the Danish Meteorological Agency, and private engineering companies.

The analytical approach of the case study is designed to respond to the research questions and objectives. The analytical approach takes the concept of adaptive capacity as point of departure. Based on the argument that participation and integration of climate adaptation policy issues in a range of local policy areas are critical and decisive dimensions of adaptive capacity, the study has two main focus areas; participation and urban adaptation strategy.

The analysis of Copenhagen adaptation strategy is conducted within a policy analytical perspective, applying an analytical framework based on the concepts of adaptive capacity and climate policy integration. Data production for the analysis is based on qualitative methods, including *policy document analysis*, *ethnographic observations* and *qualitative semi-structured interviews*. Moreover, BASE partners will take lead in designing a stakeholder involvement process, in order to facilitate the legislative planning process dealing with adaptation to storm-surge.

As the main challenge for Copenhagen is flooding, the initiatives of Climate Plan centre on management of water when precipitation increases. This includes local retention of water in green and blue spaces that otherwise are used for other purposes, e.g. recreation. This includes developing the green wedges already present in the city, local green spaces such as parks and green roofs, and wetlands in the coastal areas, as well as a network that connects these and eventually leads the water to the harbour area. The city's green structures also reduce the stress of increasing temperatures and thus reduce the risk of urban heat islands.

The Climate Plan also assesses the risk associated with rising ground water, flooding and increased temperatures for ground water. However, the estimated effects on ground water are only important in a long time perspective.

Moreover, the expected volumes of rainwater are taken into account when the century old sewage system is being replaced and updated.

In addition, the sewage water and the surface (rain) water is planned to be seperated, to reduce the stress on the sewage system during extreme weather events (separation of common sewer in SUDS solutions). This breaks with the traditional Danish waste water infrastructure where all water has been channelled underground in the sewage system, and requires changes of the waste water infrastructure. Due to the extensive coast line in Copenhagen, dikes are constructed or reinforced to protect agains storm surges and the rising sea levels. The city sees a clear opportunity in the climate adaptation challenge which it anticipates will brand the city in an international perspective, push green and sustainable urban development and promote green technologies and green growth, attracting investments and offering more jobs. At the same time, the city acknowledges the management of cloudbursts and the scale of investments needed, including by private actors, as major challenges. This is for example the case for storm surge protection.

In addition to risk analysis, the cost and benefits of different measures are included in the framing of increased heavy rains and cloudbursts where CBA serve to assist in the necessary priority of actions, in particular in combination with the size of the cloudburst denoted in frequency, i.e. 10 year rain, 50 year rain etc. Through the CBA, the Cloudburst Plan marks 100 year rains as the point where adaptations are more costly than the losses suffered due to flooding because of the rain.

What is the way forward - eg, what are the next steps that the NAS or Municipal strategies (or action Plans) are moving into? Copenhagen's climate adaptation strategy is specified in specific areas; at the moment with a focus on cloudbursts and on innovative water management technologies.

2.4.3 Venice

By Margaretha Breil

The historic centre of Venice is built inside a coastal lagoon, which is directly connected to the Adriatic Sea at its north-western rim. Within the Mediterranean, the Adriatic, and especially the north-western rim is one of the few areas facing some relevant tidal excursion. Under specific conditions, which combine specific astronomic and meteorological characteristics, high floods exceed the normal range of tidal excursion and flood urban areas. These occasional flooding events are part of the venetian history, and to a certain extent, the city is adapted to these events, for example with the choice of building materials which are able to resist salt water intrusion, protect buildings from humidity raising from the ground, etc.

Venice, being situated at the eastern edge of the Italian Po Plain, is subject to relevant subsidence processes caused by tectonic and, to a certain extent, also to man-made processes, as, for instance ground water abstraction from aquifers situated beyond the lagoon. These subsidence processes have determined a gradual process of sinking of the entire urban area, which has been ongoing over centuries and has been gradually compensated by raising of floor level of public and private spaces. The subsidence process has exposed an increasing part of the urban surfaces to flooding; climate change induced sea level rise will additionally contribute to increase surface of flooded areas and increase frequency and levels of flooding.

The occasional flooding of urban areas generate relevant economic and social impacts, which increase with the level of the flood event and its duration. Climate change related sea level rise will exacerbate this phenomena, making flooding events become more frequent and more intense.

Impacts

Impacts considered in the context of the BASE case study refer mainly to damages by flooding and rising levels of ground water, caused on private building structures. These damages are expressed, mainly in terms of increases in maintenance costs encountered due to increasingly frequent flooding and rising levels of ground water, which brings building elements in closer and/or more frequent contact with salt water. This means that plaster and bricks need to be exchanged more frequently, and building elements such as doors or floors may have a shorter lifetime than in buildings not exposed to salt water. Further impacts considered relate to partial interruptions of urban life and activities caused by flooding of public spaces. These impacts which are already well known and experienced will be exacerbated by climate change induced sea level rise.

Case study research and adaptation

Until the recent past, rising sea levels and increases in the number of flooding events have mainly been discussed in the context of local subsidence tendencies, determined by local anthropogenic and natural factors (Camuffo & Sturaro, 2003; Carminati, Doglioni, & Scrocca, 2005). In recent debates, climate change has gained some importance with respect to urban policies, but this leading, up to now, to a series of international presentations of the Venice experience and strategies, whereas local reflections on proactive strategies for adaptation to climate change are only slowly gaining pace. The city is indeed preparing, in these days, first steps for a municipal adaptation plan, which considers the whole of the municipal area, so including the areas of the mainland potentially interested by the impacts from Cloudbursts and heat waves.

Without a direct reference to climate change impacts, investments have been made by the city of Venice for protecting the city from periodic floodings. Since the occurrence of a major flood event in 1966, public works have been put in place by the municipality, with support from the national government tackling the problem of periodic flooding of the historic centre. These measures consist of restauration and protection of buildings, and historic monuments against high water and public pavement levels have been raised to ease traffic and communication during flooding a flood preview and alert systems. The municipality has put in place an e-flood observatory and forecasting centre, which provides information for an early warning system alerting city users and inhabitants in case of major flooding events. In case of high water, provisional walkways are laid out in order to connect important parts of the city with public boat stops.

Image 2.5.2: Public walkways at S.Marc's Place (copyright: Insula)

Furthermore, a major flood protection infrastructure, financed by the central government, is actually under construction, which aims at temporarily interrupting the influx of water into the lagoon in situations of high water with mobile barriers. Although initially not designed for changing climatic conditions and increasing sea levels, the constructor states its physical capacity of withstanding increasing sea levels (and consequently storm surge levels) up to 60 cm. With regards to this protection infrastructure, major critiques have been advanced based on the consideration of construction and maintenance costs and alterations of habitats in the lagoon and the litoral islands. The implications for the urban (and harbour) economy of the implementation of this infrastructure under increasing sea levels are made explicit by some authors (Fontini, Umgiesser, & Vergano, 2010; Vergano, Umgiesser, & Nunes, 2010).

Figure 2.5.3: Location of the mobile barriers (MOSE)

In parallel to these public activities, private home owners have been implementing measures protecting their premises, which consist of small barriers for doorways, raising floor levels in ground floor units, introducing physical barriers between layers of brick walls impeding the raising of humidity (*risalita capillare*), or creating a comprehensive concrete barrier protecting the entire ground level part of a building (vasca). These investments made by private owners and small companies, to adapt their premises to rising sea levels represent an important complementary action with regards to public flood protection and early warning systems.

Until the recent past, rising sea levels and increases in the number of flooding events have mainly been discussed in the context of local subsidence tendencies, determined by local anthropogenic and natural factors (Camuffo & Sturaro, 2003; Carminati, Doglioni, & Scrocca, 2005).

In recent debates, climate change has gained some importance with respect to urban policies, but this leading, up to now, to a series of international presentations of the Venice experience and strategies, whereas local reflections on proactive strategies for adaptation to climate change are only slowly gaining pace. The city is indeed preparing, in these days, first steps for a municipal adaptation plan, which considers the whole of the municipal area, so including the areas of the mainland potentially interested by the impacts from Cloudbursts and heat waves. With regards to the public policies put into place up to now with regards to flooding of the historic centre, major critiques have been advanced to the big infrastructure project MOSE which is actually underway; although not designed for changing climatic conditions and increased sea levels, the constructor states its physical capacity of withstanding increasing sea levels (and consequently storm surge levles) up to 60 cm. The implications for the urban (and harbour) economy of the implementation of this infrastructure under increasing sea levles are made explicit by some authors (Fontini, Umgiesser, & Vergano, 2010; Vergano, Umgiesser, & Nunes, 2010).

Image 2.5.4: Protection measures in private building

2.4.4 Prague

By Eliska Lorencova

Floods have been recognised as a major natural hazard within Central Europe, especially since the end of 1990s, when the whole region experienced several very harmful events (Kundzewicz et al., 2005). According to many authors dealing with the problem of floods, the overall effect of such events is very likely to increase in the future, not only because of changing climate but also due to socio-economic changes in society (Mitchell, 2003; Kysely et al., 2011; Rojas et al., 2013). Regarding the changing climate, the greatest issues potentially are wetter winters, dryer summers with more precipitation extremes and weather fluctuations in general (Kysely et al., 2011). As mentioned by Rojas et al. (2013), the Czech Republic is one of the countries most threatened by future floods in terms of extent and cost of possible damage, and it is therefore absolutely crucial to invest in adaptation and flood protection measures.

The case study for Prague will focus on the problem of floods and will consist of the cost benefit analysis of current flood control system (FCS) which construction started in 1999. In 2002, Prague was hit by catastrophic floods which count among one of the greatest and most expensive natural disaster is the modern history of the Czech Republic. During this event, water flow in the Vltava River reached the level of 500-year flood. At that time, some construction of the first part of FCS had already started which saved a part of the historical centre of Prague, but even despite of that, the total damage was estimated to 24 billion CZK (1 billion EUR). The damages were especially on infrastructure, housing and environment. Based on this experience, the plans for FCD were changed in order to increase its resistance up to the 2002 flow rate (Slavíková et al., 2007). Since the great floods in 2002, the city has experienced quite a few events (2006, 2009, 2013), however none of these was of a comparable extent to the floods in 2002.

Prague, the capital of the Czech Republic, is located in the temperate climate zone. According to the latest research, the average annual temperature has shown a long-term upward trend in the last few decades. The average annual temperature in the last fifty years has changed significantly, with a trend of gradual increase (less than 0,3°C/10 years) - significant increases of the temperature have been recorded in summer (0,4 °C/10 years), slow increases have been recorded in winter months (less than 0,1 °C/10 years). The average annual rainfall in the last two decades has increased by approximately 5% when compared to the standard period (1961-1990). The temporal variability of average daily precipitation in the two decades has increased in the warm half of the year and decreased in winter months.

Even though there are efforts of Prague municipality to develop and implement flood control measures, the whole system is not flexible enough to correspond with future climate change and appears rather as a reaction to past events. The climate scenarios for the region predict a change not only in frequency but also in intensity of extreme events (IPCC, 2013) and it is therefore crucial to address these future threats in an adaptation strategy. Recently, the city has no strategy dealing with the adaptation to climate change. Some tentative adaptation measures have been very briefly mentioned in city's Strategic plan, which is now being updated. A common understanding of the need for climate change adaptation is yet to be developed.

Besides that, the Czech approach to flood management is of a traditional character (river training, construction of embankments, reservoirs buildings, etc.), which rather aims at reducing flood risk than decreasing vulnerability and increasing adaptive capacity. This is crucial especially due to high uncertainty and partial unpredictability which is connected with floods. It is clear that the previous floods in Prague had meteorological causes such as extensive precipitation or ice damming and changes in temperature, but as stated by Yiou et al. (2006), the relationships between the amplitude and climate variables is not very clear.

This case is prospective since, up to recently, the city has no strategy dealing with adaptation to climate change. Some tentative adaptation measures have been very briefly mentioned in the city Strategic Plan, which is now being updated. A common understanding of the need for climate change adaptation is yet to be developed.

In this context, the case study City of Prague focuses on two main topics:

- Analysing the process of adaptation to climate change and urban adaptive capacity and
- Developing (through participatory approach with local stakeholders) potential adaptation measures, assess Cost and Benefit Analysis (CBA) and pathways for flood risk management under changing climate.

Within these two topics, the case study aims to answer following research questions:

- The process of adaptation to climate change, urban adaptive capacity
    - What adaptation measures have already been implemented and how they reflect the uncertainty of future climate change (projections)? Were these measures implemented in order to adapt to the impacts of changing climate?
    - How is the concept of adaptation to climate change integrated in key sectors (in documents, plans, strategies, policies)?
    - Who is the main actor in the process of adaptation to climate change? What are the main factors (drivers) that contribute to the adaptation process in city and what are the factors that hinder the process?
- Future adaptation measures and pathways:
    - What are the potential future adaptation measures and adaptation pathways that will deal with future climate? What are their estimated costs and benefits?
    - What are the attitudes/preferences of different stakeholders for particular types of measures/pathways?

For this case study, the expected outputs are as follows:

- Evaluation of the degree of integration of the concept of adaptation to climate change in documents (plans, strategies, policies) in key sectors, description of implemented adaptation measures
- Analysis of the adaptation process (main actors, drivers, obstacles)
- Developing future adaptation measures/pathways together with stakeholders involvement, the quantification of these measures/pathways (costs and benefits)

A group of various stakeholders with different preferences for potential measures are included in case study research:

- Prague City Hall representatives (Department of Spatial Planning and some other departments) - a key stakeholder in terms of implementation of adaptation measures
- Water managers (River basin authorities - Povodí Vltavy s.p.) - a key stakeholder responsible for potential measures in water sector
- Prague Public Transport Company representatives - initiated and already implemented some measures after flood in 2002
- Local developers developing in flood prone areas
- Group TIMUR (Initiative for local sustainable development) - a promoter of "green" adaptive measures.

Currently we are engaged in:

- Designing and develop several adaptation measures through the Participatory Adaptation Pathways approach: several different alternatives will be developed (e.g.: minimal possible alternative based mainly on technical measures, an alternative with the emphasis on "soft" solutions, an alternative based partly on technical and partly on ecosystem-based measures, etc.)
- Prioritizing and quantifying alternative adaptation pathways

Tools:

- **PRIMATE** tool is likely to be use

2.4.5 Jena

By Oliver Gebhardt

Jena is a German city (105,000 inhabitants) located 250 km South-west of Berlin. It is characterized by a long-standing civic culture, strong engagement of the citizens in public matters and a vivid intellectual, cultural and economic life and has an international reputation as a scientific centre. The city has been among the best ranked business locations within Germany for the last 5 years. About 21,000 students are enrolled at the Friedrich-Schiller-University Jena and about 5,000 at the Jena University of Applied Sciences. More than 4,500 scientists work at the R&D departments of the local companies and the numerous internationally renowned research institutes including many institutes of the leading German research societies.

Since the late 19th century Jena has been one of the world’s most important centres of the optical industry. Many of the nowadays existing optical companies have their origin in the former Carl Zeiss factory. The local economy is primarily based on high-tech industry and research. In addition to the optical industry software engineering and biotechnology are relevant economic sectors. Jena is a growing city (population, GDP, demand for land) in a shrinking region.

Impacts

Jena is located in the hilly landscape of Saale river valley surrounded by shell limestone slopes. The city centre in the valley is situated at 160 m a.s.l., whereas the surrounding mountains rise up to 400 m a.s.l. Jena is part of the warm-temperate zone of Europe which is characterized by warm summers and relatively cold winters. The average precipitation of 587 mm p.a. is relatively low compared to other municipalities in the region. Due to its specific geographic location (including orographic and topographic conditions) Jena is exposed to various climate change related risks, especially heat stress and flooding. Based on different climate projections (various models and scenarios) a substantial increase in the exposure towards these risks is expected.

In the last 100 years the average annual temperature (+1.2 K) and the number of summer days (Tmax≥ 25°C) and hots days (Tmax≥ 30°C) increased appreciably. The annual precipitation rate remained rather stable and seasonal precipitation rate increased slightly for the hydrological summer and somewhat more pronounced for the hydrological winter. A further increase of the annual average temperature and the number of summer and hot days is expected. The same holds true for seasonal average temperature for the hydrological summer and winter. Annual precipitation rates are very likely to decline. Projections of the seasonal precipitation rates differ substantially depending on the model used. The expected temperature increase and the decrease of precipitation rates will have a negative effect on the climatic water balance in spring and summer.

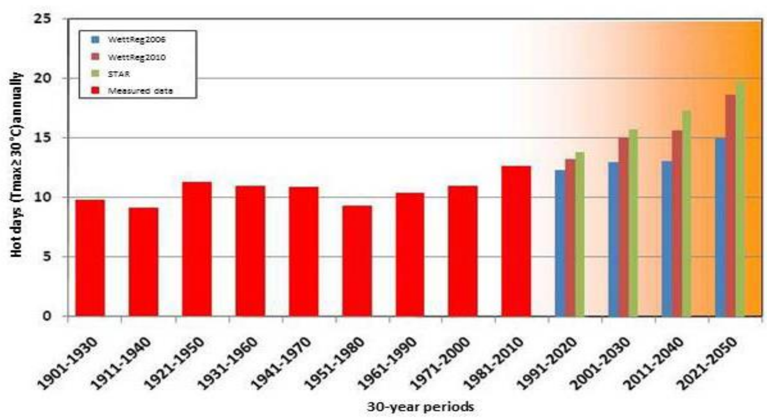


Figure 2.5.5 Past and projected number of hot days (Tmax≥ 30°C) for 30-year periods. Source: Modified figure based on City of Jena (2013, p. 30).

The increase of the annual average temperature comes along with an increase of the number of hot days (Tmax ≥ 30°C), hot nights (Tmin ≥ 20°C) and most probably heat-waves. It is expected that not only thermal comfort and productivity will be negatively affected by this trend but also that heat related diseases, as for instance cardiovascular complaints, will occur more often. Elderly and ill people as well as children are considered to be most vulnerable to heat stress.

The exposition to heat stress is highly depend on the degree and mode of soil sealing, the properties of the building structures and the availability of green and blue structures. On the basis of measured data for the recent past (1971-2000) the number of summer days (Tmax ≥ 25°C) is highest in the city center and the urban quarters Jena-Nord, Jena-West, Jena-Süd, Wenigenjena, Burgau, Löbstedt and Zwätzen. These areas are predominately classified as city center, commercial or industrial area. The risk of heat stress is much lower in the suburban areas and the large housing estates which are located more distant to the city center. Fortunately, only few of the facilities taking care of people mostly affected by heat stress (ill, elderly, young) are located in high risk areas.

Even though projections of extreme events are highly uncertain an increase in the intensity of (thunder) storms and heavy precipitation events and thereby a higher risk for soil erosion and (surface) floodings is expected. In Jena flooding is primarily been caused either by the first-order river Saale or by the second-order river Leutra. Additionally, heavy precipitation events can exceed the capacity of the sewer system and lead to sewer overflows. To date evidence regarding the climate change related flood risk for the river Saale is rare and mixed. The ESPON project simulated for different sections of the river a change in inundation depth of +/- 1m (Scenario A1B, 2100). Beyond these estimates at the moment, there is no information available regarding changes in flood return periods for the river Saale under different climate change scenarios at the level of the state and the municipality. One of the major problems of estimating the climate change related changes in flooding risk are the complex and varying causes of such events. In 1994 the combination of snowmelt and heavy precipitation events caused a serious flooding while the last flooding in 2013 was primarily due to many second-order rivers discharging into the Saale after many consecutive days of rain.

In spite of lacking scientific proof public debate ever more links the increasing frequency of flooding events to changing climatic conditions. Inter alia on the basis of recent events (severe river flooding 2013) and despite of the immanent uncertainties related to the impacts of climate change the city administration assumes that the flooding risk especially in connection with heavy precipitation events will increase. Therefore, some measures which have been framed as climate adapation measures have already been implemented.

The areas especially exposed to the risk of flooding have been mapped using modelling data, the data of the flooding in summer 2013 and data of the missions of the fire brigade for the period January 2009 to July 2011. The areas with the highest flooding risk are the residential area “Ringwiese” (district Winzerla) and some plots in the districts Wöllnitz, Maua and the city center. Highest material damages can be expected for the industrial area Göschwitz, some plots in the western part of the large housing estate Lobeda and the recreational area Paradies, where the football stadium is located.

The following map displays the locations which are especially exposed to various the climate change related risks: heat, drought, flooding, erosion and the respective combinations of these risks (see **Figure 2.5.6**).

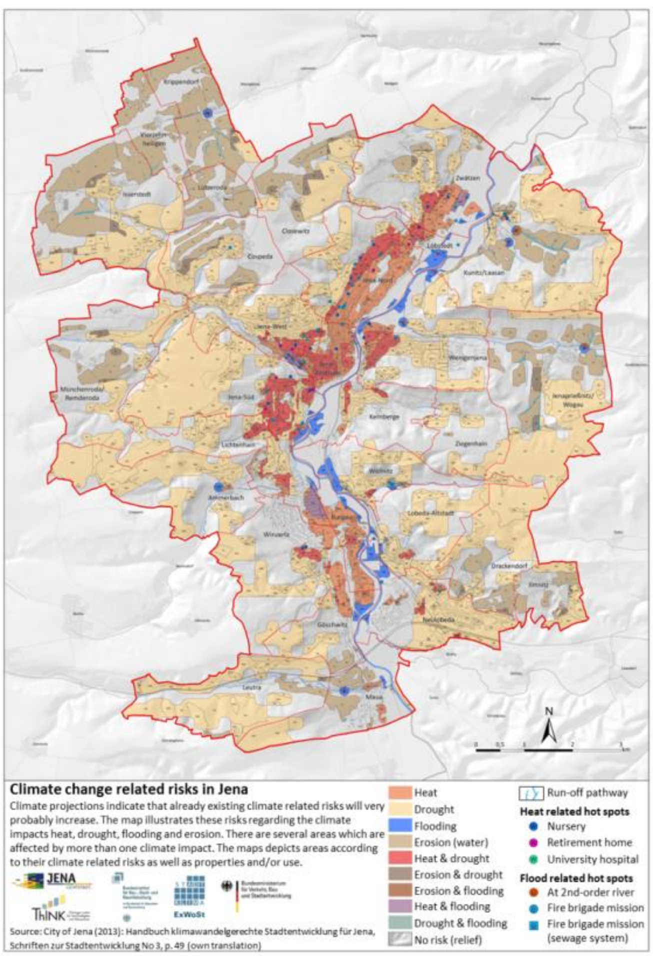


Figure 2.5.6: Climate change related risks in Jena. Source: Modified figure based on City of Jena (2013, p. 49).

Case study research and adaptation

Due to the specific locational aspects and a well established public discourse about the exceptional climatic conditions in Jena the city administration and political decision makers already for decades were well aware of the city's exposition to various climatic threats. The IPCC report in 2007 put the topic of climate change further up on the political agenda. The city commissioned a small pilot study carried out by the Institute of Geography of the University of Jena for a basic analysis of current and future climatic risks. In 2009 the Department of Urban Development & City Planning started the development of the local climate change adaptation strategy - JenKAS to further improve the knowledge about and mitigate climate change related risks. This process was supported by a national research funding programme Experimental Housing and Urban Development of the German Federal Ministry of Transport, Building and Urban Development. It involved scientists, local and regional stakeholders and decision makers. The strategy was approved by the city council in May 2013.

Since then it is being put into practice through mainstreaming into established planning processes and various supplementary projects producing additional information on climate change related impacts and climate adaptation options.

The strategy consists of various elements. Its backbone is a handbook on climate change sensible urban planning including information on current and future climatic conditions and their potential impacts in Jena. The handbook also includes a discussion of legal framework conditions and instruments for climate change adaptation and best practice examples of the successful climate change adaptation in Jena and elsewhere. Furthermore, exemplary economic assessments of adaptation options applying multi-criteria analysis for two projects in Jena are presented. For each city district climatic conditions are described in detail in the handbook and risks visualised using a traffic-light labelling system (see **Figure 2.5.7**).

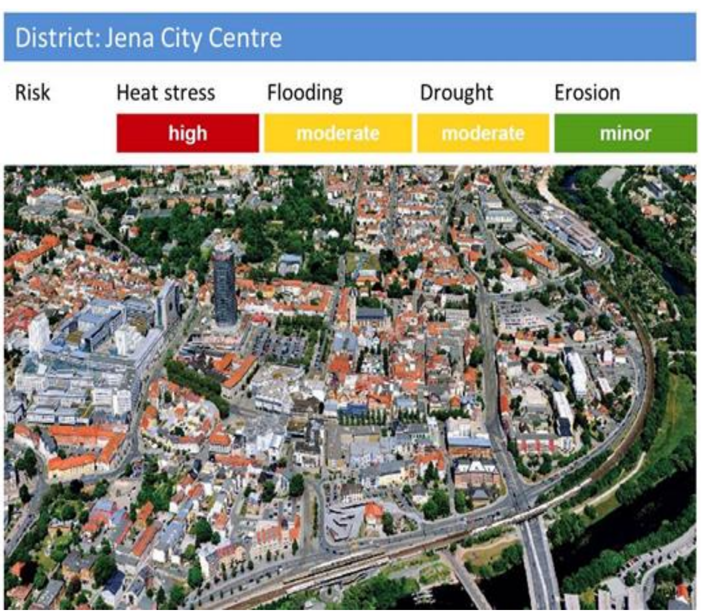
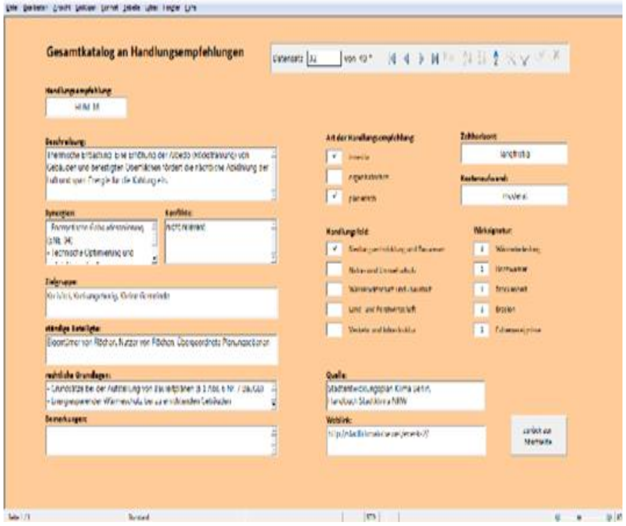


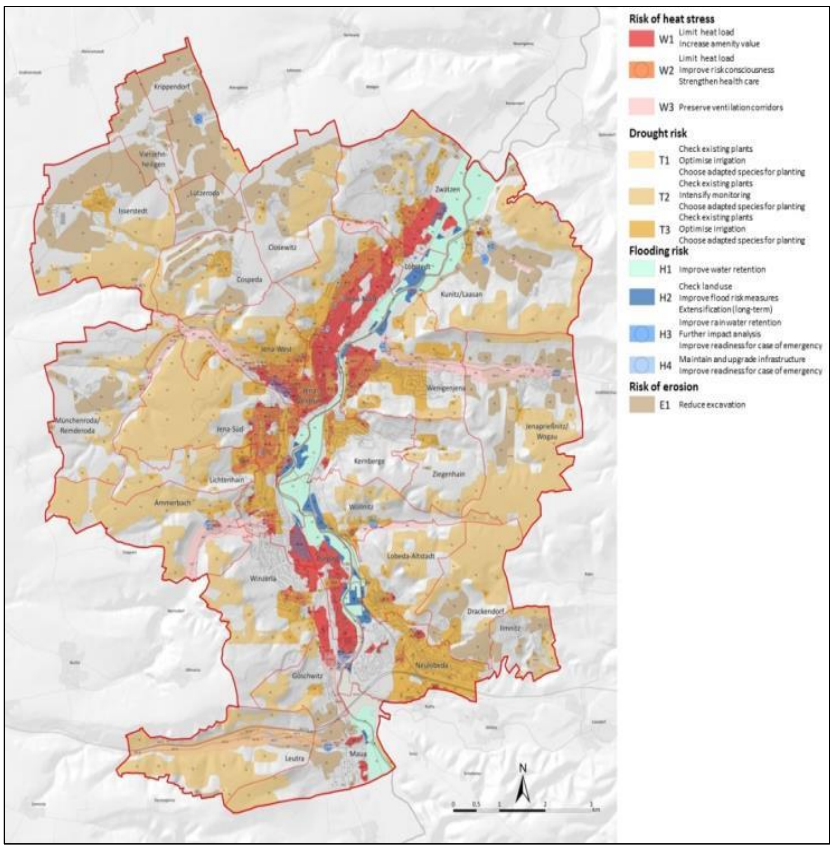
Figure 2.5.7: Risk assessment on district level: Traffic-light labelling system. **Source: Modified figure based on City of Jena (2013, p. 95).**

Figure 2.5.8: JELKA: User interface.

Moreover, a decision support system called **JELKA** (Decision support for local climate adaptation in Jena) is introduced which has been developed by the city administration and the Thuringian Institute for Sustainability and Climate Protection (**ThINK**) to facilitate the implementation of the strategy by making existing information more accessible and provide tailor-made recommendations for different types of stakeholders and/or decision makers.



JELKA (see **Figure 2.5.8**) is a database which uses an algorithm to prioritise 118 urban adaptation measures by climate impact (e.g. flooding, drought, erosion …), field of action (e.g. water management, infrastructure, environmental protection …) or spatial unit (city districts). Depending on the special demands and perspectives of the user she obtains suggestions for the most relevant adaptation measures for the respective climate impact, field of action or spatial unit which is of interest. The Department of Urban Development & City Planning does not only provide the tool for everyone who's interested but also runs trainings to enable local planners to make use of it for their daily work.



A series of maps has been produced to visualise various climate change related risks, e.g. heat stress, drought, river/surface flooding, erosion, and combinations thereof. Additional maps depict information on special issues, e.g. the intra-night volume of cold air flows which has been simulated using the cold air drainage model KLAM_21 of the German Weather Service – DWD. On the basis of the climatic risks and potential adaptation measures identified a map was produced illustrating recommendations for urban planning in particularly affected areas (see **Figure 2.5.9**).

Figure 2.5.9: Climate change adaptation related recommendations for urban planning in Jena. Source: Modified figure based on City of Jena (2013, p. 72).

All climate adaptation related information is accessible through a website (http://jenkas.de) which is been used to keep the public informed about ongoing climate adaptation activities.

The implementation process of the adaptation strategy consists of two main components. Firstly, the mainstreaming of climate change adaptation, i.e. the consideration of data and use of tools available for supporting climate change sensible urban planning, is promoted through various activities. Secondly, projects with very specific research questions, e.g. mapping and climate risk analysis of trees within the city limits or the identification of heat stress hot spots using temperature sensors installed at public buildings, are commissioned to produce additional knowledge relevant for local climate change adaptation. These projects are administered by a team within the Department of Urban Development & City Planning and carried out by different scientific partners.

BASE scientist from the Helmholtz Centre for Environmental Research - UFZ analyse the development of the urban adaptation strategy inter alia reflecting on the understanding of climate adaptation by relevant actors, role of leadership, steering mechanisms applied, types of knowledge used, stakeholders involved in the process and the multitude of drivers and barriers of this process. The mainstreaming of the adaptation strategy into the existing institutional setting is been analysed by investigating the drivers promoting and barriers hindering this process.

The implementation process is further supported by the BASE project by developing climate adaptation checks for three major building projects, i.e. multi-criteria assessment of preliminary drafts of land development plans under present and projected climatic conditions, to help designing a final draft which suits best current as well as future conditions. The projects include the redevelopment of a central urban square (3 ha), the reconstruction of the public area surrounding an apartment complex and the development of the new neighbourhood at an edge-of-town location (6.6 ha). The BASE team does not only develop showcases for mainstreaming of climate change adaptation into urban planning but as the projects vary substantially in size, location and the stage of development BASE activities will improve the understanding of the conditions under which such an adaptation check is most viable.

For the analysis of heat stress potential the innovative tool **URBAHT (Urban Heat Tool)** is applied (see **Figure 2.5.10**).

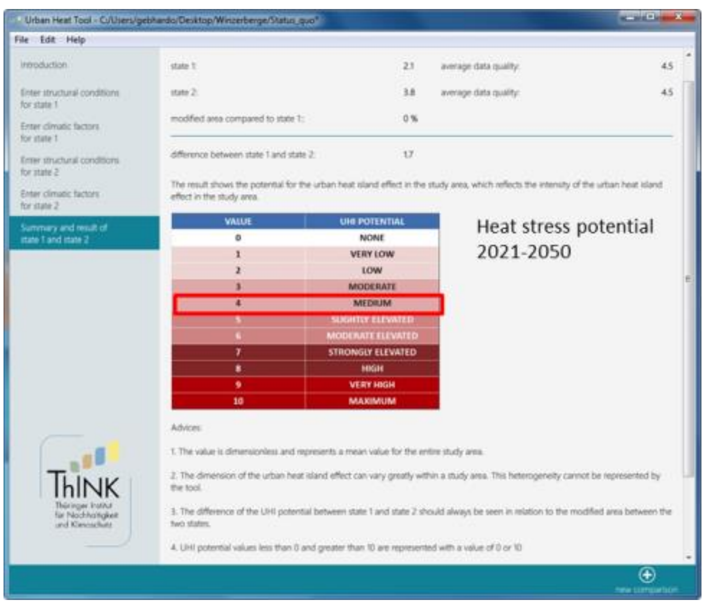


Figure 2.5.10: Estimation of heat stress potentials using the tool URBAHT: Result screen

This software uses an algorithm to process data on various structural and climatic factors to determine the heat stress potential of variations of land development plans. The innovative aspect of this approach is that in general the data needed to run the tool can easily be obtained from public sources. The quality of the data used is documented in the final results. URBAHT enables local planners to (roughly) estimate heat stress potentials without resource and time consuming simulations using software packages as for instance ENVI-met. Even though the high degree of applicability comes at the cost of less accuracy, experience shows that this might be a necessary trade-off if considerations of climate change are to be integrated into established planning routines. For building projects of outstanding importance more elaborate micro-climatic analyses are commissioned by the Department of Urban Development & City Planning.

The alternative drafts are prioritised by applying the multi-criteria outranking method PROMETHEE[6]. The assessment is carried out using the tool PRIMATE[7] which has been developed by UFZ scientist. For each project the alternative drafts are ranked on the basis of their perfomance regarding various criteria taking into account the preferences of different stakeholders and/or decision makers. Remaining uncertainties are documented. The results of the assessments are discussed with and considered by the planners in the further decision making process.

As local climate change adaptation is an on-going process involving various administrative departments, stakeholders and scientists the "JenKAS working group" was established. BASE scientists became an active part of this group which meets regularly every 2-3 months to discuss current projects, new project ideas and to share new climate change related insights and thereby preserve the momentum unleashed by the development of JenKAS local climate adaptation strategy.

2.4.6 Leeds

By Dabu Guan

The Leeds case study aims to develop and rigorously evaluate adaptation strategies for managing urban flood risk in the Leeds city region. An introduction of historical climate trends and a projection of future climate are developed for Leeds. Flooding risks, vulnerabilities, flooding damages and adaptation measures are identified. The case study combines top down approach – input-output analysis - with cost-benefit analysis to evaluate the direct impacts of flooding events such as building damage and its knock-on effects through supply chains. The case study will contribute to the BASE project by designing a new modelling approach to assess the macroeconomic effects of climate change adaptation measures, which will be used in the Rotterdam case study for comparison. The modelling framework could provide quantitative evidence in the selection of adaptive measures in the future.

Impacts

Leeds is a city in West Yorkshire, England. It has a total population of 757,700 (2011), which makes Leeds the second largest local government district by population behind Birmingham

[6] Preference Ranking Organisation Method for Enrichment Evaluations

[7] Probabilistic Multi-Attribute Evaluation

(ONS, 2013). Leeds is one of the largest centres for business, legal and financial services in the United Kingdom, second only to London. Leeds has an oceanic climate, which has a relatively narrow annual temperature range. The warmest month is July with a mean temperature of 16°C, while the coldest month is January with a mean temperature of 3 °C. Leeds is one of the driest cities in the UK with a mean total rainfall of 114.3mm in December (the highest) and 63mm in July (the lowest). **Table 2.5.2** shows the monthly average temperature and precipitation in Leeds.

Table 2.5.2.: Monthly average temperature and precipitation in Leeds

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Average High (°C)	5.5	5.6	8.1	10.7	14.3	16.9	19.1	18.7	15.9	12.1	8.3	5.8
Average Low (°C)	0.5	0.3	1.7	3.2	5.9	8.8	11.1	10.9	8.9	6.1	3.2	0.9
Precipitation (mm)	109.8	77.2	81.5	72.9	65.2	77.1	63.0	81.1	77.1	99.8	105.2	114.3

Source: World Meteorological Organization (Available from: http://worldweather.wmo.int/010/c00039.htm)

Climate change is already beginning to affect Leeds. According to the weather data recorded (for the period between 1985 and 2011) in the former Leeds Weather Centre and the Leeds City Council weather station, severe weather condition such as flooding, gales and wintry conditions are more frequent nowadays than the past. The Leeds City Council has developed a Local Climate Impacts Profile (LCLIP), which identified the information of every severe weather event between 2002 and 2008, including location, level of impacts, consequences, and etc. It concludes that Leeds is most vulnerable to floods, which will mostly disrupt transportation and emergency services.

The future climate impacts in Leeds are identified. According to the Leeds City Council (2009) and the Yorkshire and Humber Assembly (2009), key climate change impacts on Leeds are

- Average daily temperatures rising by 2 °C;
- Extreme hot temperatures in summer could reach 34 °C, which exceeds the threshold (29 °C) of declaring a heat wave in Leeds. The hot temperature could have significant health impacts such as heat stroke and heat exhaustion.
- A reduction in annual rainfall up to 6% by the 2050s, which may result in lower water availability and higher water demand in Leeds;
- Change of rainfall pattern - with more wetter winter and drier summer, which could lead to more frequent river flooding and flash flooding in winter. In addition, the Leeds city centre is likely to be affected by a 1 in 20 year flooding risk from the River Aire. A 1 in 20 year risk of flood would incur approximately £400 million of direct economic losses and affect 120,000 passengers travelling from Leeds Rail Station per day (Leeds City Council, 2007).
- Increase in the number of extreme rainfall events in the northern and upland areas;
- Increase in the number of dry spells (over 10 consecutive days without rain).

Case study research and adaptation

The UK Climate Change Risk Assessment 2012 (CCRA) provides a detailed analysis to the risks and opportunities of climate change for the UK (Defra, 2012). To response to the CCRA, the UK government published the National Adaptation Programme (NAP) in 2013 (Defra and Environment Agency, 2013), which contains a mix of policies and actions to adapt to future weather conditions. NAP highlights the responsibility of the government as well as the roles of local authority, industry, community and civil society in climate adaptation and encourages the collaboration of different stakeholders. The development of NAP is guided by the vision of '*A society which makes timely, far-sighted and well-informed decisions to address the risks and opportunities posed by a changing climate.'* Adaptive capacity is broadly defined as the local characteristics in the UKCIP. For example, the level of impacts of a flooding event will depend on local factors, such as people's experience in dealing with flooding, the adequacy of drainage systems of local community, preparedness of people and etc. The Leeds City Council has implemented a number of adaptive strategies and actions, which are introduced in the following.

Climate Change Partnership

The Climate Change Partnership consists of a group of local organisations and businesses in Leeds. The major objectives of the partnership are to ensure that Leeds reduces carbon emissions and adapts to potential impacts of climate change. Members of the partnership include individuals from Leeds City Council, Environment Agency, Leeds University, ARUP, Metro, and etc. and meet every three months (Leeds City Council, 2012).

The West Yorkshire Resilience Forum consists of officers from the emergency services, health agencies, the Environment Agency and local councils are responsible for assessing climate risks, planning for emergencies and keeping the public informed during and after an emergency. Flooding is considered as the most important current climate risk to Leeds. The local authorities also work on the identification of other climate risks and their impacts on health and social care, transport, utilities, the built environment, the natural environment and waste.

Leeds Climate Change Strategy

The first Leeds climate change strategy was published in 2009 and then revised in 2012 (The Leeds Initiative, 2012). The strategy sets out plans and priorities for Leeds to tackle the causes and impacts of climate change. Majority of the strategy focuses on low carbon development in Leeds, including improvement of energy efficiency, application of renewable energy sources, promotion of public transport services. Regarding climate change adaptation, the strategy identifies several priorities for action, including

- Develop and deliver an appropriate flood defence scheme to protect Leeds city centre (together with Environment Agency)
- Identify key climate risks and priority actions
- Develop and trail a methodology for detailed vulnerability mapping of key climate risks across the city

Surface Flooding Adaptation Measures: Sustainable urban drainage system

The traditional method of dealing with surface water has been to pipe it away from developments and discharge it to the sewerage system or nearby watercourses. It has implications for water quality, the ecology and amenity of watercourses, including canals, and downstream flooding. Sustainable drainage seeks to mimic more natural drainage processes by allowing rainfall to soak into the ground where possible or by delaying discharges. Since the focus of Leeds case study is on flood risk management, we consider both the traditional physical infrastructure and the green infrastructure in our research.

The case study aims to develop and rigorously evaluate adaptation strategies for managing urban flood risk in the Leeds city region. Research questions of Leeds case study are: what are the existing adaptive measures in urban flooding management in Leeds? What are the potential future impacts of flooding to the Leeds city region? How to improve existing adaptive measures of flood management in the future? What are the costs and benefits of existing/improved adaptive measures? The case study will evaluate the direct impacts of flooding events such as building damage and its knock-on effects through supply chains. A combination of input-output analysis and cost-benefit analysis will be used to examine various flood risk management options. The case study will consider both physical infrastructure and ecosystem-measures such as sustainable drainage system in dealing with flood risks. The case study will contribute to the BASE project by designing a new modelling approach to assess the macroeconomic effects of climate change adaptation measures, which will be used in the Rotterdam case study for comparison. The modelling framework could provide quantitative evidence in the selection of adaptive measures in the future.

Analysis of the urban economy is central to understanding the broad costs and benefits of climate change adaptation. Cost-benefit analysis is a tool used to calculate and compare benefits and costs of a project, programme or government policy. Cost-benefit analysis has two main purposes: to determine if it is a sound investment/decision (justification or feasibility) and to provide a basis for comparing projects. It involves a comparison of the total expected cost of each option against the total expected benefits, in order to assess whether the benefits outweigh the costs and by how much.

Assessments of the adaptation measures on cities have traditionally based on on-site and local level of cost-benefit analysis. Since economies are coupled, cost-benefit of implementing adaptation measures can be exaggerated throughout the wider economic systems (regional/ national/global). For example, the benefit of adaptation infrastructure from macroeconomic perspective can be: the total economic damage (physical damage and propagated damage in the entire economic supply chains) saved from flooding and other disasters and economic growth triggered by infrastructure investment.

The aims of the input-output model are three-fold:

- Adapt the city scale Adaptive Regional Input-Output Model (ARIO) to quantify cost-benefit of adaptation measures for case study cities from a macroeconomic perspective.
- Linking the city scale ARIO models with national input-output tables (for each case study city) to estimate the cost and benefit of implementing local adaptation measures to the national economy

- Further integrate the national scale ARIO model with the World Input-Output Database (WIOD) to estimate the cost and benefit of implementing local adaptation measures to the EU and other countries' economies.

Methodology

A variant of the Adaptive Regional Input-Output model (ARIO) will be developed to explore the vulnerability of city economy to climatic changes induced extreme events (i.e. flood / drought) and quantify the cost-benefit of adaptation measures implementation. The ARIO model will be adjusted for each case study cites according to the features of the city and nature of extreme events that can potentially attack the city.

A city level **ARIO** will be constructed in the following steps:

- Review of cost-benefit analysis definition in climate change adaptation context.
- Quantify direct cost-benefit of adaptation measures:
    - Marginal abatement cost analysis evaluates the cost of any adaptation measures
    - Event Accounting Matrix (EAM) will be developed to specify initial damage of potential extreme event to case study cities without adaptation measures. The EAM consists of a set of damage functions at the scale of case study regions including direct damages and business interruption. Information on recovery costs after damaging events will be compiled. The physical damage can be seen as 'direct benefits' of adaptation measures.
- Measure indirect cost-benefit:
    - Estimate economic cost/benefit triggered by investments in constructing adaptation infrastructures and other spending
    - Quantity indirect cost/benefit by integrating EAM (damage functions) into the ARIO models. Such cascading impacts can be seen as 'indirect benefit' of adaptation measures. The cascading impacts can be measured at city/national/global (e.g. EU) levels.

Data needs and linkages with other models/cases study within BASE

The data needs for the ARIO models are three-fold

- Microeconomic /adaptation database for MACC in every case study city.
- Damage functions (e.g. flooding depth model) based on local risk analysis
- City level input-output tables and the respective national input-output tables.

2.4.7 Rotterdam

By Ad jeuken

The prime focus of this case is flood risk management from the main river tributaries in the Rotterdam area and some attention for the related urban water system. The current system can be divided in the main water system and the urban water system with on the one hand high emphasis on safety measures including the prime defences like dikes, storm surge barriers 'the Maeslantkering' and 'the Hartelkering' and pumping and drainage systems in the polder areas behind the prime defence system. The second part of the current system consists of the main sewage system, local retention possibilities and other objects related to urban water management. Adaptation measures aim at providing sufficient flood prevention for the coming decades. This with respect to both the local situation, effects of climate change on sea level, storm setup and river discharge, and socio-economic development affecting the harbour and city of Rotterdam.

Rotterdam is located in the densely populated area in the western part of the Netherlands. This, and adjacent areas have a long history in flood risk management and related disasters. Most prominent is the disaster of 1953, mainly affecting the delta south of Rotterdam. This led to the building of the so-called Dutch Deltaworks, whereof the Hartelkering and the Maeslandtkering are components. Also the norms for risk where established for the first time, based on a risk approach outlined in the 1960's. Due to climate change projections, near floods in the riverine area in the hinterland of Rotterdam, and a growing awareness economic development led to higher risks, a delta committee was installed in 2008 to advice parliament for the decades and centuries ahead. The result of this advice (Delta committee 2008) and several research programmes in the first decade of the 21st century led to the installation of the Delta Programme. This is a hybrid institutional programme during four years and aimed at providing a detailed strategy until 2100. The case Rotterdam falls under the umbrella of this nation-wide program and is, thus, influenced by developments ongoing in the whole nation (regarding amongst others the concept of Adaptive Delta Management (van Rhee 2012), Multi Layered Safety (I&M 2008) and a discussion regarding flood risk norms).

Another part of Rotterdam's history is its urban development. For centuries it is a harbour, located in the northern part of the Rhine-Meuse delta. This location led, since the industrialization, to a sharp increase in harbour-bound activities. The prospering city was heavily bombed at the start of WWII and its city centre was destroyed. In the decades after the war, Rotterdam was quickly rebuild and grew quickly to become the largest deep sea port of the world (currently the 4th largest harbour). This led to three important developments from the perspective of flood risk relevant for this case: seaward harbour extension, high economic investments in the city centre and urban sprawl due to high employment possibilities. Thus, next to flood risk the city is currently confronted with redevelopment of old, inner city port areas, maintaining its attractiveness as port for economic activities and managing a high cultural urban diversity.

The institutional system regarding flood risk management is divided among different governmental actors, including the national government, water boards and municipalities. The river tributaries and the coastal zone are the prime responsibility of the National government, with involvement of several ministries. The urban water system is the prime responsibility of the municipality and partially of the water boards in the area, although national actors also have a role. In both systems other stakeholders like the port authority have stakes in decision-making about water, and decisions made by these stakeholders influence the state of the system. To the lowest level individual decisions of citizens can influence the effectiveness of public adaptation policy.

Rotterdam is located adjacent to the North Sea. Thus, the general climate is dominated by the sea and rather mild due to the Atlantic Gulf stream (Rotterdam has a Cfb climate in the Köppen-Geiger classification). Located in the Rhine-Meuse delta and adjacent to the North Sea, the topography is flat and the soil mainly consist out of old clay and peat layers. This made the area very fertile, which in the larger Rotterdam area is visible in high revenue agriculture activities and horticulture (see map with land use, **Figure 2.5.11**). The water system in the area and the whole tributaries of the Dutch Rhine and Meuse is highly managed leading to creating polder areas by pumping out the water. This intensive pumping led to soil subsidence, which enforces the natural soil subsidence processes due to the retraction of ice after the last ice age. Thus, there is a gross sea level rise due to climate (see next section for the scenarios) but also an increased effect for Rotterdam's flood risk due to glacial and human induced soil subsidence.

Figure 2.5.11

Scenarios used

Used by the latest municipal strategy: Climate scenarios from the KNMI, 2006 (Van den Hurk et al. 2006) and updated in 2009 (Klein Tank & Lenderink 2009). The Rotterdam Adaptation Strategy also uses the Deltascenarios, created in the Deltaprogramme, based on the two extreme KNMI 2009 scenarios (G and W+) and two socio-economic scenarios (Global economy and regional communities). The four scenarios are depicted in **Figure 2.5.12** and specified for the region in **Table 2.5.3**. These can be related to the IPCC emission scenarios B1 (for the pressure and rest scenarios), being a low emission scenario and A1F1 (for the steam and warm scenarios) being a high emission scenario.

The most important study is the translation of the deltascenario's for the Rijnmond Drechtsteden by the Deltaprogramme in 2011 (DPRD 2011). This study gives a regional image of the national four extremes as indicated above. The main numbers are included in table 5.

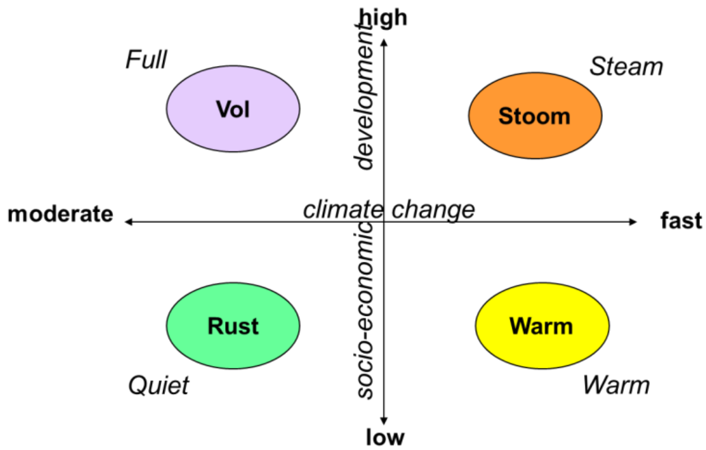


Figure 2.5.12: Scenarios used in the Delta programme: horizontal axis intensity of climate change and socio-economic development.

Table 2.5.3: Regional climate change and socioeconomic scenarios for the larger Rotterdam area (derived from DPRD 2011: table 2a & 2b)

Climate Change Scenarios

	Reference year	Pressure and Rest		Steam and Warm	
Year	2000	2050	2100	2050	2100
Av. Rhine discharge Februari (Q)	2900	3100	3200	3400	4000
Av. Rhine discharge September (Q)	1800	2000	2100	1300	900
Av. Meuse discharge Februari (Q)	480	500	520	530	590
Av. Meuse discharge September (Q)	89	92	94	48	30
Sea level rise (cm)	-	15	35	35	85
Extreme high Rhine discharge 1/100 year (Q)	12000	13000	14000	14000	17000
Extreme high Meuse discharge 1/100 year (Q)	2900	3000	3200	3200	3600
Extreme low Rhine discharge 1/10 year (Q)	630	650	670	520	420
Extreme low Meuse discharge 1/10 year (Q)	18	18	18	10	6
Average precipitation in winter		↑4%	↑7%	↑14%	↑28%
Average precipitation in summer		↑3%	↑6%	↓19%	↓38%

Socio-economic scenarios

	Reference year	Pressure and Steam		Rest and Warm	
Year	2000	2050	2100	2050	2100
Inhabitants NL (*10^6)	16	20	24	15	12
Economic growth (% a year)		2.6	2.0-2.6	0.7	0-0.5
Urbanization (% land surface)	16	20	25	17	10
Agricultural landuse (% land surface)	67	59	70	62	67
Nature (% Land surface)	17	21	5	21	23

A range of studies exist concerning climate change effects and adaptation for the Rotterdam area. In order to use these for this case a short literature review was executed to illustrate the use of different scenarios in these studies. The main scenarios used are the 2006 KNMI scenarios (Van den Hurk et al. 2006) and studies calibrating and building upon these scenarios (which were based on the AR 4 IPCC scenarios). Hereafter a short oversight of different used scenarios is given.

- Climate change scenarios
    - **De Moel et al. (2013):** Van den Hurk et al. (2006) KNMI climate change scenarios 2006 for the Netherlands, KNMI Scientific report WR 2006-01, KNMI, De Bilt. Translated for the local situation in: DPRD (2011) Regionale deltascenario's Rijnmond-Drechtsteden.
    - **Ward et al (2012):** Van den Hurk et al. (2006) KNMI climate change scenarios 2006 for the Netherlands, KNMI Scientific report WR 2006-01, KNMI, De Bilt
    - **Wardekker et al. (2010):** KNMI (2006) Climate in the 21st century: four scenarios for the Netherlands. Royal Netherlands Meteorological Institute, De Bilt, and: Van den Hurk et al. (2006) KNMI climate change scenarios 2006 for the Netherlands, KNMI Scientific report WR 2006-01, KNMI, De Bilt, and: Van den Hurk et al. (2007) New climate change scenarios for the Netherlands. Water science and Technology 56(4), 27-33.

- Demographic scenarios
    - **De Moel et al. (2013):** none
    - **Ward et al (2012):** CBS Statline (continuous updating)
    - **Wardekker et al. (2010):** Vrom (2007) Startnotitie Randstad 2040. Ministry of housing, spatial planning and the environment, The Hague.

- (Socio)Economic growth scenarios
    - **De Moel et al. (2013):** none, also the studies cited do not include socio-economic growth scenarios.
    - **Ward et al (2012):** Huizinga & Smid (2004) Vier vergezichten op Nederland: productie, arbeid en sectorstructuur in vier scenario's tot 2040. CPB rapport.
    - **Wardekker et al. (2010):** Vrom (2007) Startnotitie Randstad 2040. Ministry of housing, spatial planning and the environment, The Hague.

- Other
    - **De Moel et al. (2013):**
    - **Ward et al (2012):** Regarding soil subsidence: Rijkswaterstaat (http://www.geofoon.nl/bodemdaling), and: Van de Meulen et al. (2007) regional sediment deficiencies in the Dutch lowlands: implications for long term land use options. Journal of Soils and Sediments 7, 9-16., and: Van Asselen (2011). The contribution of peat compaction to total basin subsidence: implications for the provision of accommodation space in organic-rich deltas. Basin Research 23, 239-255.
    - **Wardekker et al (2010):** Surprise events constructed based on some literature of global climate change and by taking extremes from for example the Delta committee (2008)

Impacts

For the area outside the defence zones in the centre of Rotterdam, Wardekker et al. (2010) indicate the disturbances and challenges the area faces due to climate change. The Rotterdam Adaptation Strategy also indicates main effects and the related impact of these climate change effects. In this strategy several scenario studies are integrated (see: id. p. 20). In the strategy the same main impacts as in De Moel et al. (2013) and Wardekker et al. (2010) are indicated but on a city wide level. These main effects are temperature increase in the summer. This has main impacts concerning: more warm days, more heat waves, reduced air quality and drought. Drought can induce problems with warm river water, which reduces the possibility to cool power plants, leading to a reduction in energy production. Also water supply could be limited. Sea level rise with main impact an increase of flood risk and increased closure of the storm surge barrier Maeslantkering limiting shipping traffic, this is combined with the effect on wind and windstorms leading to a possible increase in storm surges with NW wind but projections are ambiguous and thus need not be taken into account. Altered river discharge due to increasing precipitation and melting water from the Alps, affecting the closing regime of the Maeslantkering and decreasing discharges due to drought, hampering inland shipping and increasing concentrations of pollutants and salinity. The main impact however is an increase in flood risk due to higher mean discharge and higher peak discharges (see **Table 2.5.3**). Lastly, a main aspect is the effect of precipitation extremes, leading to increased surface flooding and sewage problems which is amplified by a lack of storage capacity. De Moel et al. (2013) do not specifically translate the climate change scenarios for the local unembanked river foreshore, nor do they calibrate for future change in socio-demographics or economic development in the local unembanked area.

Case study research and adaptation

Key research objectives are amongst others to gain insight in:

- The governance and institutional opportunities and limitations of adaptation pathways for the Rotterdam region
- The relation between autonomous versus planned adaptation in the Larger Rotterdam region
- The assessment and integration of cost/benefit into the adaptation pathways approach
- The role of uncertainty in tackling climate change adaptation for the Rotterdam region
- The larger-scale effects of city-wide climate change adaptation on economic parameters for the national economy and worldwide cascade effects

This in addition to the formal BASE requirements regarding the data collection and dissemination of results.

2.5 Human Heath

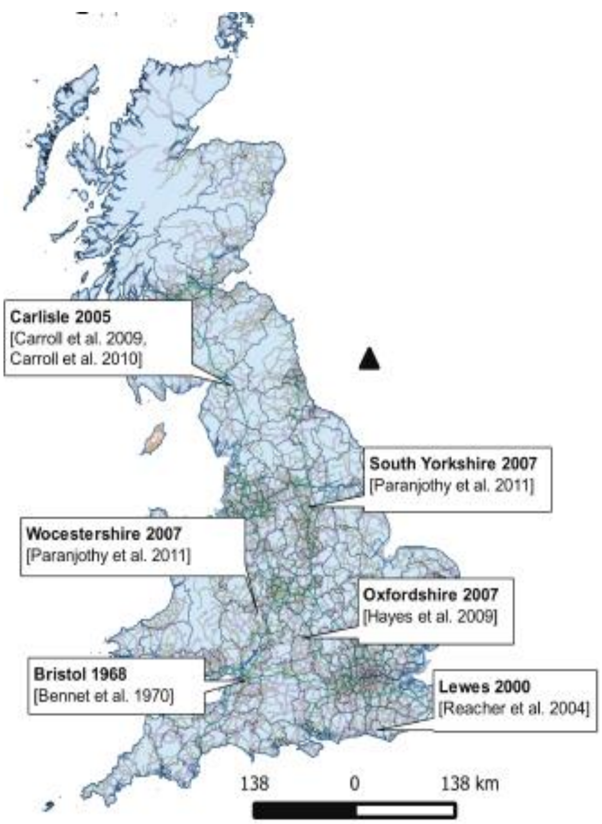
Overview of impacts and adaptation challenges

By Timothy Taylor

Two recent reports provide a useful overview of the impacts of climate change in the UK, and it is on the back of these that we are constructing the case study on health. The first, the UK Climate Change Risk Assessment identified and, importantly, placed monetary values on a range of health outcomes (Hames and Vardoulakis, 2012). In terms of mental health, this quantified the mental health risks as low (£1m-£9m by 2080s). However, this does not seem to consider the increased risk of mortality in those with mental health conditions and used a study by Floyd et al (2003) to value the disutility. The Floyd et al study, as noted in Hames and Vardoulakis (2012) has a number of weaknesses, including in the reporting of willingness to pay (a single value is reported with no statistical information).

The second study, Vardoulakis and Heaviside (2012) brings together a range of studies on the impacts of climate change on health. Mental health was not a particular focus of this study, though it did briefly discuss the potential for negative impacts due to flooding and possible positive impacts due to increased engagement with the natural environment. For flooding, this study identifies both primary and secondary stressors. Recent studies reviewed suggest that flooding can have profound impacts on mental health that can persist over time.

Recent studies linking flooding to mental health in the UK, the flood event and their location are shown in **Figure 2.6.1**



Adaptation options for mental health may include:

- Expanded provision of mental health care services, including treatments (e.g. medication, therapy);
- Non-medical based interventions – e.g. “green prescriptions”;
- Adaptation in agricultural sector – e.g. in terms of measures to reduce impacts of climatic variation on farm incomes and livelihoods (insurance, crop changes)

Figure 2.6.1: Recent studies in the UK on specific flood events and mental health; Source: Edwards (2014)

2.5.1 Mental Health and Climate Change in the UK

By Timothy Taylor

The case study will develop a methodological framework to assess costs and benefits of cross-sectoral adaptation strategies to reduce the impacts of climate change on mental health in the UK. It will focus first on the identification of climate change impacts on mental health, drawing on a review of the secondary literature and statistical analysis of secondary data, drawing on GIS methods. We will then attempt to identify potential adaptation options and conduct cost-benefit analysis if possible, or evaluate evidence as to the cost-effectiveness of alternative interventions.

Methodological approach

As in the case for the case study on adaptation to health risks in Cornwall, in this case study we adopt a "science-first" approach. First, we attempt to identify the likely linkages between climatic variation and mental health, before identifying possible adaptation options.

Key steps include:

- Review of literature on climate change and mental health risks
- Statistical analysis of effects of climatic variability on mental health – drawing on secondary data on prescriptions, hospital admissions and climate
- Valuation of impacts – drawing on existing literature on costing mental health impacts
- Identification of adaptation options
- Assessment of adaptation options using cost-benefit analysis

Key stakeholders to be engaged in this case study include the following:

- National Health Service – especially the National Sustainable Development Unit;
- Mental Health Trusts;
- NGOs, e.g. MIND;
- National Farmers Union (NFU);
- Patient groups; and
- General practitioners.

Impacts

The case study will focus on major likely climate change induced mental health risks. To establish the likely mental health risks, we first review existing literature on climate change risks in the UK. We plan to exploit secondary data on mental health in England to estimate the potential impact of climate change, looking at data on presciptions and hospital admissions. We will examine the spatial variation and the impact of climatic variation. We will then attempt to value the impacts and identify adaptation options. Adaptation options will be assessed using cost-benefit analysis where possible.

2.5.2 Human Health Climate Impacts in Cornwall

By Timothy Taylor

The case study will develop a methodological framework to assess costs and benefits of cross-sectoral adaptation strategies to reduce the impacts of climate change in Cornwall, UK. It will focus on local plans for adaptation to climate change. We provide a pragmatic approach to identifying, estimating and comparing the costs of the main adverse climate change impacts on human health. This case study will be used as a mean to explore potential tools for decision-making, drawing in particular on the tools of cost-benefit analysis and multi-criteria analysis.

Cornwall is a county located in the far South West of the United Kingdom. It has a population of 532,300. Cornwall is characterized by a mild climate, but has experienced several major extreme events in recent years, notably incidences of flash flooding in Boscastle and major coastal flooding due to storm surge in early 2014.

Methodological approach

The IPCC Fourth Assessment Report identified several ways that climate change impacts, adaptation and vulnerability assessments are being integrated into decision making. These are summarised in table 2.6.

Important to note from this is that the way climate change is integrated into decision making, has implications for the methods used to analyse policy. Figure 2.13 illustrates the difference in approach – with the important distinction being that two types of methods (adaptation and vulnerability approaches and risk management approaches) start from the definition of policy.

The UK Climate Impacts Programme and a number of other assessments have started from the science – first identifying impacts and then assessing the risks and adaptation options needed. Ranger et al. (2010) argue that under this approach, often when adaptation options are assessed in practice one has to repeat the risk analysis because of missing data – however, it is likely in whatever case the analysis will be iterative given the stream of new information on climate change impacts and new information on key parameters such as costs.

In the case study on adaptation to climate change related health risks in Cornwall, we will broadly adapt a “science-first” approach.

Table 2.6.1: Approaches to integrate climate change into decision making

Method	Description	Implications for design of policy
Impact based approaches	Evaluate impacts and then use as basis to identify adaptation options. Has a science first basis.	“Science-first” approach
Adaptation and vulnerability based approaches	Starts from the processes of enhancing adaptive capacity, independent of assessment of climate risk. Approaches identified enhance robustness to climate changes or shocks.	“Policy-first” approach
Risk management approaches	Focuses on decision making and offers framework for incorporating all approaches – and explicitly considers uncertainty.	“Policy-first” approach

Source: Based on Ranger et al (2010)

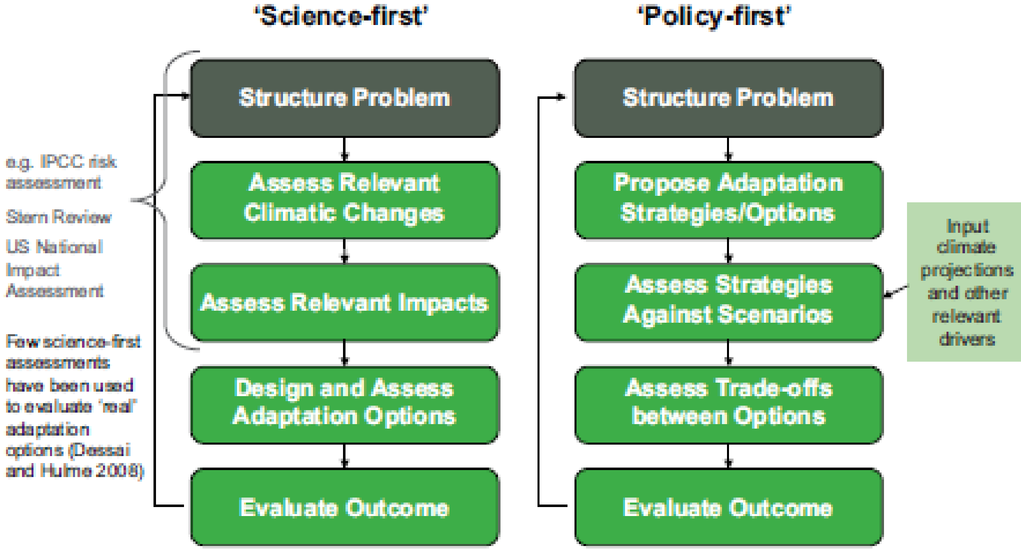


Figure 2.6.2: Comparison of "science-first" and "policy-first" approaches

Source: Ranger et al (2010), based on Dessai and Hulme (2008)

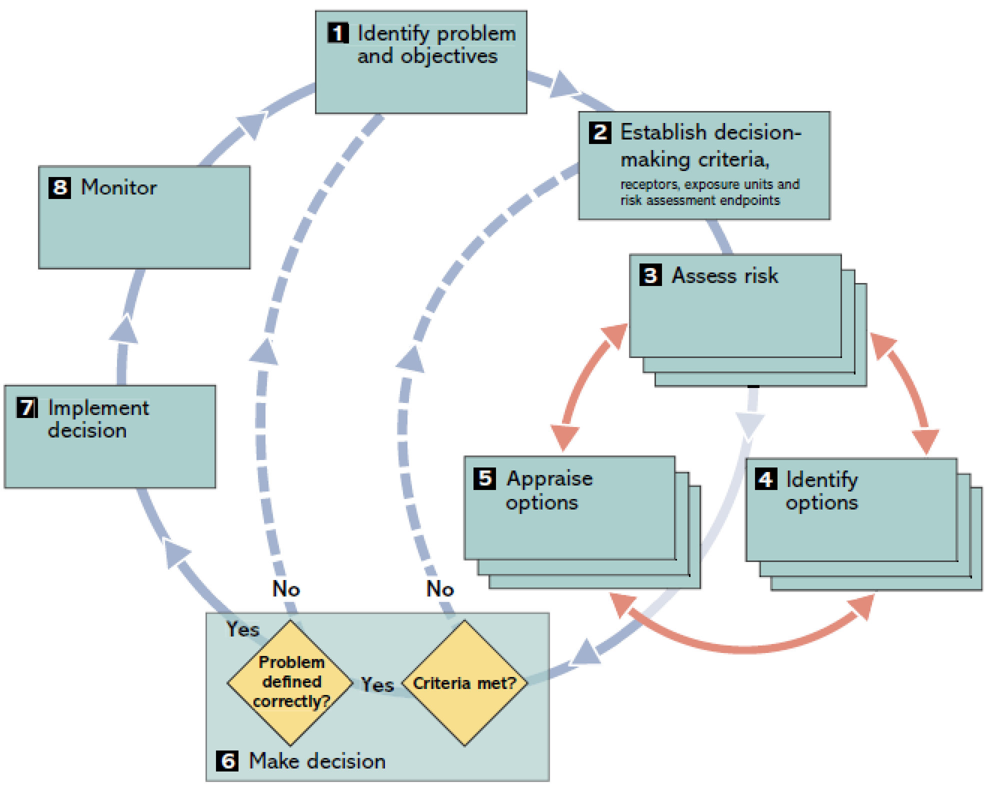


Figure 2.6.3: UKCIP framework to support good decision making in the face of climate change risks

Source: Willows and McConnell (2003)

Stakeholders involved:

Key stakeholders to be engaged in this case study include the following:

- Cornwall Council – a unitary authority with responsibilities for public health, environment, planning and provision of other key services. Stakeholders within Cornwall Council will include:
- Environment division – with responsibility for climate change adaptation planning;
- Public Health – with responsibility for public health interventions. Public health has recently been moved into the council from the NHS;
- Planning – with responsibilities for spatial planning and the local plans;
- Royal Cornwall Hospitals Trust, the major provider of health care in Cornwall. The Royal Cornwall Hospitals Trust is part of the National Health Service;
- Cornwall Health and Wellbeing Board;
- University of Exeter Medical School – which has a major teaching hub located in Cornwall;
- Patient groups; and
- General practitioners.

Impacts

The case study will focus on major likely climate change induced health risks. To establish the likely health risks in the Cornish context, we first review existing literature on climate change risks in the UK, before attempting to estimate the likely impacts in Cornwall and identify potential adaptation options.

An overview of health climate impacts in the UK:

Two recent reports provide a useful overview of the impacts of climate change in the UK, and it is on the back of these that we are constructing the case study on health. The first, the UK Climate Change Risk Assessment identified and, importantly, placed monetary values on a range of health outcomes (Hames and Vardoulakis, 2012). This study showed the following:

- The importance of reductions in cold based mortality (with estimates that by the 2080s these might be worth £1 billion);
- That heat based morbidity is likely to be more significant than increased heat based mortality;
- Flood related morbidity and mortality is likely to be lower in magnitude than the above in terms of costs; and
- That skin cancer cases are likely to rise, leading impacts between £10 to £99 million by the 2080s.

The second study, Vardoulakis and Heaviside (2012) brings together a range of studies on the impacts of climate change on health. This study considers the following impacts:

- Impacts of temperature on human health;
- Impacts of changes in air pollution under different scenarios;

- Impacts of aeroallergens on health under climate change;
- Impacts of climate change on health through the indoor environment;
- Impacts of changes in ultraviolet radiation;
- Impacts due to flooding;
- Impacts due to vector borne diseases
- Co-benefits due to emissions reductions
- Quantifying impacts of climate change on health in Cornwall

Case Study Research and Adaptation

We have drawn on the CCRA and HPA work to identify, initially in qualitative terms the impacts on health in Cornwall. An overview is shown in **Table 2.6.2**

Until recently it has been assumed that climate change will decrease winter mortality in temperate countries as winters warm (Hames and Vardoulakis, 2012). Two recently published articles have shown that winter warming will not decrease winter mortality, one in the UK (Staddon et al. 2014) and one in the USA (Ebi and Mills 2013). Furthermore the increase in winter temperature volatility and the possibility of increased cold spells (Hames and Vardoulakis, 2012), increased severity of temperature drops, occurrence of earlier cold spells, could all lead to increase in winter deaths despite generally warmer winters. This makes the prediction of how climate change will impact winter deaths very uncertain. Currently, Cornwall has over 300 excess winter deaths per year, which is similar to the national average (NHS 2012). This is because despite a higher proportion of elderly residents, an older housing stock, and a relatively high level of fuel poverty, Cornwall has a generally milder winter climate, and escapes a proportion of cold spells suffered by the rest of the country. A decrease in excess winter deaths will be more dependent on progressive welfare and equality policies than on climate change.

We may anticipate a particular increase in the occurrence of skin cancer in Cornwall. This will arise due to the combined effects of several mechanisms including increased summer irradiance, increased UV effectiveness, and changes in human behaviour. First, warmer and drier summers with potentially less cloud cover will significantly increase average irradiance in the summer months, and in addition there will be a lengthening of the summer season from 3 months (June-August) to 4 months (mid May-mid September) (UKNEA 2011). Second, the effectiveness of UV in causing skin cancer is highly temperature sensitive and increases by ca. +5% for each 1°C rise in air temperature (van der Leun and de Gruijl 2002), meaning that by 2050-2080, the UV effect would have increased by at least 10%. Third, changes in human behaviour as a result of a warmer and more agreeable climate and weather, will result in greater time spent on outdoor pursuits including sun bathing. It is worth noting that the incidence of skin cancer has doubled since 1970 primarily as a result of such altered behaviour (Quinn et al. 2001).

In terms of heatwaves, in the 2003 European heatwave Cornwall was less affected than other areas of the UK, such as the South East, but nonetheless exhibited a significant number of excess deaths, especially amongst the elderly. Thanks to its location as a peninsula jutting into the Atlantic Ocean, Cornwall will suffer less from this aspect of climate change than other regions, but the health costs may nevertheless be substantial.

Table 2.6.2: Overview of likely impacts of climate change in Cornwall

Health impact	Probability of increase
Heatwaves	Certain
Skin cancer	Probable
Winter excess deaths	Unlikely
Flooding	Certain
Storms	Possible
Wildfires	Probable
Drought (mental health)	Probable
Water quality	Probable
Water borne disease	highly probable
Food quality	Probable
Food borne disease	Probable
Tick borne disease	highly probable
Mosquito borne disease	(highly) probable
Other vector borne disease	possible/probable
Hayfever	highly probable
Asthma	highly probable
Other respiratory disease	Probable
Green tides	possible/probable
New risks	Probable

Future work includes quantifying these impacts in physical terms, drawing on the estimates from the CCRA and informed expert opinion on the likely effects on health in Cornwall.

In order to cost the impacts of climate change on health in Cornwall, we have pulled together a range of values for different health endpoints identified. Then values are presented in **Table 2.6.3**.

Table 2.6.3: Values for Health Endpoints

Health Endpoint	Value (Range)	Source
Heat based mortality	£60,000 for a life year, 4 months mid point (2-6 months)	Defra (2007) – IGCB Hames and Vardoulakis (2012)
Heat or cold morbidity	£625 for a Hospital Admission (350-900 range)	Defra (2007) – IGCB
Flood and storms mortality	£1.49 million for the VPF	Defra (2008) Defra Flood and Coastal Defence Appraisal Guidance: Social Appraisal
Floods morbidity	Cost of treatment: £970 per depressed person, assume 10% depressed if flooded	Hames and Vardoulakis (2012)
Ozone related mortality	£16,090 for a life year in poor health, 4 months mid point (2-6 months)	Defra (2007) – IGCB Hames and Vardoulakis (2012), 2010 prices
Cold based mortality	£33,800 for a life year, 6 months	Defra (2007) – IGCB Hames and Vardoulakis (2012), 2010 prices
Non-fatal injuries	£72,338 on average	Hames and Vardoulakis (2012), 2010 prices
Skin cancer	Cost of treatment: £841.75 Cost of mortality: £1.49 million for the VPF	Hunt (2011), with adjustment for exchange rate
Depression	£970 per case	Hames and Vardoulakis (2012), 2010 prices based on Bower et al (2010)
Lyme disease	Cost of treatment: £1129 per case	Based on Scottish treatment costs
Asthma	Cost of illness: £199.20	Based on Ayres et al (2010), adjusted for inflation
Hayfever	Cost of illness: £985.83 (moderate/severe)	Based on transfer from Germany – Schramm et al (2003), adjusted for inflation and exchange rates
Colon cancer	Cost of treatment: £52,123 Productivity loss: £3,685 Disutility: £712,592 Total: £768,401	Mean value of lung cancer and leukemia based on Hunt (2011), with adjustments for exchange rate and PPP GDP where appropriate
Gastroenteritis	Cost of illness: £28.49 Pain and suffering: £49.14	Dwight et al (2004), cited in Hunt (2011) and adjusted for exchange rate Hunt (2011) based on Barton and Mourato (2003) and Machado and Mourato (2002) and adjusted for exchange rate and PPP GDP

Heat warning systems

Cornwall is part of the national UK heat warning system and has plans in place to address extreme heat events.

Education and Monitoring

Providing education about climate change risks and how to prepare for them is maybe the most cost effective way of minimising health impacts of climate change. However, education on its own will not be the answer to all the health risks, although it is probably the most important single preventative action that can be taken to tackle a wide of range of issues. These include: coping with heatwaves by keeping cool and avoiding dehydration; minimising UV exposure by covering up more to prevent skin cancer; checking for and removing ticks after outdoor activity to reduce the risk of Lyme disease transmission; and awareness of bathing risks from exotic marine visitors such as jellyfish and sharks.

Monitoring of risks is a key area in health protection and crucial for the efficacy of preventative measures aimed at minimising the impact of these risks on human health. Monitoring can provide information allowing individuals to minimise their exposure to the risk in question. Classic examples of this would be monitoring of air pollution and pollen concentration. Monitoring is also particularly useful in keeping track of intermittent or emerging threats. This can include monitoring of vectors and pathogens in the environment, of algal blooms and biotoxins in seafood, and of wildfire occurrence. Monitoring of harmful algal blooms (HABs) will become more intense in the future to maintain the safe exploitation of seafood, especially shellfish. Cornwall with both its large fishing and tourism industry will require sound monitoring of HABs to prevent mass seafood poisoning (Marques et al. 2010). Sections of coasts will have to be declared off limits for shellfish collection occuring more frequently than currently. Monitoring of vectors and diseases will need to include not only endemic risks but also potential emerging risks, either as a result of range shifts or novel disease. Checking for the occurrence of vectors and diseases normally present further south should not pose much problem. However, checking for novel diseases covers a very broad in scope. One area to focus on would be zoonoses (Akhtar et al. 2009), especially those associated with farm animals and pets. Indeed many of the recent disease scares have zoonotic origins including avian and swine flu, SARS and West Nile virus.

Risk Control and Regulation

The methodology for controlling the risk of a particular climate change impact, where the risk is clearly manageable, is highly dependent on what the risk is. The scale of the endeavour may range from large infrastructure projects for flood control, to pest control for disease carrying insects. Flood control is in most cases the first, and often only, thing that local government and local communities in Cornwall will put forward as proof they are adapting to climate change. The interesting point here is that it is something that is already viewed as important by the population as it is already affecting them. Coastal defences in Cornwall generally require the height of the defences to be increased or other measures to be taken to cope with rising sea level and potentially increased frequency of storms. Cornwall is also particularly vulnerable to flash flooding due to the landscape and to the location of many of the smaller villages and towns. Controlling flash flooding is in some ways more complex, but arguably less expensive. A key requirement for controlling flash flooding is to take a landscape view (Opdam et al. 2009). Flood control work around Pickering in North Yorkshire (Forestry Commission 2010) highlights some of the actions that can be taken including tree planting and blocking of gullies with natural debris to slow flood water.

Farm runoff control will become more of a health issue as climate change progresses (Boxall et al. 2009). Controlling runoff adequately will be a central environmental concern for Cornwall in the coming decades especially as climate change will worsen runoff from agricultural land. Cornwall could learn how to minimise storm runoff from regions further south in Europe. For example, Provence, southern France, has long dry summers with often very violent rain storms, but does not suffer regular flash floods due to structures created to collect storm waters. Brittany, on the other hand, can illustrate how ignoring farm nitrogen runoff can lead to nefarious environmental effects (e.g. green tides), which can destroy local tourism (Morand and Merceron 2005).

Mosquito control was crucial in eradicating endemic malaria from much of Southern Europe. Mosquitos were successfully controlled in the 1930s/1940s by a policy of spraying and drainage of suitable habitats (Dezuluet 1973). Although suitable habitats are relatively rare now in the UK, including Cornwall, there is a momentum for recreating wetlands and marshlands both for recreational and for ecosystem service purposes (Hughes and Paramor 2004). The balance between controlling mosquitos and land use changes inadvertently creating mosquito habitat is an area that will need addressing in the future.

Pollen control is receiving greater attention both as a result of the impact of certain agricultural crops on allergy sufferers and because of the greater creation of green space in urban areas, which often leads to increased levels of urban pollen. An understanding of the impacts of crops or green space plants in towns and cities on pollen production must be a first step in preventing negative impacts on human health. A good example of where this would have been useful from a health perspective is the planting of birch trees (*Betula*) around Milan. Birch trees were planted to enhance the city, however this caused a sharp increase in the prevalence of hayfever and asthma (Asero 2004). Climate change will result in plants shifting their range northwards and increase the spread of invasives, such as ragweed (*Ambrosia*). Controlling the spread of the plants involved, and preparing for the effects of increased pollen will require good monitoring and warning systems in place.

In the context of limiting the impacts of climate change on human health, regulation has several facets, including planning and building regulation, environmental pollution control, and food and water safety standards. Local government has control over local development and as such is in the position to make sure that new builds and redevelopments are adapted to, or at the very least have in-built capacity to adapt to, the predicted future local climate. In Cornwall, care should be taken to limit developments at risk of flooding. In addition planning considerations should be made with regard to land use changes, especially in the uplands, to limit and slow excess water runoff after storms. Recent moves to integrate public health into the Local Authority may help to promote such policies.

Environmental pollution control should be reassessed and if necessary reinforced to cope with climate change impacts. This is both true for air and soil and water pollution. In Cornwall, air pollution has local specificities including traffic pollution in 'canyon' streets, and clay dust pollution from the China clay industry in central Cornwall (Parsons et al. 2003). Along with increasing surface ozone, a warmer climate will exacerbate these issues. Soil and water pollution in Cornwall is mainly due to agricultural runoff and will increase under climate change unless stricter regulations are put in place. Water and food safety standards are high in the EU and prevent many potential health risks. However, as more research demonstrates new health risks, especially in relation to agricultural compounds, these standards will also need tightening.

Adaptation Assistance

Most communities will require guidance from central and local government or national organisations in adapting to climate change. In Cornwall, in addition to the focus on standard vulnerable segments of the population, there are three key industries which will be impacted most by climate change: agriculture, fisheries and tourism. Tourism as a whole could reap vast rewards from a more clement climate, however there is the possible that certain tourist areas could be hard hit by climate change impacts, including more frequent flooding and possible green tides. The destruction of local tourism could lead to big increases in mental health problems unless help is at hand to assist the affected communities to adapt. Fisheries could also greatly benefit from a warming climate, however some fisheries workers could find themselves unable to adapt to the new conditions. In addition there is the increased risk from HABs which could decimate local fisheries (Hoagland et al. 2002). Cornwall must be able to assist its fishing communities in adapting to new climate change realities. The Cornish farming sector is possibly the community at greatest risk from climate change impacts. This is not to imply that climate change won't bring benefits in terms of longer growing season, but that there will also be large downsides. The climate for Cornwall is predicted to become more variable (Hames and Vardoulakis 2012), which means greater uncertainty for farmers and greater risk of crop or animal losses. Assistance must be made available to farmers to better understand the risks and be better prepared for the predicted climate change. Helping farmers adapt to the increased uncertainty must be viewed as a priority in light of the fact that farmers already suffer from a higher than average level of mental ill health (Simkin et al. 1998).

2.5.3 Madrid

By **Sébastien Foudi**

Introduction

The case study will develop a methodological framework to assess costs and benefits of cross-sectoral adaptation strategies to reduce the impacts of heat waves in the area of Madrid. The analysis will focus on the co-benefits of a set of adaptation measures. The area of Madrid has been chosen as a case study due to its multiple vulnerabilities due to climate change, its large size and population. The study will identify measures with cross-sectoral co-benefits, assess their costs and benefits, and develop collaboration with relevant stakeholders with authority or interests in the city of Madrid.

This case study will be used as a mean to explore potential tools for decision-making able to provide information to plan effective adaptation. According to Füssel (2007), effective adaptation is realized by evaluating the co-benefits of adaptation, which will increase the perceived benefits of the measures to be implemented. He argues that co-benefitting in this sense means making the most efficient use of resources, e.g. identifying existing adaptation measures in place or including adaptation criteria into existing activities or processes, thus reducing costs; or motivating the provision of additional resources. Adding to this, Harlan and Ruddell (2011) argue that one of the biggest challenges in city plans is calculating the cost-benefit ratio of adaptation measures. However, identifying and calculating co-benefits are one of the most effective ways to prioritize adaptation measures.

Methodological approach

In order to accomplish the above, we have designed a specific methodology as follows (see Fig. 15). In Step 1, we improve the understanding of the linear and non-linear cascading effects that can be caused by climatic impacts, i.e. the primary, secondary and tertiary effects related to heat waves and droughts on health. This information is used in Step 3 to maximize co-benefits of planned adaptation measures, which will be identified with the stakeholders beforehand.

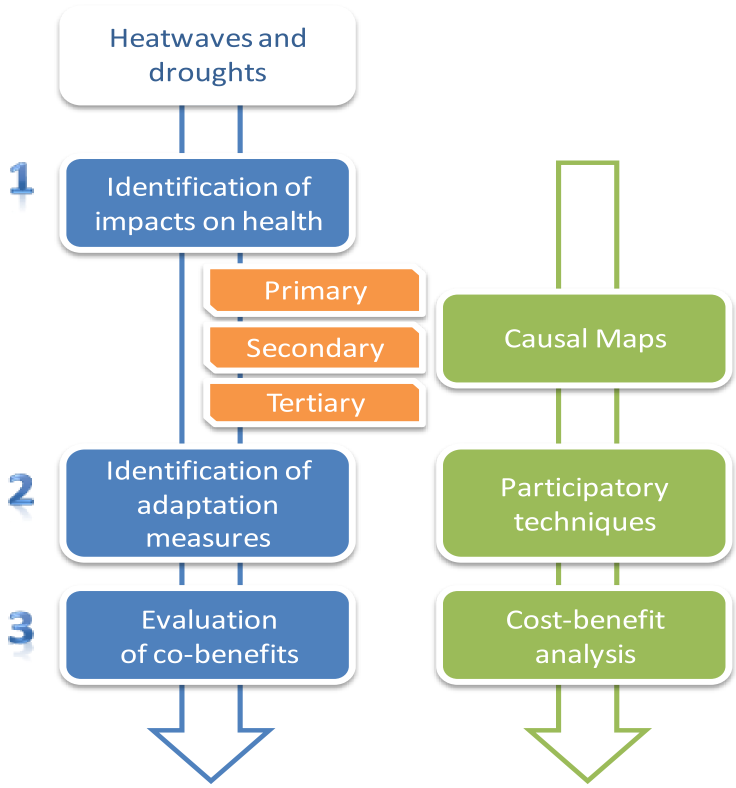


Figure 2.6.4: Methodological approach

Stakeholders involved

As earlier mentioned, the work to be developed in the case study involves a participatory process in which stakeholders with competences or interests in the city of Madrid. In a first step, a stakeholder meeting has been organized with the partners of this case study. This first meeting involved stakeholders from the Spanish Ministry of Health, Social Servies and Equity, Madrid municipality, Madrid community (regional level), the Spanish Climate Change Office, the Health Department of the Goverment of Navarra, the water utility foundation Canal Isabel II, a union of farmers, the electricity company Iberdrola, experts from the Autonomous Univerasity of Barcelona and Politecnic University of Madrid. A second step will involve an extension of the stakeholder map including technicians or representatives of urban planning department of the city of Madrid, urban design and urban greening experts, health experts and others to be identified. Those will participate in the development of a causal map.

Case study

With a population of 3.3 million people, Madrid is the third largest city in Europe (after London with 7.4 million and Berlin with 3.4 million) and the one with the largest below poverty population. The metropolitan area of Madrid includes 6.5 million people and ranks 18th in the world global cities. Madrid is already experiencing severe impacts of drought; during 2011-12, there has been a period of 7 months without rain and the reservoirs that provide urban water are below minimum. The prospect of using strategic ground water or building additional reservoirs is a threat to ecosystems. Furthermore, Madrid is in the Tagus River Basin, a transboundary river that supplies water also to Lisbon, a city with 0.5 million people. This case study will address adaptation of urban health and wellbeing and its cross-sectoral co-benefits.

An overview of health climate impacts

In the Spanish context, important research was published with the report 'Global Change in Spain, 2020/2050: Climate Change and Health' (ISTAS, 2012). This report covers the main climatic impacts and their health effect specifically relevant for the Spanish region given the experienced and expected impacts. As a result the following impacts have been considered significant:

Table 2.6.4 Climate Change potential effects in Spain and related health risks.
Source: (ISTAS, 2012)

POTENTIAL EFFECTS OF CLIMATE CHANGE IN SPAIN	ASSOCIATED HEALTH RISKS
EXTREME EVENTS	
Increased frequency, duration and intensity of heat waves	Increases in heat related deaths, especially from cardiovascular and respiratory problems, with particular effects for the elderly, the infirm and the weak.
Possibility of significant cold snaps	Increased cold related deaths, from cardiovascular and respiratory problems (though to a lesser extent than from heat), affecting particularly the elderly, the infirm and the week, including children and young people.
More frequent droughts	Impact on mental health Increases in outbreaks of waterborne diseases Increases in outbreaks of food-related diseases Greater risk of forest fires (respiratory and cardiovascular problems) Problems in agricultural production: higher prices and shortages of basic foodstuffs in extreme cases
A tendency for more episodes of torrential rain and subsequent flooding	Direct effects: drownings, injuries, diarrhoea, vector-borne diseases, respiratory infections, skin and eye infections, mental health problems Damage to supply systems (deterioration in the quality of drinking water) and sewerage systems, crops, housing, living conditions and the mobility of the population Damage to health care system provisions and amenities

WATER AND FOOD	
Contamination of water supplies and water used for recreational purposes Reduction in net water offtakes and increased demand	Increases in outbreaks of seasonal waterborne diseases Increased exposure to biological and chemical pollutants
Impact on the distribution, seasonality and transmission of food-related diseases	Increases in food-related diseases
Increases in the transporting and dissemination of human agents from inland areas towards coasts and estuaries (as a result of storms and flooding) Changes in environmental and oceanographic variables (temperature and salinity) Flourishing of toxic algae and bio-accumulation in marine products for human consumption	Contamination of marine products (by toxins and marine pathogens and by human and animal pollutants) Food poisoning related to the conservation of marine products
VECTORS	
Changes in vector capacity Appearance of potential breeding sites (after extreme rainfall)	Changes in the incidence and distribution of vector-borne diseases
ATMOSPHERIC POLLUTION	
Increased concentrations of some pollutants in the ambient air, which are especially significant in the cases of suspended particles and ozone	Increases in hospital admissions: respiratory diseases, cardiovascular diseases * Increases in the death rate * *Future regulations to control ozone and PM2.5 particles are highly influential here
POLLEN	
Increases in the production of pollen and fungal spores Longer pollen seasons Potential changes in the geographical distribution of species that produce allergenic pollen	A worsening in respiratory and allergic problems such as allergic rhinitis and asthma
UV RADIATION	
Increased exposure to UV radiation	Cancer and other skin diseases, cataracts, eye damage Effects on immunological systems

In particular, this report highlights that heat waves in Spain will have an impact on mortality, especially cardiovascular and respiratory and significantly in old, sick or weaker people. Also that droughts, will impact mental health and water and food born diseases. As indirect impacts, a higher risk of forest fires will increase cardiovascular and respiratory problems and that agrarian productivity problems may lead to an insufficiency of basic food provision in extreme cases.

The comfort temperature in the Community of Madrid has been calculated as 20,3 °C considering 24 hours average daily temperatures (ISTAS, 2012), and it has been also evidenced that in Madrid, delayed effects of high temperatures can come between 1 and 4 days after the heat stroke (ISTAS, 2012). In contrast, cold waves effects have longer term effects than heat waves. In Madrid, mortality due to cold waves has been determined between

7 and 14 days after the extreme temperature in the case of circulatory diseases and between 5 and 11 days in the case of respiratory diseases (ISTAS, 2012).

According to D'Ippoliti et al. (2010) the influence of heat waves on mortality shows great geographical heterogeneity among cities. They found that, "considering all years, except 2003, the increase in mortality during heat wave days ranged from + 7.6% in Munich to + 33.6% in Milan" (D'Ippoliti et al., 2010, p. 37). The study of Diaz et al (2002) in Madrid on heat waves from 1987 to 1992 indicated an increase in mortality up to 28.4% for every degree the temperature rises above 36.5 degrees C, and worse effects associated to circulatory disease-related mortality on women over the age of 75. Also, they found that "low relative humidity enhances the effects of high temperature, linking dryness to air pollutants, ozone in particular". Later studies (Garcia-Herrera et al., 2005) indicate that a 21% increase of mortality is given in Madrid with each degree above 36 degrees C.

The last report from the Spanish Government developed by the Ministry of Health, Social Services and Equity (Spanish Government, 2013) highlights that the main climate change effects on health in Spain are related to extreme temperatures, water quality, air quality and vector-borne diseases. The effects of climate change on health can have multiple paths as illustrated by De Sario et al. (2013) (see **Figure 2.6.5**):

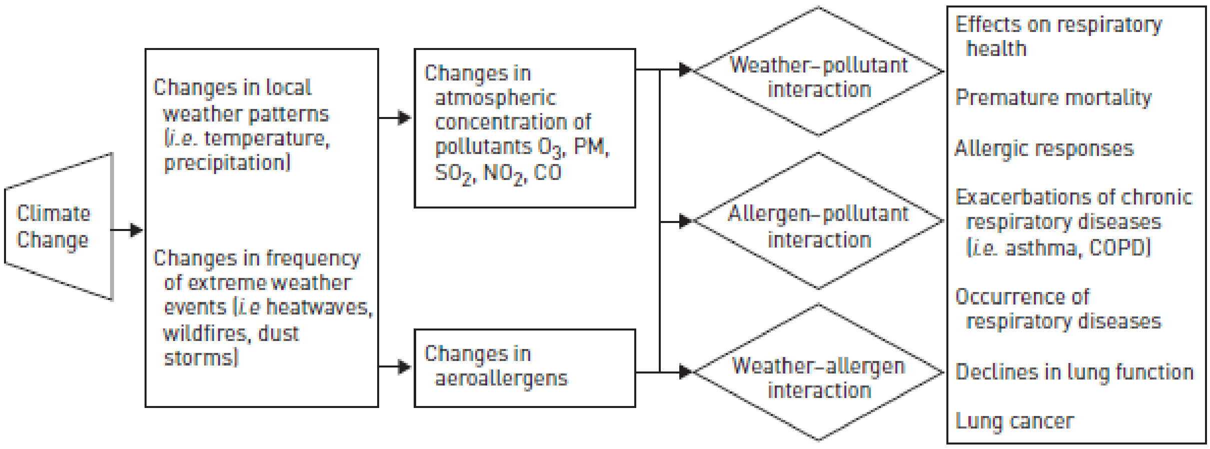


Figure 2.6.5: Climate change: its influence on extreme weather events, air pollution and aeroallergens, and effects on respiratory health. PM: particulate matter; COPD: chronic obstructive pulmonary disease. Source: De Sario et al. (2013)

As an example, high temperatures in Europe and the Mediterranean are accompanied by African South wind and dust storms (De Sario et al., 2013), and this also applies to Madrid (Garcia-Herrera et al., 2005). This increases the particulate matter. Studies in Madrid show that an increase of PM10 only on dust days has significant effects on all-cause, cardiovascular and respiratory mortality (Jiménez et al., 2010).

Regarding the allergies, according to the Global Change report (ISTAS, 2012), there is a significant seasonal peak of asthma-caused hospitalizations (between May and June) in the Spanish regions located at the heart of the peninsula such as Guadalajara, Madrid, Toledo, Valladolid, Salamanca and Badajoz. The quick transitions from cold to warm temperatures, rain scarcity and the coincidence with the pollen season, are the cause of the increase in pollen induced allergies. Not many others studies have been developed in the region of Madrid though regarding other types of impacts (De Sario et al., 2013), to our knowledge.

Preliminary results

Causal Maps

As an input for the stakeholders' meeting (see following section), a preliminary causal map was developed showing the main health impacts cause by climate change mainly related to heat waves and droughts. This work was done jointly with the team responsible for the water related impacts in the case study (see section 2.7/2.7.1 Water Resources). **Figure 2.6.6** shows the identified main impacts of droughts, extreme rainfall and heatwaves. **Figure 2.6.6** shows the causal map preliminary version of the main climatic changes and their impacts affecting the city of Madrid.

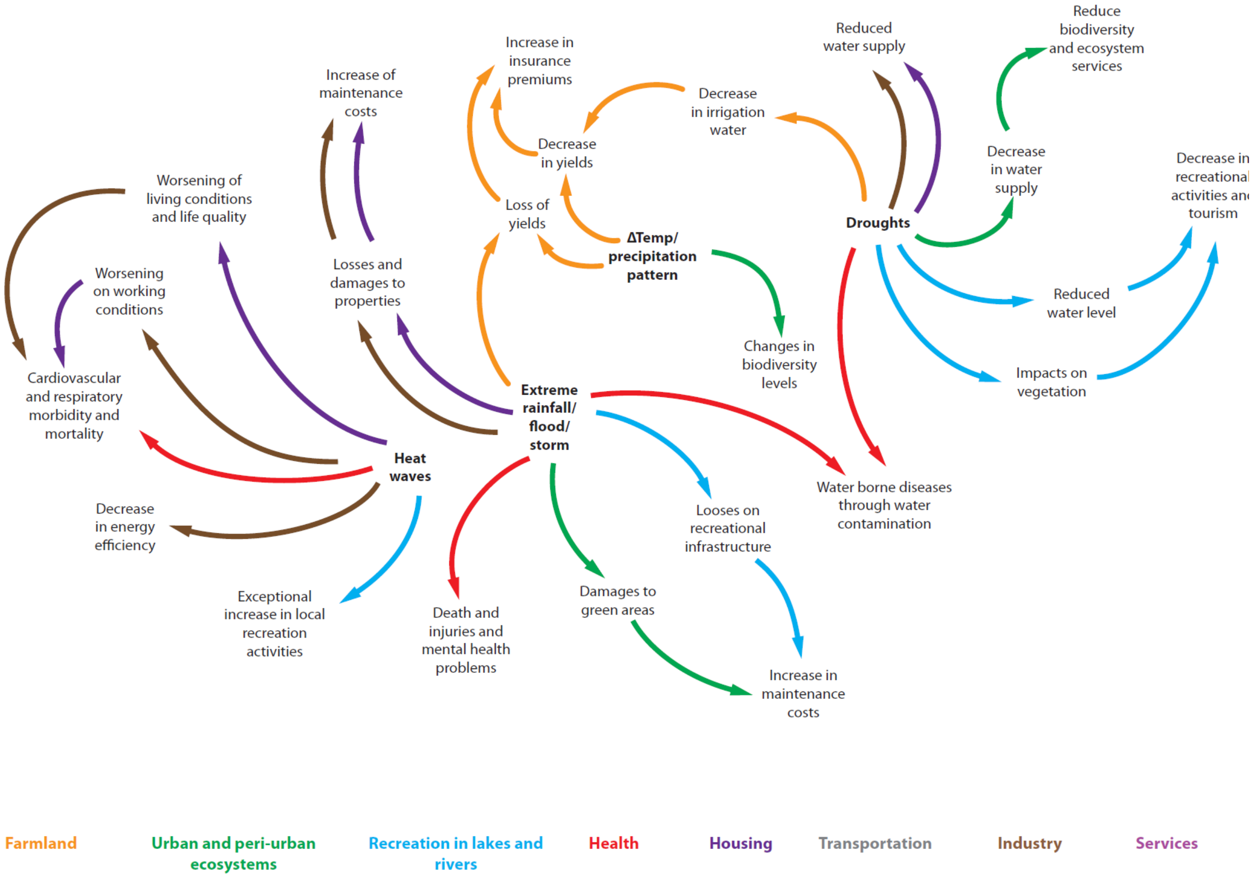


Figure 2.6.6: Causal map of the main climatic changes and their impacts affecting the city of Madrid: preliminary version

Results from stakeholders meeting: potential climate impacts on health

In this meeting, three potential risk areas as regards the impacts of climate change on human health were identified by the stakeholders: (i) Biological risks such as new vector-borne diseases, (ii) Physical risks such as heat-waves and cold snaps and (iii) Chemical risks such as atmospheric pollution and increased concentrations of contaminants in water.

Changes in the hydrological cycle as a result of climate change will result in a reduction in water resources and in the quality of those resources, and an increase in extreme events. Both these changes will have consequences for human health. The expected increase in extreme events will affect supply infrastructures, and may cause cuts in supply, so that the population finds it difficult to access good-quality drinking water. Climate change will also have consequences for food security and the availability of food in sufficient quantities and qualities. These effects may compromise consumers' choice of foods and result in changes in eating habits. Another possible impact is the increased risk of chemical and microbiological contamination of foodstuffs. Another possible impact of climate change is a change in the pattern of diseases originating from foodstuffs. For example, higher temperatures will mean a greater need to refrigerate foodstuffs and a greater proliferation of legionella bacteria. Increases in the area of crops for the production of biofuels will also reduce the resources available for the production of foodstuffs.

Adaptation policies and plans

Spain adopted in 2006 a **National Climate Change Adaptation Plan (*Plan Nacional de Adaptación al Cambio Climático –PNACC-*)** (MARM, 2006). This plan is the instrument that sets the approach and guidelines on adaptive action in the country so far. As the national reference framework, it was approved by the Climate Change Policy Coordination Commission and the National Climate Council. In this plan the health sector has been identified as priority for sectorial evaluation in their second work programme. According to De Gregorio et al. (2014), this instrument emerged to respond to the high vulnerability of the Spanish territory to the impacts climate change "by providing a reference framework for the coordination of Public Administrations in the activities of impact assessment vulnerability studies and adaptation to climate change" (2014, p. 23).

Many initiatives have been launched within the framework of the PNACC. For example, **the Climate Change Health Observatory** is created within this framework as an instrument to analyse, evaluate and track the effects of Climate Change on public health and on the National Health System, allowing the execution of adaptation policies to reduce the Spanish population's vulnerability to climate change (Spanish Government, 2013). In 2011, in the context of the PNACC, it was also approved a '**Plan of preventive actions of the temperature excess effects on health 2011'**. This Plan establishes measures to be implemented by national authorities, autonomous communities and local authorities. It also establishes criteria to monitor mortality and other kind of information to preventively act against these health impacts. The strategy is based on the following activities:

- Temperature forecast from the data supplied by the Spanish National Institute of Meteorology (AEMET)
- Information to citizens about the effects of excessive temperature.
- Implementation of an information system for mortality and morbidity, for social and health services.
- Coordination of the social services in order to identify the vulnerable population, like childrens, elderly people.
- Emergency planning system, for first aid or hospital assistance.
- Coordination of the admisnistratives and public authorities and the private sectors.

Additionally, the recently published report on 'Impacts on health of climate change' (Spanish Government, 2013) reviews the main impacts on health applicable to the Spanish territory.

The Autonomous Community of Madrid approved its **Strategy on Air Quality and Climate Change** (2006-2012) in 2007 (Comunidad de Madrid, 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 **Climate Change Network of Spanish Municipalities** (*Red Española de municipios contra el Cambio Climatico,* RECC)) in 2005 and the CoM (Covenant of Mayors) in 2008. The **Plan of Sustainable Energy Use and Climate Change Prevention** (*Plan de Uso Sostenible de la Energía y Prevención del Cambio Climático*) 2008-2012, was approved in 2008 as a requirement to join the CoM (Madrid City Council, 2008). The plan specially focuses on health issues within the measures regarding adaptation. It recognises the adverse effects of climate change on health of extreme temperatures, extreme events, 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 consequences of the European heat waves of 2003 raised the awareness of the necessity to implement prevention plans to face heat wave risks. Before 2003, Rome and Lisbon were the unique cities to have such a plan. Therefore, in 2004 the Community of Madrid initiated a **Plan of Alert and Prevention of Heat Waves Risks**. The main objective of the plan is to reduce the mortality and morbidity impacts of unsual increase in temperature. The plan consists in improving the information given to citizens about prevention measures and to professional health services and social authorities. This plan is activated annualy from the 1st of June to the 15th of September. The warning system of this plan has defined the threshold of alert, based on the scientific literature described previously. In Madrid, the threshold has been estimated at 36.5°C, threshold above which mortality increases significantly. A second threshold is estimated at 38.5°C, where mortality increases deeply (Communidad de Madrid, 2013).

The plan of the Community of Madrid defines **3 levels of alert**:

- **Normality:** when the temperature of the day and the 4 consecutive days is below 36.6°C.
- **Prudence:** when the temperature of the day or of one the 3 next days is equal or higher than 36.6°C and below 38.6°C with a duration shorter than 3 consecutive days.
- **High risk:** when the maximum temperature forecasted for the day or the 4 next days is equal or higher than 38.6°C or when 4 consecutive days of temperature higher or equal to 36.6°C are forecasted.

The intervention measures are graduated with the degree of risk. In the N*ormal* situation, no specific measure is advised, citizens are informed on the potential impact of high temperature on health (solar radiation effect, etc). In the *Prudence* phase, health services are alerted and citizens receive recommendations for prevention. In the *High risk* phase, in addition of the measures of the anterior phase, direct interventions to vulnerable people are implemented by the health authorities.

T**he temperature threshold definition** is crucial to determine the alert. Potential differences in the definition of meteorological extreme alerts and health alert can have non negligible consequences on human health. Ill-defined alert threshold would reduce the efficiency of the prevention (Linares et al., 2013; Tobias et al., 2012). Moreover, **prevention plans** have fixed date of activation, which can result in significant non prevented cases of death: cases of death occurring before the 1st of June are not covered by the prevention plan and could have been avoided with flexible activation dates. If **climate change** modifies the seasonality of heat waves, prevention plans would have to be flexible enough to target the population during the adequate period of heat

Results from stakeholders meeting: health-related adaptation measures

Regarding the adaptation measures that would be likely to initiative in the short term, the stakeholders reported:

- AIR QUALITY: The Regional Community of Madrid has a solid track record in the monitoring of air quality. For example, emission allowance trading in the region began in 2004. At regional level, Madrid has a strategy in place to monitor air quality with a view to mitigating CO2 emissions. The latest checks show that good levels of air pollution continue to exist, and that the objectives set are being met. The prevailing crisis is another factor that is helping to moderate emissions. The regional government acts as a manager and takes charge of the implementation of measures and day-to-day operations, but is not charged with drawing up specific studies. It stresses the importance of such studies as tools for planning and decision-making, and indicates that is important for studies to be expressed in terms of costs. This quantification of measures is essential to help managers understand problems and make decisions.
    - checks are currently run on nitrogen oxide, ozone and particles.
    - Particles are not currently a problem.
    - Nitrogen oxide levels are decreasing on average throughout the network.
    - Paradoxically, ozone levels are increasing. This is curious because ozone is a by-product of nitrogen oxide: ozone is not emitted directly but rather indirectly due to the effects of solar radiation and high temperatures. It should be studied whether climate change is a factor in this increase in ozone levels.
- NEW TECHNOLOGIES: certain technologies such as biomass (intended to make use of organic matter and reduce CO2 emissions into the atmosphere) may be a problem if it is not monitored in areas with high population densities, as it may give rise to particle problems. Checks need to be made on what type of boiler is used and exactly what is burned.
- FOOD SECCURITY: increased vigilance is necessary to offset increases in potential exposure to chemical and microbiological risks, and to assess palliative measures taken.

Results from stakeholders meeting: perception of costs of health-related adaptation measures

Regarding the perception of costs related to adaptation measures, the stakeholders reported:

- AIR QUALITY: The costs of mitigation measures to improve air quality in cities must be assessed. If such measures are not taken an increase in respiratory diseases can be expected. The measures in question include on the one hand setting up new green areas and improving existing ones, and on the other hand encouraging greater use of public transport on the grounds that it is more sustainable than private vehicles.
    - The costs of adaptation measures for future air quality in cities must also be assessed. These costs include those of setting up air quality monitoring networks. Such networks are intended, among other things, to inform the public of heat waves and poor air quality, and to provide recommendations on how to mitigate their negative effects. Other adaptation costs that must be considered by those arising from the need to develop better predictive air-quality models and climate change bio-indicator systems. Using existing monitoring networks to detect potential impacts and monitor trends entails very little extra cost, because they are already in place.
- WATER AVAILABILITY: There is also a need to estimate the costs associated with measures to adapt to the expected decrease in water resources available in cities. Such measures could include re-using wastewater on green areas, crops and even in homes for some purposes, and conducting studies to assess the risks that this might entail.

2.6 Water Resources

Overview of Impacts and Adaptation Challenges

By Pedro Iglesias

Climate change is a major source of uncertainty for today's vulnerable societies. Prioritizing adaptation policy to these uncertain conditions is a major challenge. This uncertainty is especially relevant for the water sector because it links to agriculture and food security, industry and energy, ecosystems, cities, and culture. Climate change comes in conjunction with high development pressure and increasing populations that is a major challenge for water management.

Deliverable 4.1 defines shared starting points, research practices and questions to be answered in case studies and includes an overview of water management challenges that compares impacts and adaptation strategies for each sector analyzed in BASE. This section summarizes the key aspects included there and shows the linkages between sectors observed in BASE case studies. It is divided in three subsections: direct impacts, challenges and linkages between sectors in case studies.

Drought is a naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems. Droughts occur everywhere; they are recurrent and differ from other natural disasters in their slowness of onset and their commonly lengthy duration. Droughts affect

Water scarcity, which refers to a condition of water resource systems when there is not enough water to adequately supply their demands in a given time horizon. Water scarcity may be temporal, associated to a prolonged or intense drought, or structural, when water demands exceed the water resources exploitable under sustainable conditions.

In water scarce regions, it is also required to predict changes in drought frequency and magnitude. Droughts are critical to design regulated water supply systems in arid regions, and they represent the most demanding conditions for the operation of these systems.

There is a great deal of debate regarding global climate change and its expected results. Patterns and trends show that its effects will ultimately affect water resources availability and thus have an impact on water ecosystems. The consensus is that the effect will accentuate the extremes with more pronounced droughts. If it persists, climatic zones are likely to migrate, leaving the climate of some regions dryer, other wetter, and all more variable and unpredictable. Certain regions dependent on water (e.g. major farming areas, or large population centres) will experience more water scarcity.

Floods are the other side of the expected climate change impacts, in which water covers dry land causing usually an enormous loss of lives and properties. There is low confidence in projections of changes in fluvial floods due to limited evidence and because the causes of regional changes are complex, although there are exceptions to this statement. There is medium confidence (based on physical reasoning) that projected increases in heavy rainfall would contribute to increases in rain-generated local flooding, in some catchments or regions. Earlier spring peak flows in snowmelt- and glacier-fed rivers are very likely, but there is low confidence in their projected magnitude. (IPCC, 2012)

Some specific effects can be linked to areas exposed to water scarcity and drought:

- **Natural water resources**: Hydrological stress is expected to increase in central and southern Europe. For the 2070s, the percentage of surface area under conditions of severe water stress is expected to increase from the current 19% to 35%. Populations living under water stress conditions in regions from 17 countries of Western Europe are projected to increase by between 16 to 44 million. It is also predicted that the volume of certain rivers may diminish up to 80% during summer seasons; reservoirs may lose resources due to decrease of rainfall and droughts frequency will be increased. A reduction of average natural water resources will produce increasingly more frequent and more intense episodes of water shortage. It is also foreseen that climate change will produce alterations in the variability of water resources, intensifying the frequency and magnitude of extreme events, like floods and droughts, which will produce important impacts on the population. (Iglesias et al 2012)

- **Water demand (irrigation, urban supply and industry)**: Climate change is expected to result in an increased water demand; higher temperatures are expected to lead to increased water demand for irrigation and urban supply, hydroelectric potential of Europe may decrease 6% in average and between 20 and 50% in the Mediterranean region. However, industry may not increase consumption of water because of technology efficiency.
- **Water quality:** Climate change will also affect water quality. There are many possible routes of interaction, such as reducing the flow available for pollution dilution, the temperature increase, with consequent changes in the activity of biological processes, chemical modification of the flow of water through the soil, with the alteration of the transport of nutrients and pollutants, and so on. Although there are many processes involved, the results so far point to a likely deterioration of water quality, especially in areas where the natural river regime has been significantly altered (ref).
- **Ecological status of water bodies:** Natural ecosystems will be altered by climate change. Numerous ephemeral aquatic ecosystems in the Mediterranean region are predicted to disappear and permanent ones to reduce in size (ref). In addition to natural alterations, the increase of pressures on consumptive water uses will imply an increased human intervention on the hydrological cycle, which will have additional impacts on the natural environment. It will be necessary to canalize adequately the human intervention to minimize environmental impacts, tending towards a new equilibrium situation consistent with the modified climate, since it would not be reasonable to counteract the effects of climate change by means of the artificial conservation the existing ecosystems before the change. The challenge of environmental management consists on anticipating the negative effects of climate change by means of the analysis possible scenarios and on adopting management strategies that are positive in the current situation and do not worsen the situation in case of adverse climate change.

Challenges to water management

Climate change is only one of many pressures faced by water management today and in the future. However climate change is a very significant pressure since it has a direct impact on all aspects of water for people. A range of adverse impacts include reduced water availability and more frequent extreme events, such as droughts and floods (Alcamo et al., 2007, Arnell and Gosling, 2014, Arnell, 2004, Arnell et al., 2004, , Nijssen et al., 2001, Rosenzweig et al., 2004, World Bank and the United Nations, 2010, IPCC, 2012). These negative impacts may put water resources management, certainly at the level of individual land managers and regions, at significant risk (summary of evidence in IPCC, 2007, Bates et al., 2008).

Scenarios of water availability

Climate studies show that the effects of climate change will ultimately affect water resources availability and point out that the effect will accentuate the extremes with more pronounced drought and flood periods. Hydrological stress is expected to increase in central and southern Europe where water quality is also expected to deteriorate.

In the North of Europe climate scenarios project increases in air temperature and precipitation during the 21st century and these will results in changes in hydrology. Seasonal changes in discharges in Finland are the clearest anticipated impacts of climate change.

Scenarios of flood intensity and frequency

According to the IPCC report "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (IPCC, 2012), "there is limited to medium evidence available to assess climate-driven observed changes in the magnitude and frequency of floods at a regional scale because the available instrumental records of floods at gauge stations are limited in space and time, and because of confounding effects of changes in land use and engineering."

Floods caused by spring snowmelt are expected to decrease or remain unchanged, whereas autumn and winter floods caused by precipitation increase especially in large lakes and their outflow rivers (Veijalainen, 2012).

The role of infrastructure

In Europe drinking water and wastewater systems are aging. Some components are more than 100 years old. Infrastructure services (transport, communications, water, sanitation) assist in economic development and have a greater effect on the welfare (rent and well being) of the poorest; infrastructure provides a double potential to reduce poverty. There is a large body of evidence that access to clean water of the poor population improves significantly their wellbeing, having very large impact on child mortality, general health – helps increase the human capital and the economic rent of the poor. At the medium time horizon, has a large impact in the inequalities – a 10% more access to clean water reduces the GINI coefficient a 0.01 (Calderón-Servén 2004).

In BASE water management cases are closely inter-linked with the agricultural and rural development studies, and include:

- Climate adaptation in the Tagus River Basin of Spain and Portugal that will incorporate urban areas and health. The trans-boundary component of this case study will deal with water availability from Spain to Portugal and the political issue and strategic/policy challenges to overcome.
- Climate adaptation responses to flooding problems in two Danish predominantly rural municipalities.
- Climate adaptation responses to drought and water availability problems in two regions of the Czech Republic.
- Drought adaptation in the region of Alentejo in Portugal.
- Adapting flood risk management and river basin management plans to climate change in Kalajoki River Basin in Finland.
- Adapting flood risk management and river basin management in Lake IJsselmeer.

Case studies will include modeling climate change impacts and exploring adaptation measures with stakeholders trough a series of innovative participatory methods. Case studies will finally provide data on costs and benefits of different adaptation measures and offering examples and experiences on involving stakeholders in adaptation planning.

2.6.1 Iberian

By Pedro Inglesias and Ana Iglesias

The Iberian Case Study will focus on identifying drivers and barriers to climate change adaptation in the water and health sectors from a bottom-up perspective.

Though there is a general consensus that in the study area temperatures are rising there are not clear conclusions on the average rainfall. Nothing can be deduced form the observed data and models do not give matching results. The same can be said concerning cyclones. But extreme phenomena are going to sharpen. Drought periods are longer and heavy rainfall happen more often. An increase in hail is expected. It also seems that frosts are going to be heavier though the number of frost days is going to decrease. Snow is going to decrease which will have an impact on the hydrologic cycle. Finally there is going to be a certain change in the seasons, Mediterranean autumn moving westwards.

Hydrological cycle

The main impact on the hydrologic cycle in the study area is that there will be a decrease in water resources and an increase in irregularity. Changes in hydrologic cycle will directly affect drinking water supply. Rising temperatures and decreasing water resources will have a negative effect both on the quality and the quantity of drinking water. The same can be said of irrigation water.

Droughts and floods will be more frequent and of greater magnitude. Hydrologic cycle changes have a strong impact on housing and urbanization, health, energy production and agriculture and forestry. The Water Framework Directive for the protection of inland surface waters, groundwater, transitional waters and coastal waters imposes the conditions needed by water bodies to achieve their sound ecological status.

National Adaptation Strategies

Spanish Adaptation Plan was elaborated by the Ministry of Agriculture Food and the Environment and was approved by the Government in 2006. The objective is to achieve the integration of adaptation to climate change measures based on the best available knowledge in all sectors and management of natural resources that are vulnerable to climate change policy, to contribute to sustainable development.

The Plan is developed through work programs that allow prioritizing and structuring activities contained therein. The First Work Programme was approved in 2006, together with the Plan itself, in order to address immediate priorities and cross-cutting aspects of adaptation in Spain. The Second Work Programme was adopted in July 2009 and finally, in December 2013 adopted the Third Work Programme, which aims to comprehensively address adaptation to climate change.

The Spanish Adaptation Plan includes the following sectors:

- Biodiversity
- Water resources
- Forestry
- Agriculture
- Coastal zones

- Hunting and inland fisheries
- Mountain areas
- Soils
- Fisheries and marine ecosystems
- Transport
- Health
- Industry and energy
- Tourism
- Finances and insurances
- Urban Planning and Building

The Spanish Adaptation Plan proposes the following measures, activities and areas of work:

- Development of regional climate-hydrology models that ensure reliable scenarios, including extreme events
- Development of models for the ecological quality of water bodies
- Application of hydrological scenarios generated for the XXI century to other highly dependent on water resources sectors (energy, agriculture, forestry, tourism, etc.)
- Identification of the most sensitive indicators of climate change within the framework of implementation of the Water Framework Directive
- Evaluation of possible water management system under the hydrological scenarios generated for the XXI century
- Development of guidelines for incorporating in the process of Environmental Impact Assessment and Strategic Environmental Assessment considerations of the impacts of climate change to the plans and projects of water sector
- The platform where information about adaptation to climate change in Spain is called Adaptecca. (www.adaptecca.es)
- The economic crisis has had important effects both on the estimates of the socio economic development and on the drinking water consumption patterns. There is a need to improve future estimates of supply and demand, as well as forecasts of population growth.
- Preliminary results of the case study mark two important adaptation lines:
- The increase in the magnitude and frequency of extreme events will require greater storage capacity. This may conflict with environmental flows.
- The likely deterioration of water quality due to rising temperatures will require further investment in water treatment processes. This measure is particularly important in rural areas.

Preliminary Results

A series of stakeholders has been selected to be involved in the project, which includes representatives of private and public sectors, most of them with decision-making responsibilities. All stakeholders were personally interviewed by the Spanish team members and a stakeholder's meeting was held in November 2012 with those who were willing to participate. The final list included members of the National Office for Climate Change, Regional Government, Madrid Municipality, Ministry of Health, representatives of the Farmer's Unions and Water Supply and Energy companies, together with relevant members of the research community.

This meeting took form of a one day workshop in which impacts were discussed in the morning and adaptation measures and costs in the afternoon. The preliminary conclusions are being studied by the research team and will help drawing a causal diagram that will help to identify drivers and barriers.

Next steps also include a survey that will be conducted in autumn 2014 that will give the counterpoint of the non-institutional stakeholders' opinions

2.6.2 Kalajoki

By Milla Mäenpää and Anne-Mari Rytkönen

Kalajoki case study in Finland focuses on adapting flood risk management and river basin management plans to climate change. In Finland, climate scenarios project increases in air temperature and precipitation during the 21st century, which will result in changes in hydrology. Seasonal changes in discharges are the clearest anticipated impacts of climate change. Floods caused by spring snowmelt are expected to decrease or remain unchanged, whereas autumn and winter floods caused by precipitation increase especially in large lakes and their outflow rivers. (Veijalainen et al 2012). In the case study Kalajoki river basin, the flood with 100 year return period is projected to decrease 16,6 % from 2010 to 2039 and 17,6 % in the period 2070–2099. The highest discharges occur in spring, but increased winter discharges may enlarge e.g. risk for frazil ice dams (Veijalainen et al 2009). Current models do not take into account potential increase in heavy rains. The annual runoff and precipitation are expected to increase throughout Finland (Veijalainen et al 2012). Predicted changes in precipitation and temperature increases the nutrient load from catchments to water bodies in future climate (Rankinen et al 2009). Increasing air temperature, changes in timing and magnitudes of discharge as well as changes in nutrient leakage may also have an impact on water temperature, water quality and ecology (Veijalainen et al 2009).

With regard to the risk of flooding, Finland is currently one of the least vulnerable regions in Europe (Schmidt-Thomé et al. 2006), and the annual damages caused by floods are relatively low. The direct climate change impacts on hydrology in Finland during the 21st century appear to be for most parts manageable. There may even be some positive impacts in the form of increased hydro-power production. In areas with increasing floods, adaptation in land use planning and water resources management is needed to reduce the flood risk (Veijalainen 2012).

Adaptation in water resources management

Adaptation to seasonal changes in discharges and more frequent flooding may include changes in watershed regulation permits and practices, land use planning (prohibiting construction on flood risk areas), permanent and temporary embankments and other protection measures (Veijalainen 2012). In order to improve the ecological status of water bodies, efficient allocation of water protection measures is also needed. In river basin management plan (2010–2015) and related programme of measures, climate change impacts on ecological status of water bodies were evaluated. Water protection measures were divided into positive, neutral and negative with respect to climate change adaptation. Most measures presented in the plan were regarded as neutral. Some measures, like adjusting the regulation practices may support objectives of both river basin planning and climate adaptation.

In the case study area, several projects have been implemented during the past 50 years to protect the infrastructure and agricultural land from floods. These include flood embankments, dredging the river channel, building submerged weirs, dams and reservoirs as well as regulating natural lakes. Currently, the emphasis in flood risk management (FRM) planning is shifting towards flood communications, warnings and maintenance of current structures. Increasing the water retention capacity of the river basin, adjustment of regulation practices and using the agricultural land as temporary water storage are additional measures under consideration.

In FRM plans, future developments in climate, hydrology and occurrence of floods on a long term need to be taken into account. In addition, the measures need to be integrated with the objectives of river basin management planning (RBM). Vice versa, in RBM planning, water quality and quantity issues, sustainable use of water resources and flood risk management are taken into account. FRM and RBM plans are both subject to strategic environmental assessment (SEA).

Adaptation governance and motivations

Finland adopted its first National Adaptation Strategy (NAS) in 2005 (Ministry of Agriculture and Forestry, 2005). Water resources management is one of 15 sectors covered by the strategy. Responsibility for implementation of the NAS lies with sector ministries, so detailed adaptation actions for water resources management are included in sectoral action plans prepared by the Ministry of Environment (2008, 2011) and the Ministry of Agriculture and Forestry (2011) that share responsibility for the sector in Finland. Measures included in the action plans focus on e.g. integrating adaptation into regional river basin management plans, flood risk management plans and other measures developed in response to national implementation of the Water Framework Directive and the Floods Directive.

Kalajoki river basin is named among the 21 nationally significant flood risk sites. The criteria used in identifying the sites were probability of floods and potential consequences, particularly impacts on human health and safety, public services such as water and energy supply and traffic, and risks for the environment and cultural heritage. Potential damage to private property or agriculture were not of key importance in selecting the significant sites.

Flood risk management aims to respond to current extreme events keeping in mind the future developments, such as climate and land use. The planning unit is the river basin, which usually encompasses several municipalities and regional administrative units. For cooperation between the authorities, a flood management group has been designated for each river basin. The flood management group is composed of regional authorities, municipalities and regional rescue services. The flood management group sets the objectives for flood risk management and approves the proposal for the plan and the measures included in it. Information to be presented in the flood risk management plan includes a description and grounds for the prioritisation of measures, estimated costs, parties which have shown interest in implementing the measures and the financing possibilities, as well as how the progress in the implementation of the plan is to be followed.

The flood risk and river basin management plans assign actions mainly for the public sector, focusing primarily on the national and regional levels of administration, though some actions are designed for local level actors such as water utilities. In many cases, implementation of planned measures is somewhat uncertain: FRM plans are not directly binding and the national financial support for e.g. flood management structures has been cut substantially. The misfit between planning and implementation is obvious.

It can be said that climate adaptation is not the main driver for action in the Kalajoki case study. Based on the discussion in local water forum and flood management group, climate change is not observed as a major concern in the region. No extreme flooding or weather conditions have been observed during recent years and there is also no historical evidence of extreme events becoming more common. However, during the early winter 2013, the untypically warm weather and heavy rains led to seasonal record-breaking water levels and discharges in many rivers throughout Finland. Even though no major damage was reported, the event raised the interest of the public and the media towards flooding and potential impacts of the climate change. In addition, the question of extreme weather events is expected to gain more attention among the public in the near future, as the recent (from 2014 on) reform of flood compensation system has shifted more responsibility from government to private sector, landowners and insurance companies. This is expected to become one of the main drivers for becoming more aware of flood risks and implementing adaptation measures.

Goals, Methods and results obtained within BASE

Kalajoki case study in BASE aims to identify possibilities to achieve “climate proof” river basin management plans (RBMP) and flood risk management plans (FRMP) according to the Floods and Water Framework Directives. The case study focuses on comparing alternative management choices and their impacts in Kalajoki river basin in Western Finland. The case study supports ongoing planning processes.

The specific objectives in BASE are to:

- develop a framework for and assess the adaptive capacity of river basin and flood risk management measures
- identify potential synergies and conflicts between flood risk and river basin management planning
- assess the costs and benefits of flood risk management measures
- assess the acceptability of measures among stakeholders and citizens
- identify the possible future adaptation pathways in water resources management

The methods being used include:

- hydrological modeling using the Watershed Simulation and Forecasting System (WSFS): impacts of flood risk management measures and impacts on nutrient leaching
- multi-criteria decision analysis (MCDA) of flood risk management measures. The use of two MCDA software, Web-HIPRE and PRIMATE will be compared.
- survey on the public acceptability of the flood risk management measures
- cost-effectiveness analysis of river basin management measures
- the case study includes participatory elements. The stakeholders involved are local flood management group and local water forum.

Common features in the BASE case studies dealing with water resources include seasonal changes in hydrology, impact on water quality and quantity and extreme events becoming more frequent. The Spanish case study focuses on decrease in water resources and water supply. In the Finnish case study, the direct climate impacts on hydrology appear to be less severe but require adjustment of current policies e.g. in flood risk and river basin management.

Integration of multiple objectives in water resources management is a common feature in the Spanish and Finnish case studies. In Spain, there is an attempt to create a framework for integrating adaptation in water sector, which has extended experience in droughts, with other sectors where the climate change perception is not as accurate. In Finland, the climate adaptation perspective is being built into sectoral plans, such as river basin management plans and flood risk management plans.

The Finnish case study aims to identify potential conflicts and synergies in these adaptation processes. The case studies can support each other e.g. by providing indicators, comparing the key adaptation needs in different sectors as well as comparing adaptation perception in different parts of Europe.

The schedule for the abovementioned tasks is presented in **Table 2.7.1**

Year	**2013**			**2014**				**2015**
Months	Apr-Jun	Jul-Sept	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec	Jan-Mar
BASE months	7-9	10-12	13-15	16-18	19-21	22-24	25-27	18-30
Supporting and facilitating the work of the Regional Kalajoki water forum	•							
Evaluating cost-effectiveness of river basin management measures	•	•	•					
Modelling the climate impacts on nutrient loading		•	•	•				
Modelling the climate impacts on hydrology		•	•	•				
Evaluating adaptive capacity of river basin & flood risk management measures				•	•	•		
Developing a framework for evaluating synergies and conflicts of different measures				•	•	•		
Participatory multi-criteria analysis of flood risk management measures			•	•	•	•		
Developing adaptation pathways for water resources management					•	•	•	•
Survey on public acceptability of flood risk management						•	•	•

Table 2.7.1: The schedule of tasks in Kalajoki case study

2.6.3 Lake Ijsselmer (Delta Program)

As part of the Delta Program, all the sub-programs based their problem assessments on the so-called *delta-scenario's* to ensure consistency among the subprograms. The delta-scenarios are combinations of climate change and socio-economic developments. The climate scenarios are based on the IPCC –scenario's and translated to the Dutch situation by the KNMI (Royal Netherlands Meteorological Institute). The socio-economic scenarios are based on Living Environment scenarios of the the Dutch institute PBL, which were based on the European Four Futures of Europe scenario study. The four delta-scenario's called STEAM, BUSY, WARM and REST vary from moderate to rapid climate change and from socio-economic growth to decline. Each of these four scenario's create quite different challenges with regard to water management.

The most relevant climate change impacts related to the IJsselmeer Region is sea level rise, which could hamper the drainage of water into the Wadden Sea and would require additional pumping capacity. A second concern, reaching beyond the IJsselmeer-region to the whole Western part and Northern part of the Netherlands, is the expected effects of more long-lasting dry spells during summer. The water from the Lake IJsselmeer is now sometimes used to supply additional freshwater in case of drought. In the future this will be needed more often.

Hence there are two strategic climate change related challenges with regard to lake IJsselmeer.

a) Should the water level of the lake be raised in sync with sea level rise to ensure drainage into the Wadden Sea, or should pumping capacity increase.

b) Should the water level be more flexible during summer to ensure avalability of freshwater for agriculture, nature etc during dry spells.

The regional effects of raising the water level and increasing flexibility are numerous: dikes, sluices, wharfs, shores should al be adjusted, seasonal freshwater demand from agriculture and nature are not synchronized, surface water levels which are all in open connection with the lake, and the groundwater levels in the area are all influenced by the water level in the Lake.

The two main objectives of the Delta Program are guaranteeing flood protection and freshwater supply taking into account the uncertainties with regard to climate change and socio-economic developments. Like all subprograms, the IJsselmeer region subprogram has been working to develop a strategy to deal with the two challenges described above. Participating in the program were representatives from municipalities, waterboards, provinces and national government. The program has carried out a problem analysis based on the delta scenarios in 2011. In 2012, they developed possible strategies and in 2013 they made more detailed studies of the preferred strategies, leading to a draft policy decision consisting of five pillars:

Pillar 1: Draining and pumping

The current draft policy decision declares that up until the year 2050, water from the IJsselmeer will be discharged into the Wadden Sea using a combination of draining and pumping. To enable this, additional pumping capacity will be built. This strategy is much cheaper than allowing the water level to rise gradually along with the sea level. The underlying argument for this strategy is that a significant rise in the water level is not realistic before 2050.

For the period after 2050, the possibility of allowing the water level to rise structurally will be kept open. The Delta Program will be studying this further in the year ahead.

Pillar 2: A flexible water level in the lake

With regard to the flexibility of the water level, the draft policy decision declares to allow more flexibility. In this way, the water management authorities can respond more sufficiently to expected weather conditions and freshwater demands as the current, fixed target levels are becoming increasingly difficult to enforce anyway. However, a more flexible water level management does require adjustments to the assets of the areas along the banks and the spatial design and planning. With a buffer of 20 cm, the IJsselmeer lake is able to offer sufficient supply of freshwater up until 2050. A prerequisite is that the different water management authorities (in charge of the main water system, the regional water systems) and users reach agreement on a common approach for achieving more efficient use of freshwater. After 2050, it may be needed to allow the river IJssel to discharge more water into the IJsselmeer when the water level is low during summer. This may serve also as an alternative for raising the water level of the lake.

Pillar 3: Flexible water levels in the surrounding water systems

Water management of the regional water systems should be less dependent on the water level in lake IJsselmeer. If this were the case, these systems too could have more flexibility in their water levels. The waterboards see opportunities in the near future, for instance though the optimisation of flushing thier water systems.

Pillar 4: Reduction of freshwater usage

Users of freshwater, for instance farmers, are now making endless use of available freshwater supply. In the future they will be stimulated to be more aware of their usage, to reduce their usage and create water retention buffers on their own lands and be more self-supporting.

Pillar 5: Investing in flood protection

The dykes along the lake keep the people safe. Investments need to be done to guarantee the same level of protection.

This climate adaptation strategy of the IJsselmeer-region consisting of these five pillars is expected to be cost-effective, robust and flexible.

Focus on implementation analysis

Despite the vast body of literature on climate change and the need for climate adaptation, less attention has been given to the actual implementation of climate adaptation strategies. We consider climate adaptation strategies as a specific category of policy implementation, since a) climate change impacts will occur in the long term, nonetheless in the near future decision have to be made on how to act, b) there is irreducible uncertainty on how and how fast the climate will change, c) therefore, the strategy needs to be adaptive and responsive to the actual change by keeping other adaptation options open, and d) as a result of the above reasons, climate change in itself is often not perceived as a strong enough driver alone for profound infrastructural investments and there should be other functions fulfilled as well. Hence, these features require specific governance arrangements. Therefore, our research question is: *what kind of governance arrangements are able to deal with these specific characteristics of climate adaptation policy?*

This case study will develop a typology of governance arrangements based on the magnitude of the adaptation challenge on the one hand and the expected frequency by which adjustments need to be made on the other. The typology will be applied to the case study of lake IJsselmeer in The Netherlands for which adaptation strategies have been developed within the Delta Programme. The presented governance arrangements consist of the set of stakeholders, actions, means and instruments to guide and facilitate the adaptation strategy. We will analyse to what extent the various arrangements can deal with high and low frequency adjustments in the policy, small and larger transformations and the notion of keeping options open to remain flexible.

The results of the study can help to implement the adaptation strategies in the Dutch Delta Program and contributes to the application and development of Adaptive (delta) management, the guiding concept in the Dutch Delta Program. Furthermore, it will contribute to the further scientific development of the Adaptation Tipping Points Approach (ATP's) (Kwadijk, et al. 2010), the adaptation pathways approach (Haasnoot et al 2011, 2012) and the institutional and socio-cultural analysis of adaptation pathways (Van der Brugge et al. 2013).

2.7 International Cases Overview

By Jouni Paavola

Research on International cases allows BASE to draw lessons from adaptation in other regions in the world, thus complementing results and insights from other case study subgroups. These group of case studies a less in-depth approach than the European case studies. Altogether, the selected cases explore climate change impacts and adaptation in countries/regions from 3 continents.

Each international case study highlights aspects of adaptation that are not central in the European cases. The Eastern United States study examines how certain groups such as ethnic minorities, can be more vulnerable or have reduced adaptive capacity in the United States, highlighting that environmental justice considerations are highly relevant in adaptation to climate change. This could be relevant also in Europe, for example, groups of immigrants with limited language skills and social networks may not be reached by early warning systems.

The Mekong case study examines adaptation pressures in the delta, which are likely to mean that incremental steps in adapting a current agriculture-centered economic system are futile; and that a more fundamental and comprehensive transformation of the economic support system is needed for successful adaptation. Similar transformations may be needed in Europe, for example in the increasingly arid and water-stressed Mediterranean region which still depends on water-intensive agricultural exports.

The Cuban case study explores the extraordinarily successful disaster mitigation strategy in Cuba, which combines bottom-up and top-down processes for collaborative learning from experience for improved disaster risk reduction measures. It highlights that adaptation preparedness may benefit from practices that are currently used in Europe, for example to improve preparedness of major industrial and other disasters by bringing responsible actors together in large scale training exercises.

The Brazilian case study complements the European cases which focus on planned adaptation with cases that look at adaptation in business organizations and in higher education. The case study is still in its preliminary stages and will be looking at synergies between technological research centers, universities, and companies, as well as providing a general look at Brazilian state-of-the-art on Climate Change issues and a bigger focus on adaptation policies that can be comparable to Europe.

In what follows, the international cases are introduced and the key climatic changes and their predicted impacts are discussed. Adaptation policy frameworks, plans and processes are then described. This is followed by summary of results or/and plans for further work. The cases conclude with reflections on the key lessons to be learned for adaptation in Europe.

2.7.1 US East Coast – Cultural Dynamics of Adaptation to Climate Change

By Grit Martinez

This contribution explores the role of culture in relation to local knowledge and values as displayed in interpretations and actions of distinct groups of residents, concerning adapting to climate change in Dorchester County. Situated in the Mid-Atlantic area on the East Coast of the US, Dorchester County is at risk due to projected high sea level rise, flooding, salinisation and increased erosion.

The research is based on the theoretical position that interpretation of risks and responses by distinct groups are shaped by frames or systems of cultural knowledge and values. For our study region, we were interested in which ways local knowledge and values of major cultural groups (e.g. watermen, farmers, winemakers, trappers), shape their understanding and perceptions of climate change risks, and in turn the consequences of that cultural knowledge in terms of vulnerability, adaptation and resilience. Our research also includes perspectives of under-represented, poor Afro-Americans for whom threats posed by natural hazards and anthropogenic changes are disproportionately proximate. Furthermore, we incorporate perspectives of employees from the local zoning and planning department, views that allow us to better under the policy contexts of our study groups' different cultural perspectives. Methodologically speaking, our findings are based on ethnographic methods (including qualitative interviews with key cultural groups in Dorchester County, quantitative survey from a workshop with coastal authorities from several Chesapeake Bay counties) as well as document analysis. In particular, we focus on images of nature, sense of place and change, risk perception and barriers. In addition, we also considered socio-economic factors such as economic development and public and private (coastal) property issues. We found that beliefs and values of a distinct group of people in a given region shape their perceptions of climate change and hence their responses to changes in the environment and their communities.

Impacts

The state of Maryland, particularly Dorchester County has been chosen due to its high projections for sea level rise. Recent studies have corroborated these projections and provide more specificity than the Intergovernmental Panel in Climate Change's (IPCC) 2007 findings. For example, in 2009 the US Environmental Protection Agency (EPA) released the synthesis report, Coastal Sensitivity to Sea-level Rise: A Focus on the Mid-Atlantic Region. The report concludes that the Mid-Atlantic region is one area of the US that will likely see the greatest impacts of climate change due to rising waters, subsidence, increased storms and a high population concentration along the coastline. The EPA identifies substantial shoreline areas that are already feeling the effects of sea level rise and erosion of tidal marshes. The fact that the region is classified as a high-risk area expected to be affected by storm surge events and hurricanes was recently once again brought to the forefront of public awareness by super storm Sandy, which hit the East Coast in late October, 2012.

In 2007, under Governor Martin O'Malley a Climate Change Commission was put in place. One of the highlights of the Commission's work was a focus on adaptation strategies and measures to decrease vulnerability to sea level rise and storms in the Chesapeake Bay, which constitutes a significant portion of Maryland.

The Chesapeake Bay Program's Science and Technical Advisory Committee (STAC) produced a state-of-the-science review for climate change in the bay. The report estimates that in the 21st century, relative sea level rise will be approximately 0.7 to 1.6 meters—with variability across the bay. Tidal range is expected to increase, as is extreme wave height in storms. A rise in sea level of these magnitudes will have a dramatic multiplier effect on Maryland's coastal environment and the communities along it. While the extent and range of impacts may vary, it is generally agreed that the low-lying Eastern shores, and Dorchester County in particular, are in the high-risk category, susceptible to erosion, flooding and inundation.

Adaptation

Since 2008, the Maryland Department of Natural Resources and the Maryland Chesapeake & Coastal Program have been active in designing instruments to support adaptation activities. In Maryland, for instance, a website entitled "Coast Smart Communities" was put in place for counties and political decision makers: Counties who are interested in learning more about adaptation can obtain services from Maryland's coastal program. Although these services are available, the use of the services is voluntary, and consequently the more politically conservative regions of the state may not fully take advantage of the information. A variety of studies point out that conservative political attitude in the US makes people less responsive to climate change issues. For instance, studies exist which show the relationship between political attitudes and climate change perception.

Results

In 2012, a survey was conducted amongst employed officials involved in decision-making for coastal management in several counties in Maryland. The data were collected during a workshop entitled "Obstacles to Adapting to Climate Change—a Discussion with Practitioners," held in Annapolis on 7 March 2012. The workshop was lead by Ecologic Institute. The purpose of the survey was to illustrate the perceptions of these planners and managers of residents' behaviour and willingness to acknowledge environmental changes and adapt according to their individual capacities. It was also intended to understand which role local values play in this process according to the perception of the audience. In total, 13 questions were asked to the audience which comprised 20 participants. Here we focus and present those questions that explicitly dealt with culture, environmental change and climate. To analyse the data we used box plots.

Table 2.8.1: Short overview of results

Study Site	Methodology/ Timeframe	Key findings on how values and beliefs shape Interpretation of environmental risks and policy responses
Annapolis (Maryland)	Survey among officials involved in decision-making for coastal management in several counties in Maryland. March 2012	• The physical size of a place and the sense of belonging to the land shape the perceptions of coastal protection and types of activity chosen. • Coastal identity is a strong driver regarding protection/maintenance of coastal properties. On the contrary, physical infrastructure and landmarks can provide barriers regarding long-term change in behavior or living conditions when dealing with changes in the coastal environment. • Using the term 'climate change' tends to hinder the facilitation of adaptation measures. • Private action as a means to adapt to coastal changes seems to be preferred than public or state driven action.

2.7.2 Mekong

By Ad Jeuken

The Mekong Delta plan has presented 4 possible future visions for economic development of the Mekong Delta, while also incorporating the challenges of adapting to climate change. Water resources are a vital element in this vision. The BASE case study will seek to organize the adaptation steps that need to be taken under different climate and socio economic scenarios, using adaptation pathways and in addition specifying major triggers for taking decisive actions under uncertainty. Focus areas will be water resources management and flood risk management. But since this is an integrated development plan, triggers for taking decisions are probably defined by other agendas.

The Mekong Delta stands at crossroads. In the past decades, the Mekong Delta successfully developed into the granary of the country and turned Vietnam into one of the leading rice exporters globally. Recognising the need for higher income generating possibilities in the agricultural sector, in 2000 the Vietnamese government introduced a policy on agricultural diversification which shifted production from rice mono-culture to a more diversified rice-based farming system which includes aquaculture, fruits and horticulture. In recent years, the region has been committed to official government development objectives for the Mekong Delta in becoming a balanced multi-sector economy with increasing urbanisation and industrialisation. However, despite all efforts, industrial development in the Mekong Delta falls behind and actual developments are deviating from existing government policies aimed at high-tech agricultural development and full exploitation of the competitive advantages of the region. Due to its geographical situation, the Mekong Delta is likely to be severely affected by the adverse impacts of climate change. Peak flows and river floods are set to increase in the wet season. Decreases in dry season flow may lead to serious fresh water shortages. The sea level will rise and saltwater intrusion will further increase, subjecting large areas of the coastal delta to a brackish environment.

Transboundary developments may further aggravate the stress on land and water resources. Socio-economic developments determine to a large extent the ever-increasing pressure on the delta's land and water resources, even more than climate change. Developing an appropriate strategy to mitigate and adapt to these changes has become crucial. The Government of Vietnam has for a long time recognized the vital role of water as a key natural resource for the development of the Mekong Delta. In 2008, the National Target Program respond to Climate Change (NTP) was issued with the main strategic objective to assess climate change impacts on sectors and regions, and to develop feasible action plans to effectively respond to climate change in the short - as well as the long-term. The premise for the Mekong Delta Plan is to contribute to realising and maintaining a prosperous delta, both economically and socially, in which its population can thrive in a vigorous and dynamic economy that is founded on sustainable use of its natural resources, and well adapted to changes in water resources and climate. It spells out what uncertainties and challenges confront the delta from now to 2050, and from 2050 towards 2100, and presents a clear long-term vision towards Agro-Business Industrialisation as a promising future strategy. Taking into account the existing government policies and the institutional framework, it is recognised that the orientation for the agricultural sector in the delta needs to shift from a focus on production towards a focus on added value by improving the product-value chain, involving public-private partnerships and introducing market-based mechanisms. The Mekong Delta Plan includes 'no-regret' and priority measures, as well as measures that can be deferred towards the longer-term that Vietnam could adopt to ensure a safe, prosperous and both economically and environmentally sustainable and climate proof future for the delta region.

Climate change has been studied extensively, at global, regional and national scales. Because the large uncertainties in future climate change often a scenario approach is used. Internationally there is to a certain extent good agreement on the effects of low, moderate and high climate scenarios. For shorter-term climate change projections the uncertainty is lower and it is well possible to base assumptions for projects close to a low climate scenario. MoNRE (Ministry of Natural Resources and Environment) has done this for Vietnam. This can be a good approach to avoid upfront overinvestment in today's projects, when the eventual climate scenario is yet uncertain ("avoid regret measures"). For longer-term approaches, such as establishing a delta plan, it is important to be aware of the uncertainty in future climate. A useful way to include uncertainties in the planning process is the use of different scenarios. Rather than adopting a fixed value, the delta plan approach considers minimum and maximum developments, the ranges of expected sea level rise, of low discharges and of high discharges in order to assess ranges of measures to be taken. In the preparation of this delta plan this range has been established [see **Table 2.8.2**].

Table 2.12: Moderate and High Scenarios for the Mekong Delta

	moderate scenarios		high scenarios	
	2050	2100	2050	2100
increase wet season flow	no change	10%	0 – 10%	20 – 50%
increase wet season rainfall	0 – 5%	5 – 10%	10 – 20%	10 – 30%
dry season flow	+/- 5% (higher or lower)	5% higher or 15% lower	10 – 30% lower	30 – 60% lower
decrease dry season rainfall	0 – 10% less	5 – 15% less	10 – 20% less	20 – 40% less
increase salinity intrusion	slight	moderate	moderate	dramatic
sea level rise*	20 – 30 cm	57 - 73 cm	40 – 60 cm	78 – 95 cm

Table 4-1 Characteristics of high and low socio-economic outlook in the Mekong Delta[23]

	moderate outlook			high outlook		
	2025	2050	2100	2025	2050	2100
Population[1]	18 million	15 million	7 - 8 million	20 million	30 million	40 million
urbanisation	28%	30%	<40%	36%	45%	>60%
GDP growth[2]	2 - 3%	<2%		4-6%	>4%	
% share GDP industrial sector	20 - 25%	<30%		35 - 40%	>40%	

PhD student, Sreeja Nair, will be conducting case studies for her PhD research in selected Asian countries and collaborate with the BASE project for the Mekong Delta case to provide critical insights into the application of adaptation pathways in different countries and policy contexts. She will be assisted by researchers at Deltares that have retrospective experience in building the Mekong Delta plan and the application of the Adaptation pathways approach. It is envisaged that the engagement of Sreeja with the BASE project, specifically the Mekong Delta Plan case study can also help to explore key research questions:

- Understanding uncertainties that challenge long-term policymaking, such as in development of a long-term delta management plan. This includes identifying the range of uncertainties; how well can policy analysts capture these uncertainties; what assumptions regarding current and future risks and uncertainties are made for long-term policy analysis; how are the limitations of the analysis communicated to policymakers; what difference if any, do these assumptions and use of specific approaches for long-term policymaking make on the policy decision.

- Understanding the application of adaptation pathways approach and adaptive delta management in practice.

- Gain insights for replication of the adaptive policymaking and adaptation pathways approaches to other countries.

2.7.3 Cuba

By Gil Penha-Lopes and Filipe Alves

Cuba, the biggest and one of the most famous island from the Caribbean Sea due to its political and economic history, is a large mass of land located at the border with the North Atlantic Ocean just 150 kilometers south from Florida Keys, USA (UNEP 2014). The island has a total land mass of 110 km2 – about the size of Pennsylvania or Bulgaria - and a population of 11.2 million people, 75% of which live within cities, namely Havana – capital city - and Santiago de Cuba (USDS, 2010). With an impressive 3,735 km of coastline, the island's terrain is mostly flat to rolling plains. Nevertheless, mountains that reach up to 2,000 meters can be found in the southeast of the country with Pico Turquino (2005 mts) being the country highest point. Cuba's climate, as for most Caribbean islands, is tropical as it experiences a dry season from November to April and a rainy season from May to October (USDS, 2010). Cuba's climate is strongly influenced from its geographical position, namely by its extreme exposure to extreme hydro-meteorological events such as Hurricanes, which seasonally affect the Cuban population and infrastructure and which have been well documented since the 1950's (Gonzales 2010). Between 1998 and 2008 Cuba was affected by over 20 tropical storms, however only 35 lives were lost due to this events (UNDP 2010).

Economically, the Cuban economy has witnessed major changes over the last 50 years, having experienced both times of strong economic prosperity and steep economic breakdowns. Nevertheless, Cuba has experienced positive GDP growth rates since the last economic breakdown of the early 90's, following the breakdown of the URSS, with an average rate of 5% (Cuban National Statistics, 2013).Over the last few years and due to the progressive liberalization of markets and capital flows since the last Cuban Communist Party Congress (April 2011) as well the increase in tourism, the Cuban economy has been growing close to 3% per year (CIA World Factbook 2014) while maintaining a relatively low Public Debt to GDP ratio (35,8%), official unemployment rate (3,8%) and inflation (5,5%). Still, the average monthly salary of workers is €15, and the workforce is primarily employed within services (including education, health and social services) while the percentage of population employed in agriculture has dropped to a minimum recorded of 19% (USDS, 2010).

Cuba has fundamentally two crucial climate change vulnerabilities which have been identified as potential threats to the country's development path and to the population's safety: extreme weather events; and, freshwater availability (Oxfam 2011). Both of these have been worsening since records are available, with the increase in frequency and intensity of hurricanes since the 1950's and mainly since 1976 (Gonzales 2010), and the decline in freshwater availability due to i) a reduction of precipitation (only source available), which was of 10% between 1960 and 2000 (Oxfam 2011) and is estimated to be -5% till 2050 (Centella 1999); ii) saline intrusion of groundwater aquifers – also related with extreme weather events -; iii) and finally the increase in evapotranspiration due to increased temperatures in the summer period (Centella 1999).

As for the more recent climate projections for Cuba, it is expected that for Temperature:

- Mean annual temperature does not show a significant rate of increase since 1960, as Cuba experienced warmer than average temperatures in the early 1960s. Mean annual temperature has however, increased by around 0.1°C per decade since 1970.
- The frequency of 'hot' days has only increased slightly since 1960, whilst the frequency of hot nights has increased more rapidly and significantly over this period.
- The average number of 'hot' nights per year increased by 52 (an additional 14.1% of nights) between 1960 and 2003. The rate of increase is seen most strongly in JJA when the average number of hot JJA nights has increased by 6.9 days per month (an additional 22.4% of JJA nights) over this period.
- The frequency of 'cold' days2 and nights has decreased significantly since 1960 in almost all seasons.
- The average number of 'cold'days per year has decreased by 19 (5.3% of days) between 1960 and 2003. This rate of decrease is most rapid in the months of March/April/May (MAM) when the average number of cold MAM days has decreased by 2 days per month (6.4% of MAM days) over this period.
- The average number of 'cold' nights per year has decreased by 29 (8.0% of days) between 1960 and 2003. This rate of decrease is most rapid in September/October/November (SON) when the average number of cold SON nights has decreased by 2.9 nights per month (9.5% of SON nights) over this period.

And for Precipitation:

- Mean rainfall over Cuba has decreased at an average rate of 7.4mm per month (7.1%) per decade since 1960. This decrease is mainly due to decreases in JJA and SON rainfall, of 13.9 and 8.8 mm per month (9.3% and 6.5%) per decade respectively.
- The magnitude of maximum-5day rainfalls has not shown a significant trend in observations since 1960.

This expected changes in the near future in Cuba are being study according to their impact on the most vulnerable sectors that have been identified by many international organizations such as UNDP, OXFAM, the World Food Program and that consist of:

Key Vulnerabilities:

- Agriculture/Food Security
- Coastal Zones and Marine Ecosystems
- Water Resources
- Public Health
- Fisheries
- Terrestrial Ecosystems
- Disasters
- Biodiversity

Cuba history in dealing with extreme weather events and the specific measures that were implemented since the 1959 revolution represent a unique case study worldwide, namely from a socio-politic viewpoint, in order to better understand the underlying dynamics of a system of early warning, response & rescue and management of extreme weather events, which is considered to be among the most efficient in the world - National System of Civil Defence of Cuba, July 1966 Executive Law Nº 1194, later on reviewed in November 1976 by Executive Law Nº 1316 signed by Raúl Castro - (Oxfam 2011; Gonzalez 2010).

In 1991, the country created a National Commission on Climate Change with a mandate to study the impacts of the phenomenon on its population, food production, water supplies and health (Oxfam, 2011). In the process of developing its First National Communication to the UNFCCC, Cuba established a number of institutional and legal frameworks for climate change, including the National Climate Change Group that brings together all relevant governmental and non-governmental institutions. In 2007, the country also launched the Cuban Society Program to Face Climate Change, which analyzes all sectors of the Cuba economy in terms of vulnerability to climate change and required adaptation measures. As part of this process, the National Water Resources Institute developed an Action Plan for Water Resources Adaptation to Climate Change (Oxfam, 2011). Cuba is currently in the process of developing its Second National Communication under the UNFCCC. It also cooperates with the Caribbean Community (CARICOM) members on climate change initiatives, including a 2008 statement calling for increased financing to address climate change adaptation.

In many aspects Cuba stands as a unique case study to be inspired by, to learn with, but also to view the intrinsic bottom-up and top-down challenges of a system which is, in many ways, very different from our reality in Europe.

Within BASE international case studies, Cuba represents a unique learning opportunity for Europe in two opposite perspectives: Firstly, as a potential benchmark example of an efficient and effective Early Warning System for extreme weather events that has been in constant improvement since the 60's and its worldwide recognized; secondly from a bottom-up perspective, the citizen-led and NGO supported Permaculture movement towards greater food & water resilience by local small scale decentralized food production.

FFCUL will not only review key literature on the National System of Civil Defense preparation, implementation, improvements, drawbacks and overall coherence and integration with the environmental law and Climate Change bodies in order to draw Policy recommendations for Europe but also work together with local NGO 'Fundacion Antonio Nunez Jimenez de na Naturaleza y el Hombre' to understand the bottom-up dynamics – motivations, opportunities, barriers – of the Permaculture movement in Cuba and its relation with Climate Change. Having the opportunity to participate in the International Permaculture Convergence, in Cuba, FFCUL will also run in depth interviews to local stakeholders about Climate Change perceptions and atittudes and build up a Climate Change Permaculture Inspiration book.

2.7.4 Brazil

By Gil Penha-Lopes, Filipe Alves, Fabricio Casarejos and Filipe Duarte Santos

The Brazilian case study intends to bring some new knowledge about how different sectors and stakeholders perceive climate change as well as design-to-implement Adaptation. Other than a general look at Brazilian state-of-the-art on Climate Change issues and a bigger focus on Adaptation issues, it will try to respond to the question:

"**How do multinational (or very large companies) perceive CC and their plans, actions and future aims to act on Climate Change (Mitigation and Adaptation)?**"

This case intends to achieve the following BASE major objectives:

1. Compile and analyse data and information on adaptation measures and their effectiveness.

3. Identify conflicts and synergies of adaptation policies at different levels of policy making with other policies (including climate mitigation) within and between sectors.

7. Disseminate findings by sharing the results of the project with policy-makers, practitioners and other stakeholders.

Characterization of Brazil case study based on the CSLD (see CSLD for more information):

Case ID			Typologies and characterization				
Country & Name of CS	BASE Objectives to be answered by the CS	Category of case study	Territorial zones	Scale	Process Direction	Temporal Definition	Timescale[1]
Brazil	[x] Objective 1 [ ] Objective 2 [x] Objective 3 [ ] Objective 4 [ ] Objective 5 [ ] Objective 6 [x] Objective 7	C;D	[ ] Rural [x] Urban [ ] Coastal [ ] River Basin	[ ] Local [x] Regional [ ] National [ ] Transnational [ ] European /Global	[x] Bottom-Up [ ] Top-Down	[ ] Retrospective [x] Prospective	2013 - 2014

Impacts		Sectors		Implementation	
Primary CC Impacts (Climate-Adapt)	Primary CC Impacts (BASE)	Primary and Secondary Sector (Climate Adapt)	Primary and secondary Sector (BASE)	Implemented[2]	Phase of Implementation[2]
☐ Temperatures ☐ Water Scarcity ☐ Flooding ☐ Sea level Rise ☐ Droughts ☐ Storms ☐ Ice and Snow	☐ Extreme temperatures ☐ Water scarcity ☐ Flooding ☐ Coastal Erosion ☐ Droughts ☐ Soil Erosion ☐ Vector Borne Diseases ☐ Damages from extreme weather related events (storms, ice and snow)	☐ Agriculture and forest ☐ Biodiversity ☐ Coastal Areas ☐ Disaster risk reduction [1] Financial ☐ Health [2] Infrastructure ☐ Marine and Fisheries ☐ Water Management ☐ Urban	☐ Agriculture ☐ Biodiversity & Ecosystems ☐ Coastal and Marine systems [1] Energy ☐ Health and Social Policies ☐ Transport [1] Production Systems and Physical Infrastructures ☐ Water resources ☐ Tourism	☐ Yes ☒ Ongoing ☐ No	☒ Assessment ☒ Planning ☐ Implementation ☐ Monitoring ☐ Evaluation

Since the implementation of the Kyoto Protocol in 1997 (Kyoto Protocol, 1998), many organisations have considered sustainability and climate change strategies to be business strategies (Dyllick and Hockerts, 2002; Hoffmann and Woody, 2008; Lee, 2012; CDP, 2012a, 2012b). The following scientific studies on corporate sustainability and climate change strategies are highlighted: “corporate environmentalism” (Hoffmann, 1997), “climate change strategy” (Hoffmann, 2004), “climate strategy” (Kolk and Pinkse, 2005), “corporate strategies” (Hoffmann et al., 2006), “carbon strategies” (Hoffman, 2007), “the business response to climate change” (Jeswani et al., 2008), “the corporate CO2 strategy” (Weinhofer and Hoffmann, 2010) and “corporate carbon strategy” (Lee, 2012). These studies indicate a competitive advantage for organisations capable of incorporating climate change into their strategic planning, which ensures better conditions for exploiting any opportunities that emerge from a changing business environment. The studies also reinforce the idea that climate change strategies cannot be simple add-ons but must be integrated into an organisation’s priority strategies. Climate change and sustainability business strategies are expressed as goals and execution plans intended to reduce GHG emissions and, thus, to benefit all of society.

Various studies and reports discussed in international forums (UNEP, 1972; Brundtland, 1987; ECO/-92, 1992; Agenda 21, 1992; IPEA, 2011; WBGU, 2011; RIO+20, 2012; WB, 2012; EEA, 2013; IPCC, 2012, 2013) proved that government entities have attempted to establish considerations and judgements for mitigating and adapting to the challenges of climate change and sustainability. These changes coincide with society indicating the need to transition to a low-carbon economy and searching for technically and financially feasible, pragmatic solutions to reduce GHG emissions that can be implemented for sustainable development (GCS, 2013; CDP, 2012a).

The objective of the present study is to identify and analyze the actions and degrees of commitment to emissions restriction and adaptation to CC of the large customers of an electric power utility company in Brazil, in view of the challenges imposed by sustainability and climate change.

Note: FFCUL was also invited, through Professor Filipe Duarte Santos, to be an external advisory of the Brazilian government that will support and provide advice for Adaptation in Brazil. Professor Filipe just returned from Brazil and FFCUL will have access to updated information at the country level that will also build context for Brazil case study within BASE.

Case Study rationale

FFCUL is using International case studies to provide supplementary information to the Portuguese and European BASE case studies. Within Brazil, and together with PUC-Rio University (Brazilian collaborator), we intend to focus on companies and enterprises, a stakeholder usually left aside. Although some questionnaries and enterviews were already done this case study also intended to organized workshops., However the major workshops already planned was cancelled due to strong extreme weather events (such as intensive floods) at Rio de Janeiro. We do not know if we will be able to organize another one for the end of 2014 or beginning of 2015, however the goal of this case study will be achieved with more or less participatory methodologies. Our intention was for CEOs, board members and technicians from different companies, but also policy and decision makers as well as researchers, to sit down and discuss and find solutions for the obstacles and opportunities found during Brazil case study.

Preliminary Results

see Casarejos, F. et al. (2014)

The aggregated results of the survey are shown in **Table 2.13**, which summarise the answers in both absolute (total respondents) and percentage terms. Table 1 displays the 11 central questions, corresponding to 13 subquestions with answer options, the critical actions associated with each question and the tabulated results. Table 2 displays the six subquestions with multiple answering options (a total of 48 questions), the critical actions and the results.

Preliminary conclusions

Even though some knowledge about the response of firms in advanced economies to climate change are described in the literature, very little is known about organizations in developing and emerging economies that, certainly, also have a huge and growing impact on the environment. The considerations that were obtained from the survey results associated with this complex subject were obtained from the survey results were detailed for a representative sample of high-consuming customers (classified by economic sector) of an electricity power company. With the exception of a few outliers, the average degree of commitment (CI_{med} = 0.432) for the participants was ranked Average, which indicates the incipience of proactive GHG strategies (less than 7% of the participants fell within the Excellent category) in response to the guidelines established by the Brazilian Climate Change Policy. There are very few firms who've done much. And the “average” degree of engagement seems to be very low and most likely has little effect on the overall GHG emissions. The survey reveals a low commitment to the guidelines of the Brazilian Climate Change Policy. Brazil has not enacted specific regulations to mitigate the GHG emissions associated with the generation of electricity; this finding is certainly a matter of concern due to the size and the regional influence of the country to the global climate change. Therefore, the survey indicates the need for a proactive attitude towards the mitigation and adaptation to climate change in the context of sustainable development strategies. Specifically, the survey indicates the need for realignment with new methods that address the risks, threats, uncertainties and complexities of the undesired impacts of climate change. Although Brazil lacks specific legislation to isolate the production of electricity from its negative impact on the environment, the recent (2012) initiative of the regulatory agency is encouraging. Aneel (Brazilian Electricity Regulatory Agency) Resolutions 414 and 415 stimulate solar electricity generation through an 80% rate discount (until 2017) for the use of the solar electricity distribution and transmission systems (the discount will be reduced to 50% after 2017). Although this impact will occur on different levels and time scales, everyone, regardless of his/her degree of awareness, will be affected by the global climate change phenomenon. Only a global effort with unrestrictive adherence by various nations will enable a GHG emission control plan to transition from the current

<u>Table 2.13: Answers in both absolute (total respondents) and percentage terms</u> Source: Casarejos, F. et al. (2014)

Table 1. Answers to the 11 questions of the questionnaire and corresponding sub questions.

Question #	Reference to Critical Actions	Survey questions ["Study in sustainability: Actions and commitment of large customers of a power utility company"]	Total Answers #	Total Answers (%)	Affirmative Answers [YES] #	Affirmative Answers [YES] (%)	Negative Answers [NO] #	Negative Answers [NO] (%)
Question #1	# 1 and 2	*Does the organization have a specific division to manage sustainability (Su) activities (projects, programs) and mitigation/adaption strategies for climate change (CC)?*	86	100.0	25	29.0	61	71.0
1-[NO]	Does the organization intend to create such a division?		61	100.0	15	24.5	46	75.5
1-[NO]	Are these issues (Su, CC) currently discussed by the Board of Directors of the organization?		61	100.0	8	13.1	53	86.9
Question #2	# 3, 4 and 5	*Does the organization perform greenhouse effect gas (GG) inventories?*	86	100.0	10	11.6	76	88.4
2-[YES]	Does the Organization annually project its GG emissions?		10	100.0	8	80.0	2	20.0
2-[NO]	Does the Organization intend to create GG inventories?		74	97.4	20	27.0	54	73.0
Question #3	# 6	*Does the organization know about the fiscal/tax benefits to stimulate the reduction of greenhouse GAS emissions?*	85	99.0	21	24.7	64	75.3
3-[YES]	Of the listed options, indicate the fiscal/tax benefits you are aware of: (see options in line 3-[YES] of Table 2)							
3-[NO]	Are you interested in knowing about these fiscal/tax benefits?		64	100.0	56	87.5	8	12.5
Question #4	# 7	*Does the organization know of the carbon market?*	32	37.2	13	40.6	19	59.4
4-[YES]	Indicate any of the listed options applicable (see options in line 4-[YES] of Table 2)							
4-[NO]	Are you interested in knowing about this market?		19	100.0	13	68.4	6	31.6
Question #5	# 8, 9 and 10	*Does the organization perform any periodical analysis of Risks/Opportunities created to climate change and sustainability?*	25	29.0	7	28.0	18	72.0
Question #6	# 10 and 13	*Does the organization perceive sustainability as a business opportunity?*	84	97.7	76	90.5	8	9.5
Question #7	# 10 and 13	*Does the organization perceive Sustainability as a competitive business differential?*	86	100.0	82	95.4	4	4.6
7-[YES]	Of the options offered, indicate which result from Sustainability strategies; (see options in line 7-[YES] of Table 2)							
Question #8	# 11 and 13	*Does the organization develop good Sustainability practices?*	86	100	86	100	0	0
8-[YES]	Of the options offered, indicate those effectively practiced: (see options in line 8-[YES] of Table 2)							
Question #9	# 12 and 13	*Has the organization ever participated in a program/competition that rewards sustainability?*	25	29.0	4	16.0	21	84.0
9-[YES]	In the context of this initiative, indicate whether the Organization has won any prize.		4	4.6	4	100.0	0	0
Question #10	# 9 to 13	*Did the organization received any mark of conformity or certificate in sustainability and energy efficiency?*	86	100.0	13	15.0	73	85.0
10-[YES]	Of the listed options, indicate the mark of conformity or Certificate received:							
Question #11	# 5 and 14	*Does the organizations publicize its actions regarding sustainability and climate change?*	18	20.9	18	100	0	0
11-[YES]	Of the options offered, indicate the media utilized: (see options in line 11-[YES] of Table 2]							

Table 2. Answers to the questionnaire (multiple options).

Unfolding of the Survey Questions (Multiple Choice options)		Total Answers #	Total Answers (%)	Alternatives of Multiple Options of Answers		Total Answers #	Total Answers %
3-[YES]	Of the listed options, indicate which fiscal/tax benefits may help reduce the emission of greenhouse gases (GG)?	20	95.2	a.	access to differentiated financing	13	65
				b.	tax reduction	9	45
				c.	eligibility for the green market - carbon market	10	50
4-[YES]	Of the listed options, indicate the company's current participation in the carbon market:	7	53.8	a.	has plans to elaborate a project	5	71.4
				b.	has an ongoing CDM project	2	28.6
				c.	has already obtained carbon credits (CERs, Certificated Emissions)	1	14.3
7-[YES]	Of the listed options, indicate which contributions result from a sustainability strategy:	82	100.0	a.	reduction of fixed costs	64	78.8
				b.	commitment from stakeholders and shareholders	30	36.6
				c.	strategic and operational efficiency	54	65.8
				d.	preference from consumers, suppliers and investors	54	65.8
				e.	development of new markets	43	52.4
				f.	pioneering and anticipation	45	54.8
				g.	company and product differentiation	57	69.5
				h.	Branding improvement	22	26.8
				i.	others	0	0
8-[YES]	Of the listed options, indicate which sustainability activities are effectively practiced by the organization:	86	100	a.	selective garbage collection	69	80.2
				b.	sewage and wastewater treatment	56	65.1
				c.	generation and/or utilization of renewable energy	25	29.0
				d.	recycling and reuse of residues	60	69.8
				e.	energy efficiency and raw materials optimization	36	41.8
				f.	environmental education	44	51.1
				g.	capture of rainwater	28	32.6
				h.	reverse logistics of its products	17	19.8
				i.	neutralization/compensation of carbon emissions	12	14.0
				j.	social development programs	43	50.0
				k.	cultural development programs	31	36.0
				l.	professional well-being programs	44	51.1
				m.	others	2	2.3
10-[YES]	Of the listed options, indicate the seals and certificates received for sustainability and energy efficiency:	13	15.1	a.	AQUA (High Environmental Quality) - Alta Qualidade Ambiental	0	0
				b.	LEED (Leadership in Energy & Environmental Design)	3	23.0
				c.	PROCEL Edifica (National Program of Energy Conservation) - Programa Nacional de Conservação de Energia	1	7.7
				d.	*Qualiverde*	1	7.7
				e.	Solar	1	7.7
				f.	FSC (Forest Stewardship Council)	4	30.8
				g.	*Casa Azul Caixa*	0	0
				h.	ISO 14001	1	7.7
				i.	others	0	0
11-[YES]	Of the options offered, indicate the media utilized by the organization to publicize its sustainability and climate change activities:	18	20.9	a.	sustainability report	7	38.9
				b.	"Carbon Disclosure Project" (CDP) report	0	0
				c.	corporate social responsibility report	0	0
				d.	corporate annual report	8	44.4
				e.	GHG emissions public registration (GHG Protocol)	1	5.5
				f.	radio	1	5.5
				g.	television	1	5.5
				h.	specialized journals	4	22.2
				i.	journalistic and commercial magazines	4	22.2
				j.	internet	8	44.5
				k.	others	2	11.1

manufacturing modes and relationships. The competitive advantages of these organizations must be globally reorganized with regard to current environmental issues and as a safeguard to climate change mitigation and adaptation. As recently mentioned in the Global Corporate Sustainability Report, which was published by the United Nations, although organizations declare a desire to incorporate actions that prioritize sustainability, mitigation and adaption to climate change in their corporate strategies, these initiatives only produce long-term results.

The measured low commitment to emissions restrictions of large users of electricity certainly calls for further attention to the more general context in which firms act to reduce their GHG footprints. Individual firms can only go so far in cutting emissions via efficiency measures or technological change. Power companies, on the other hand can act more centrally to lessen dependence on coal and fossil fuels more generally, even without fostering intra-firm change. In the case of Brazil, moreover, the contribution of hydropower and other renewables is already unusually high so further increments of improvement may have diminishing effect. The transport sector is surely a prime target for further national/global gain given a relatively slow pace of hybrid adoption and continuing reliance on gasoline and ethanol, not to forget the complexities associated with the latter when land use, food production and the net-negative energy effects have to be taken into account. The incisive reduction in GHG emissions proposed by the 2013 Report of the IPCC is linked to a review of the historical responsibilities of nations for different degrees of development. Each agent, regardless of size, belief or economic and social activities, is responsible for exploring opportunities to develop strategies towards development and participation in the global environment.

Further work

During 2014, FFCUL together with PUC-Rio will finalize a second questionnaire, already being answered by another set of major companies, targeting mainly adaptation topic and specifically its Costs and Benefits. A peer-reviewed scientific article is expected by the beginning of 2015

3 Comparing Adaptation Actions

Authors:Ana Iglesias; Anders Branth Pedersen, André Vizinho; Andreas Hastrup Clemmensen; Anne Jensen; Anne-Mari Rytkönen; Eliska Lourencova; Filipe Alves; Gil Penha-Lopes; Grit Martinez; Inês Campos; Jenny Troeltzsch; Margaretha Breil; Milla Mäenpää; Pedro Iglesias; Sébastien Foudi; Søren Gram; Volker Meyer

Introduction

By Filipe Alves and Inês Campos

All over Europe the Adaptation Agenda is quickly gaining momentum with several countries, regions and cities already implementing concrete and ambitious Adaptation strategies (EEA, 03/2013). Most of this wide range of adaptation measures can be found in the European Climate Adaptation Platform (Climate-ADAPT) and although many case studies all over Europe still don't make it online, Climate-ADPAT is a great indicator of the existing information available, knowledge gaps, sectors which are over researched and other still lacking proper attention.

One of the key objectives of BASE is to contribute to Climate-ADPAT with strong, coherent and comparable case studies. A strong emphasis in comparability has always been fundamental to BASE, as at the core of its objectives is the need for proper upscalling of bottom-up data and meta-analysis between case studies from which we can draw important policy lessons and guidance at the EU level.

Nevertheless, aiming for comparability between different case studies working on adaptation can be a 'tricky business' due to the local-specific nature of Adaptation Strategies and Actions. '*Because different regions have different vulnerabilities to climate change and different socio-economic characteristics, an adaptation measure that is suited to one place may not be applicable in another* (EEA, 03/2013). And even if studying the same adaptation measure in different places, the unique socio-economic, cultural and ecological characteristics of different contexts make comparability a challenging for researchers. In this respect, we might consider that Adaptation and Mitigation are an ocean apart.

Still, BASE research teams, under WP4 leadership on Common Case Study Research task (4.1) and WP6 Data Exchange Plan task (6.1) set out ambitious goals regarding comparability of case studies, structured by: common downscaling and upscalling models; common tools, such as PRIMATE and the Adaptation Pathways, shared resources and peer-to-peer training on specific methodologies, namely for participatory action-research.

Following chapter 2, where baseline research regarding climate impacts and adaptation has been described for each case study and their subgroups, in this chapter, we develop a first attempt to provide comparisons between existing preliminary research results. This exercise serves us in identifying key research focusses within each case that will strengthen their future comparability. Therefore the chapter is divided in two sections. Section 3.1 highlights current knowledge on perceptions, motivations and drivers for actions in BASE case studies; and section 3.2 focusses on perceptions and responses to risk and vulnerability within ecological, socio-political and economic dimensions. Thus, the contributions below provide an in-depth comparative analysis of adaptation actions based on preliminary findings of BASE case studies.

3.1 Perceptions, motivations and drivers for action

By Milla Mäenpää and Anne-Mari Rytkönen

This section draws on preliminary results from case studies with a focus on how local perceptions on climate change influence motivations that may trigger local actions. We begin by providing an overview on basic concepts of adaptation, highlighting the importance of perceptions for adaptation planning and actions. We follow by drawing from six case studies which are already providing clear insights on this topic.

The perception of risks covers processes of collecting, selecting and interpreting signals about uncertain impacts of events, activities or technologies. These signals can refer to direct, personal observation or indirect information from other sources. Perceptions may differ depending on the type of risk, the risk context, the personality of the individual, and the social context. (Wachinger & Renn, 2010).

The individuals relate to climate change through personal experience, knowledge, the balance of benefits and costs and trust in other societal actors. In studies of European and USA public opinions and attitudes regarding climate change, climate change is perceived as complex and sometimes misunderstood issue. (Lorenzoni & Pidgeon, 2006)

The literature on adaptations makes it clear that perception is a necessary prerequisite for adaptation (Maddison 2007). Studies show that different socio-demographic factors, such as gender, ethnic background, income, membership of environmental groups, exposure to mass media and education may all affect individual perceptions to climate change (Deressa et al. 2011). Also different degrees of knowledge, cultural preferences, responsibility and trust will all shape an individuals' position on the issue (Lorenzoni & Pidgeon, 2006).

In Europe and USA, laypeople often perceive climate change as an "un-situated" risk that threats more vulnerable groups or future generations. People are not likely to support initiatives addressing climate change unless they consider the issue a very serious societal or ecological problem, or one affecting them personally. In order to encourage individual acions to take place, providing scientifically sound information alone will not be sufficient in itself. One option to increase uptake of mitigation actions would be to seek to increase trust in government and institutional capabilities. There is also an increasing recognition that situating climate change 'in the locality' will provide the driver to initiate behavioural change, as the benefits become tangible to individual participants. (Lorenzoni & Pidgeon 2006).

Based on the results of EU project CLICO, climate change was generally considered as an additional stressor impinging on existing problems (such as food security, drought and water availability). The extent to which climate change adaptation is taken up in different countries appears to be influenced by the way it interacts with existing policy agendas – in addition to the degree of vulnerability of a country (Gerstetter et al. 2012)

Planning

Adaptation means adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. (McCarthy et al, 2001)

The IPCC distinguishes several type of adaptation:

- **Anticipatory Adaptation**— Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
- **Autonomous Adaptation**— Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.

- **Planned Adaptation**— Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

  Planned adaptation means using information about the present and future climate change in order to review the applicability of current and planned activities, policies and infrastructures. Adaptation is very context-specific as it depends on the climatic, environmental, social and political conditions in target region and sector. (Füssel, 2007).

Human adaptation to climate change is a diverse set of activities that may have close links with e.g. natural resources management, water management, disaster preparedness, urban planning and poverty reduction. Adaptation planning also shares many common features with risk management. (Füssel, 2007). Adaptation plans in developed nations acknowledge the need to mainstream adaptation into existing policies and make use of synergies among adaptation and other policy goals (Preston et al. 2011).

Actions

Adaptation actions can be classified based on the sectors considered, timing, goal and motive of their implementation. Adaptation can involve **building adaptation capacity** or **delivering adaptation actions.** Building adaptive capacity may involve creating the information, governance and social structures that enable actions to take place. Adaptation actions can be targeted at 1) accepting the impacts and bearing the losses, 2) preventing effects or reducing risks, 3) compensating the losses by spreading or sharing risks or losses and 4) exploiting positive opportunities. (UKCIP)

Most adaptation actions help to reduce risk associated with the current climate variability and may support also other objectives. Despite adaptation, all adverse impacts of climate change cannot be prevented and there will still be residual impacts. The decision on acceptable risk levels involves evaluation of the trade-offs between expected costs and benefits of different adaptation levels. (Füssel, 2007).

According to UKCIP, adaptation options are normally referred as

- **no-regrets** (actions that are worthwhile regardless the extent of future climate change)
- **low-regrets** (actions whose costs may be relatively low and benefits relatively large)
- **win-win** (actions that help to minimize the climate risks or exploit potential opportunities but have also other benefits), and
- **flexible/ adaptive management** (actions that allow for gradual adaptation).

3.1.1 Coast of Aveiro – Perceptions and bottlenecks for action

By Inês Campos

Baseline research in the coast of Aveiro included a literature review and various conversations with local stakeholders, and provided some insights into local perceptions regarding climate change. Recent interviews with local administrators and NGOs highlighted a growing political awareness of the need to act and implement an adaptation plan for the area. Finnaly, worshops and interview transcripts (see section 2.18 Aveiro Coast) indicate that local administrators are concerned with having to respond to emergency situations which were considered to be “ineffective and extremely expensive” (workshop transcript), and support instead the development of robust medium and long term plans that can effectively decrease risks and vulnerabilities.

The mayor of one of the municipalities involved has pointed out that “there is a serious situation that demands an immediate response”; while a technician from another municipality involved, remarked that “the real problem is long term planning; we can plan for now, but it’s very difficult to keep up our promises when the mayor is not re-elected.”

Such issues are not new, nor specific to this case study: long term planning is challenging in an electoral political system and in a socioeconomic landscape subject to numerous constrains, particularly under the current socioeconomic crises and structural adjustment scenarios that Portugal has been dealing with. Nonetheless, the particularities of the area are increasingly complex due to an array of institutions, administrative bodies, local associations, NGOs and national government bodies that have not been able to engage in a close inter-institutional dialogue towards a sustainable adaptation plan for the coast. Over the past decade, some immediate measures have already been taken, namely the building of 5 groynes along the coast and a few sand dredging operations. Yet these measures have been piecemeal and uncoordinated solutions, often of the initiative of the Aveiro Harbour, who recently has transported sand to the shoreline to feed the beaches of Costa Nova and Vagueira. Interestingly, interview results indicate that the harbour has been an “escape goat” for local population, who blames harbour constructions for the aggravated coastal erosion in the past years. Conversely, results indicate that residents believe they can rely on outside intervention from local and national administration bodies (including the Harbour!), who will provide adequate and timely solutions to coastal erosion, and bring back their long stretches of sand beach. Nonetheless, one of our interviewees, the head engineer of the Aveiro Harbour, claimed:

“We have to do something, we will put sand or something else, but there is no way they will have that long beach back…that is past waters…”

Though lack of institutional dialogue and collaboration were pointed out as being a barrier for adaptation policy both in our interviews and in recent studies (Schmidt et al, 2013), our workshop and interview transcritps reveled two other complementary opinions, on the perceptions and barriers to adaptation policy design and implementation.

First, it was pointed out that the closer administrative bodies are to the central government, the higher is the uncertainty surrounding the implementation of a plan. Political and administrative uncertainty emerged as a barrier for adaptation, from the point of view of local stakeholders. Local administrators and agencies complained that even if they designed a “flawless plan” (workshop transcript), and found the necessary financing mechanisms, they would still face the risk that central administrors “sitting in their Lisbon offices, just decide it’s a no-go in the last moment” (workshop transcritp).

Second, municipal technicians point out that the lack of technical knowledge to support decision-making is the reason why long term planning for climate adapation is so challenging. The technicians interviewed claimed that if there was a strong and robust technical knowledge that could benefit from the sharing of scientific information by local and national universities on this subject, they would be in a better position to advice political actors. These technicians believed that politicians deciding under budget constraints cannot afford to make mistakes and have full access to knowedge. Yet, it was mentioned by most stakeholders, that it is difficul to acess scientific knowledge, quoting an interviewee: “university research seems to be locked up in boxes, you can take a peek here and there, but you never see all the boxes together”.

Developing technical solutions, the sharing of knowledge, as well as alternative financing schemes and spatial planning policies to deal with environmental vulnerability; are key challenges for the region between Barra and Areão. Being one of the most vulnerable coastal areas in Portugal to sea level rise, adaptation planning in this region has been compromised by lack of institutional dialogue and by bottle-necks in local governance initiatives.

Ultimately preliminary results of our research in the area show there is a need for a change in local culture and attitudes regarding planning development.

3.1.2 Iberian – Perceptions on Climate Change

By Pedro Iglesias and Ana Iglesias

Efforts to develop climate change adaptation policies have been met in Spain with a lack of concrete local measures that may be understood and supported by citizens. Even in areas of strong environmental commitments, the success of various policy proposals has been mixed, reflecting a perception that the public view adaptation to climate change as opposed to economic development, aiming to understand rational choices.

The likelihood of climate change impacts will continue to increase as long as adaptation and mitigation strategies are not put in place. Given the costs and lack of incentives associated with promoting adaptive capacity, adaptation is unlikely to be facilitated through the introduction of new and separate policies, but rather by the revision of existing policies that currently undermine and the strengthening of policies that promote adaptation (Iglesias et al., 2011). Finding common ground between competing claims is a serious challenge to policy development. Nevertheless, this challenge needs to be addressed to ensure the coherence and efficiency of policy measures under a changing climate.

Several questions arise when it comes to explore the various mechanisms for **Adaptive Management**:

- Mechanisms to trace the impacts of adaptation choices?
  - near-term, longer-term
  - environmental, differential social impacts
- Institutional mechanisms to revisit previous adaptation choices?
- Social/political mechanisms to address social justice concerns, power imbalances?
- Definition and measurement of effectiveness? According to whom?
- Weighting and comparison of differential outcomes?
- Adjudication among different goals, embedded values?
- Reversibility of adaptation actions and (non)actions?
- Flexibility (socially, institutionally, politically) to respond and correct prior actions?
- Ethical obligations and legal (financial) liabilities to future generations, people and companies elsewhere?
- Forums for the expression of public discontent and redress? Mechanisms for “just” compensation?

The first conclusions of the Iberian Case Study show that perceptions of the adaptation measures are undermined by perceived or real barriers concerning:

- Feasibility of implementation

- Effectiveness
- "Collateral": Expected impacts of different choices
- While the implementation of "technological solutions" depends on:
- Availability
- Accessibility
- Affordability
- Advisability
- Acceptability

Preliminary results of the Iberian case study recommend enhancing **Decision-Support Resources** with:

- Access to critical information, tools, and knowledge
    - Understand the problem, causation, future trends
    - Develop and critically assess response options
    - Monitor impacts for adaptive management
- More than information...
- Sensitivity of decision to various uncertainties
- Useful scale and format to easily integrate into existing decision processes
- Timing of delivery
- Contested knowledge?
- Periodic review of state of knowledge?
- Willingness and capacity to learn

3.1.3 Kalajoki – Local perceptions and motivations

By Milla Mäenpää and Anne-Mari Rytkönen

With regard to the risk of flooding, Finland is currently one of the least vulnerable regions in Europe (Schmidt-Thomé et al. 2006), and the annual damages caused by floods are relatively low. The direct climate change impacts on hydrology in Finland during the 21st century appear to be for most parts manageable. There may even be some positive impacts in the form of increased hydro-power production. In areas with increasing floods, adaptation in land use planning and water resources management is needed to reduce the flood risk (Veijalainen 2012).

Finland adopted its first National Adaptation Strategy (NAS) in 2005 (Ministry of Agriculture and Forestry, 2005). Water resources management is one of 15 sectors covered by the strategy. Responsibility for implementation of the NAS lies with sector ministries, so detailed adaptation actions for water resources management are included in sectoral action plans prepared by the Ministry of Environment (2008, 2011) and the Ministry of Agriculture and Forestry (2011) that share responsibility for the sector in Finland. Measures included in the action plans focus on e.g. integrating adaptation into regional river basin management plans, flood risk management plans and other measures developed in response to national implementation of the Water Framework Directive and the Floods Directive. The action plans assign actions for the public sector alone, focusing primarily on the national and regional levels of administration though some actions are designed for local level actors such as water utilities.

Flood risk management plans are based on Floods Directive and related national legislation. Kalajoki river basin is named among the 21 national a significant flood risk sites The designation of risk sites like Kalajoki is not based on extremely frequent floods because of financial or ecological consequences or but because rare floods might cause severe risk to human health (e-g for example threatening hospital facilities)..

From the local point of view, climate change is not observed as a major concern in Kalajoki area. The extreme flooding and weather conditions have not been frequent and local people are not very concerned of climate change. The risk of climate change impacts (i.e. flooding) has come more obvious to local farmers and residents who live near flood area, not because of expected or realized impacts of climate change but more because of changes in national policy concerning the supplementation: the recent reform of flood compensation system shifts more responsibility from government to private sector. This seems as one of the main drivers for implementing the adaptation measures.

Flood risk management aims to respond to current extreme events keeping in mind the future developments, such as climate and land use. The planning unit is the river basin, which usually encompasses several municipalities and regional administrative units. For cooperation between the authorities, a flood management group has been designated for each river basin. The flood management group is composed of regional authorities, municipalities and regional rescue services. The flood management group sets the objectives for flood risk managementand approves the proposal for the plan and the measures included in it. Information to be presented in the flood risk management plan includes a description and grounds for the prioritisation of measures, estimated costs, parties which have shown interest in implementing the measures and the financing possibilities, as well as how the progress in the implementation of the plan is to be followed.

Implementation of adaptation measures depends on the nature of the measure, but most of them are of municipalities' responsibility. Implementation of measures is uncertain: FRM plans are not directly binding and the national financial support has been cut substantially. The misfit between planning and implementation is obvious. The motivation to implement the measures is depends on other motivation and drivers than climate change adaptation or risk.

3.1.4 Timmendorfer Strand – Retrospective Results

By Grit Martinez

This contribution discusses the perception of climate risks and the adaptation measures developed in the coastal community Timmendorfer Strand - located at the German Baltic Sea coast. The focus is on the socio-cultural, ecological and economically motivated reasons that led the community to engage with adaptation to climate change. The research carried out by Ecologic Institute sketches out the historical development of the community Timmendorfer Strand based on an exceptional strong storm surge in the 19th century.

Results are based on 9 semi-standardised interviews which lasted approximately two hours and were carried out in random order with local decision-makers, interested residents, local entrepreneurs, the village chroniclers and the heads of regional and “Heimat” (home) associations. In addition, around 30 passers-by were interviewed based on a standardised questionnaire at central locations in the community. Results were interpreted against broad background research, which included analysis of current development strategies but also handwritten village chronicles, literary works, and historic photographs.

In Timmendorfer Strand about 4.500 inhabitants live less than 3 m above MSL and are acutely threatened by flooding in the case of extreme storm surges. In the past the state authority for coastal protection had repeatedly highlighted the critical situation, putting forward technical solutions to the municipality for raising the dyke. In the tourism-dependent community however (annual overnight stays: 1.3 million), there was fierce local resistance against this solution which was considered visually intrusive. Protests mainly originated from fears over losing the attractiveness and hence the economic value of the coastal promenade which is a major tourist attraction. In order to overcome the stalemate, the local mayor and the state authority for coastal protection instigated a participative process aimed at developing a mutually acceptable solution. The solution marries local ideas with protection from storm surges based on an assumed sea level rise by 0.5 metres per century. A well-landscaped sea wall offers protection from storm surges of up to 2.75 m above MSL whilst also preserving the sea view so essential for tourism.

A look back at the history of Timmendorfer Strand, however, shows that the stage was set early for such a development in coastal adaptation. After the appalling consequences of the 1872 storm surge, the municipality of Timmendorfer Strand made use of the emergency funds provided at the time to invest in a comprehensive programme of reconstruction. The foundation was laid for the development of what has since become a renowned spa town. With growing prosperity and continued investment in infrastructure, the consequences of the storm surge were gradually forgotten. After World War II rapid development of tourism-oriented infrastructure ensued, pushing agriculture and fishing into a distant second place. The identity of the community has therefore long been determined by tourism and the material standards this has helped to achieve. The predominant value orientations of the current residents highlight this. Although there is appreciation of nature and the landscape as an immaterial good, most interviewees regard the Baltic and the beach predominantly as economic capital: "*The Baltic, the beach and the coast are our life blood, this is our capital*"

Due to the lack of feasible alternatives the community sees its future in continuing its strategy of high quality, intensive spa and bathing tourism. The substantial investments and the choice of an expensive adaptation strategy can thus be understood as a strategy designed to protect the community's primary material values and future development options. In Timmendorfer Strand, tourism and the associated consumerist values (such as gain orientation, individualist entrepreneurial thinking, and protection of the high standard of living) can therefore be understood as the primary drivers of coastal protection measures.

For Timmendorfer Strand, congruence can be noted between the interests of coastal protection, adaptation to climate change and tourism development. Tourism has always been a key driver of developments and represents the centerpiece of community identity. Apart from generating material wealth, this has also shaped the immaterial values of the community, promoting for example entrepreneurial thinking and investment in culture and infrastructure. Despite the low sense of threat from storm surges, the need for coastal protection is generally accepted. Protection of the community's material values as a basis for future development is the uniting force within the community. Acceptance of the chosen adaptation strategy however was also critically influenced by the community's ability to influence the proposals made by the responsible authority. This led to the implementation of a concept that benefits both coastal protection and tourism. Key to this was the good financial position of the municipality and the (moderately) participative planning process.

In order to be able to successfully plan, implement and communicate adaptation measures, knowledge of historical, cultural and socio-economic development paths and key community values is therefore essential. These need to be taken into account at every stage of planning, in close co-operation with local actors.

3.2 Comparative Analysis of Risk and Vulnerability in Case Studies

This section provides an overview of baseline case study research from the perpective of how risk and vulnerability perceptions reflect on adaptation actions and strategies. We begin by providing a clear definition of what is understood by risk and vulnerability and then draw on a few case studies to illustrate different risk perceptions and responses within the ecological, social, population, governance and economic dimensions. We expect that work under task 5.3 will provide further insights into how risk and vulnerability are locally experienced and trigger different adaptation responses. Yet a few key findings are highlighted by the following contributions.

3.2.1 Risk and Vulnerability

By Margaretha Breil and Eliska Lorencova

While the definition of the term "risk" as provided by the research community focusing on natural hazard, ("product of the consequence (cost) and probability of an event or phenomenon") is relatively straightforward, the term "vulnerability" presents relatively divergent understandings in different research communities.

In the context of research on climate change impacts, the term vulnerability is generally defined as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" is determined by "character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity'." (McCarthy, Canziani, Leary, Dokken, & White, 2001).

This definition, brought forward in the third Assessment Report by the IPCC, embraces well the complex relationship between physical impacts from changing climate, normative judgments (underlying the definition of adverse effects of climate change) and elements characterizing the exposure, sensitivity and capacity of adaptation of the system under exam has with respect to single impacts from climate change which connotes vulnerability in the climate change context. According to this definition, vulnerability is the result of conditions which can vary in place (different physical conditions determine different forms and rates of vulnerability to impacts), time (vulnerabilities can evolve over time or can be reduced by adaptation), and most importantly depending on social and institutional assets. Views on vulnerability may, furthermore, change according to the scales of analysis (from global to local).

The definition represents a useful framework for an analysis which looks for insights into resilience and potential types of action for adaptation. It represents, in fact, the result of an overlay of two different visions on vulnerability (Messner & Meyer, 2006), combining the consideration of characteristics of physical elements - places, persons and drivers, defining the vulnerability of ecosystems - with the view on vulnerability as a social phenomenon – entitlements and institutional assets determining potentially different forms individuals and communities are sensitive to impacts and able to recover from damages, resist to impacts. Or as defined by Blakie et al. (1994, 9, cited by Adger, 2006) "(…)the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard". The consideration of entitlements, or the possibility of access to resources of different kinds, is, according to this view, a determinant for the vulnerability of persons and communities (Adger, 2006). On the other side, the risk-oriented view on vulnerability which is based on a dynamic concept also of risk and exposure, allows for the analysis of so-called “disaster risk construction” in the sense that manifold human activities increase and accumulate exposure to hazards and climate impacts (Lavell & Maskrey, 2013).

The combination of these two visions allows for an understanding of vulnerability which takes into account both the physical elements of impacts, exposure and sensitivity, and the social elements of sensitivity to changing environmental conditions, while taking into account the extend or “system” under analysis.

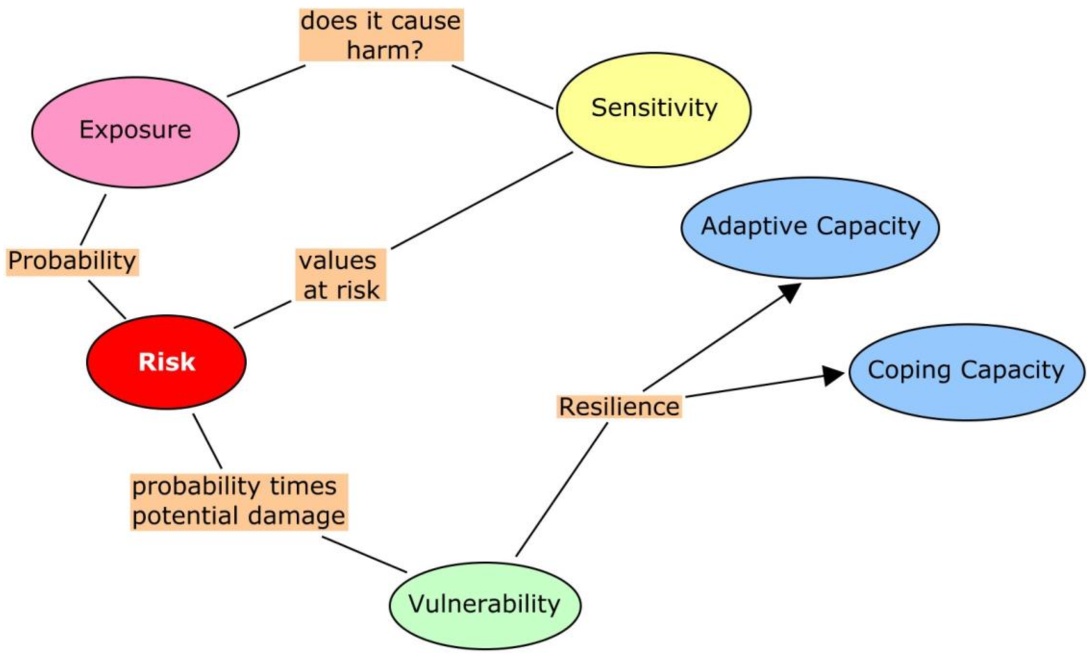


Figure 3.2.1

To conclude, vulnerability assessment is definied as a common tool to evaluate the potential for harm to occur within socio-ecological systems as a response to global climate change (Adger et al.; 2007). Measures of vulnerability typically include three components: exposure to climate change, sensitivity to its effects, and adaptive capacity for coping with the effects (Metzger and Schröter, 2006; Bergström et al., 2011). Adaptive capacity is a measure of society’s resources and capabilities to offset the adverse effects of climate change or exploit possible benefits. Accordingly, vulnerability can vary greatly between geographical areas, ecosystem services, or sectors, the following sections will expand further on this.

3.2.2 Ecological Vulnerability

By Eliska Lorencova; Roos den Uyl and Duncan Russel

Climate change is accelerating in its manifestations and increasingly influencing both ecosystems and human society (Staudinger et al., 2012). Impacts of climate change, inflicted inter alia by global warming, sea level rise or extreme climatic events, depend not only on the intensity of climatic change, but also on the **vulnerability of human and natural systems to climate change**.

Climate change could intensify existing environmental crises, such as crises concerning drought, water scarcity and soil degradation (WBGU, 1998).

As mentioned in the introduction above, **two types of generic vulnerability** determinants exist (Adger et al. 2004; Preston and Stafford-Smith 2009). First, **biophysical** determinants that are defined as physical, biological and ecological factors (e.g. climatic conditions, natural hazards, land cover, and primary productivity) influencing the harm potential. Second, **socio-economic** determinants, which are social, economic or cultural factors (e.g. demography, poverty, trade, employment, governance) effecting the harm potential. In this chapter, we focus on biophysical vulnerability determinants, in particular related to climate change.

Growing demand among stakeholders across public and private institutions exists for **spatially-explicit information regarding vulnerability** to climate change at regional and local scale (Preston et al., 2011). The use of spatial analysis in vulnerability assessment assists to build understanding about climate vulnerability and its geographic distribution and may facilitate adaptive responses of institutions and civil society (NRC, 2007; Kienberger et al., 2009). Vulnerability monitoring and indicator systems have been suggested as an effective way to manage risk and increase preparedness and stress testing (Stern et al., 2013). In this sense, spatially-explicit vulnerability assessments have the potential to act as support information for decisions related to adaptation response.

Metzger et al. (2008) applied IPCC Third Assessment Report definition of vulnerability to climate change to quantitatively and spatially explicitly assess vulnerability of ecosystem services in Europe. In the study, **vulnerability is a function of potential impacts and adaptive capacity**, where potential impacts are a function of exposure and sensitivity. Based on the IPCC SRES A1fi scenario, the study assesses and maps vulnerability of the ecosystem service indicator, the net carbon storage. The vulnerability maps were created based on a visual combination of stratified potential impact and adaptive capacity maps. To summarize, trends in vulnerability follow the trend in stratified potential impact. When ecosystem service supply increases, the vulnerability decreases, also adaptive capacity decreases the vulnerability.

Schroter et al. (2005) applied a range of ecosystem models, climate and land use scenarios to investigate ecosystem service supply and vulnerability to global change in Europe. Many changes in climate and land use decrease supply of ecosystem services (e.g. decline in soil fertility, water availability, and increase in risk of fires) and therefore increase vulnerability. In Europe, this is mainly the case of Mediterranean and mountain regions. On the other hand, global change can bring some positive effects (such as increase in forest area and productivity) as well as opportunities (e.g. 'surplus land' for agricultural extensification and bioenergy production). Finally, the spatially-explicit vulnerability assessment is prerequisite for development of adaptation strategies that need to take into account stakeholder´s involvement within the national, regional policy framework.

A different approach to the mapping of climate change vulnerability and adaptation strategies is illustrated by Watson et al. (2013). The performed ecoregional assessment of global ecosystem vulnerability integrates intactness (ecoregion's adaptive capacity) with its relative exposure to future climate change in order to assist conservation practitioners with spatially explicit adaptation guidance. Based on the findings, decline in vegetation intactness is a greater threat to vulnerability than present climate change. Therefore, development of conservation strategies will need to reflect climate change impacts and simultaneously aim to influence the intactness of ecosystems to maintain ecosystem integrity.

***Green Roof* (Czeck Republic)**

To date, no comprehensive assessment of potential climate change impacts and ecological vulnerability towards climate change in the Šumava National Park (NP) has been conducted. However, it is feasible to draw information about local ecological vulnerability from reports and research studies related to these types of ecosystems. Since the prevailing and most valuable type of ecosystems in the Šumava Mountains are coniferous forests and peat bogs, the following review will focus on these two types of ecosystems.

The dominant coniferous tree species in the Šumava Mountains is Norway spruce (*Picea abies*), comprising approximately 80% of the forest cover, which is high above the natural abundance of approximately 40%. In the Šumava Mountains, only small patches of Norway spruce are autochthonous, occurring in higher altitudes. In these areas, the climatic conditions, namely lower temperatures and higher precipitation, present the optimal habitat for Norway spruce. However, the majority of spruce forest in the Šumava NP, originating from the 19th century, was planted in the area of former mixed forests. Therefore, most of the Šumava NP area does not present a natural habitat for Norway spruce forest and causes its higher vulnerability towards climate change, especially increasing temperatures and increasing occurrence of drought episodes (Hlásny and Turcani, 2013; Hlásny et al., 2011).

The responses of spruce forests to climate change are rather complex as a result of many interacting components of the forest ecosystem such as tree cover, under canopy vegetation, allochthonous and autochthonous pests, soil environment and hydrological cycle. The second important factor is the fact that spruce forests in the Šumava NP on average more than a hundred years old, and hence their adaptive capacity towards climate change decreases (Hubený, 2012). Generally, change in temperatures and precipitation is projected to influence growth, reproduction and other vegetative processes in Norway spruce. Furthermore, droughts and increased temperatures are one of the drivers of bark beetle outbreaks, habitat widening and more frequent bark beetle lifecycles, with subsequent impacts on forest degradation. Apart from the influence of gradual changes, local spruce forests are threatened by changes in the frequency and duration of extreme weather events such as drought periods and windstorms, which may affect the forests much more noticeably than gradually changing climatic conditions (Hlásny and Turcani, 2009; Kocmankova et al., 2011). The growth of spruce forest in higher altitudes is likely to be enhanced by local climate change, resulting in expansion into higher areas. Subsequently, local alpine ecosystems, ranked amongst the most vulnerable ecosystems in the Czech Republic (ME, 2013), may become threatened.

The second valuable and vulnerable ecosystem type of the Šumava NP are peat bogs. Since peat bogs represent significant carbon stocks, their potential ecological disturbance may have noticeable impact in terms of climate change mitigation. Peat bogs are particularly vulnerable towards rise in temperatures and changes in water regime, both of which are projected for the area of the Šumava NP. These climatic trends may cause drying-up of the peat bogs, change in species composition and carbon release. Moreover, prospective change in water regime is exacerbated by other drivers, such as water drainage in the adjacent forests and former agricultural land. Finally, the condition of peat bog ecosystems is influenced by air quality and imisions, causing decline in vulnerable peat bog species and subsequent negative changes in peat bog species composition (Gallego-Sala and Prentice, 2012; Clark et al., 2010).

The vulnerability to climate change in the Šumava NP is likely to be exacerbated by additional environmental and socio-economic factors. Amongst the environmental factors, air pollution and landscape fragmentation are the most influential. In terms of socio-economic factors, intensive tourism and recreational activities are likely to increase the ecological vulnerability of the national park, together with increase in built-up land.

In terms of adaptive capacity of the Šumava NP forested areas, local experience with forest management mitigating the impacts of climate change are very limited at present (Hlásny, 2012).

Dartmoor **(United Kingdom)**

One of the key ecosystem service vulnerabilities to climate impacts is the impact on upland peat ecosystems. The UK contains 13% of the world’s blanket bog habitat of which Dartmoor is one of the main UK locations of blanket peat bog in the UK (ASC, 2012, ch4.). Upland peat provides crucial ecosystem services:

- regulating services around carbon sequestration, flood risk reduction through storage of water during precipitation events, and the filtering of atmospheric pollutions from rain water such as sulphur, nitrogen and some heavy metals;
- provisioning services in terms of providing a steady water supply through summer months;
- supporting services in terms of providing a habitat for rare peat forming UK flora and fauna; and
- cultural services as the landscape and ecosystems associated with peat are seen as a key part of the UKs natural heritage.

This upland peat habitat however, is particularly vulnerable to the impacts of climate change. This vulnerability has been exacerbated by human pressures on the upland peat environment due to overgrazing, application of fertilizers, drainage and acidification from industrial atmospheric pollution. As a result, according to a report by the UK Climate Change Adaptation Sub-Committee "[o]f the total area of upland deep peat (3,550 km2), only 160 km2 (4%) is in a favourable ecological condition where mosses are still actively forming peat. This has declined from 210 km2 (6%) in 2003" (2012, p76). While Dartmoor hosts one of the healthier blanket peat bogs in the UK, it still has areas that are severely degraded (ASC, 2012, Figure 4.3). Climate impacts are likely to further contribute to the vulnerability of this habitat through:

- increasing the risk of drying and peat degradation during drought periods;
- increased risk of changes in the flora due to drying, temperature increases, and increased wildfire risks meaning that peat forming mosses are vulnerable to being replaced by non-peat forming flora;
- and increased risk of peat erosion during extreme precipitation events, particularly on peat habitats that have already suffered from over grazing pressures (Climate South West, 2010; ASC, 2012).

The vulnerability of this delicate ecosystem means that the ecosystem services it provides are at risk for the dual pressures of human activities and climate change. Interestingly, though, these vulnerabilities are not fully accounted for in the Dartmoor National Park Authority's Adaptation Strategy (DNPA, 2011). Therefore part of the case study work will examine why this is the case and whether the current adaptation strategy is robust enough to help the vital ecosystem services provided by the upland peat habitat to adapt to climate change. It will also look in to exploring what other approaches can be taken to reduce the vulnerability of peat to climate related degradation.

3.2.3 Social Vulnerability and Participation

By Inês Campos; André Vizinho; Andreas Hastrup Clemmensen and Søren Gram

Not all BASE case studies have yet produced results that allow us to develop a detailed analysis of the social responses to climate change adaptation. Three very different cases stand out in this perspective: Alentejo; The Coast of Aveiro and Kalundburg. In this subsection we will review these case studies, highlighting results on social perceptions of risk and vulnerability.

Alentejo Region

In the case of Alentejo, social perceptions of risk and vulnerability have been core to the Retrospective Analysis of the Convergence Center (CCAA) project at Amoreiras Village (see section 3.1.2 - description of Alentejo Case Study). This region is particularly vulnerable to climate change namely to drought, water scarcity, heat waves and desertification. The main objective of the retrospective analysis of the Convergence Center was to understand the impact this organization has had locally as an inovative demonstration site for alternative practices against social desertification and as an autonomos adaptation project. Though the project was not framed as an adaptation action, its impact is directly linked to building local adaptative capacity to climate change, namely in influencing local perceptions and strategies to deal with drought and in promoting and implementing autonomous adaptation actions.

Not surprisingly, when presented with 3 possible future scenarios (complete desertification; industrialization and intensive agriculture; regenerative agriculture and sustainable villages), most participants agreed they would be working for the "regenerative agriculture and sustainable villages scenario", and claimed they would strive to find context-specific solutions to regenerate land and local living. They perceived Alentejo as very vulnerable area to desertification, but were determined to dedicate themselves to finding ways of strengthening local adaptive capacity, quoting one of the group's members:

"*We may have a 'mad max' scenario sometime in the future, but we can use our resources, our ability to work together to fight that*"

The project has had a considerable impact in the lives of those who participated in it, namely the participants of the retrospective analysis, who were motivated by ecological principles and a need to "be outside", "away from the computer" (expressions often noted in interviews and workshop transcripts). These emotional and rational motivations are reflected in the group's continued resilience to financial and social barriers to their presence in the village. According to interview and workshop results, the members of CCAA characterized the initial reaction of the villagers to their presence as "suspicious and apprehensive", yet gradually, as people were involved in the project's activities, respondents felt that not only this suspicious attitude had changed, but that the villagers respected their choices and in the process were even sometimes keen to adopt some of these practices (such as recycling, or using more efficient irrigation techniques).

Overall, for the past seven years, despite great challenges in maintain financing, CCAA has been engaged in influencing a socio-technical transition in the region, as a response to the problem of rural exodus and desertification. The group achieved this largely by promoting a deliberative governance experiment and a processes of adaptation to climate change (soil irrigation techniques novel to the region; social dynamics that make rural life more appealing; relocation of families; soil regeneration techniques).

At the governance level, the case study demonstrated the local impact of mode of a "governance from the inside" (Jorgensen, 2012), and its importance in fomenting the replication of actions that can equally build up adaptive capacity. We conclude that multiplying experimental venues and pilot projects such as this, though challenging (since it implies the relocation of households from urban to rural settings), could be a successful strategy in a regional plan against social desertification that contributes as a model to a low carbon society (Unruh, 2002), but also supports local adaptation actions and a socio-technical transition to a more sustainable Alentejo (Figueiredo & Pereira, 2011).

Moreover, analysis of CCAA from an Arenas of Development (Jorgensen, 2012) perspective, shows these actor-worlds and their performances integrate both the villagers arena and different arenas of governance. As much as the group members' performance should be geared towards empowering local villager's everyday practices and culture, their arena needs also to be empowered by other arenas of change, such as the local village residents, the local administration office or the "Junta", and the district Mayor Office. By facilitating action and responding to the village's deliberative governance process, both the Junta and the Mayor's Office would be empowering CCAA and promoting a higher sociopolitical legitimacy of the project. This has not always been the case, as was demonstrated with the analysis of one initiative led by the group - the Sustainable Village Initiative. During this iniciative, when presented with the results of the "village dreams" – a participatory event where the group and villagers identified their dreams for a more sustainable Amoreiras village -, both the Junta and the Mayors Office were not always keen on following through the implementation of actions that would realize the villagers' dreams. Motives for this were essentially political. The Junta felt that by allowing CCAA to repair some public paths and benches in the village, CCAA would be undermining their authority. The Mayor delayed building a children's playground for two years and construction was only carried out during the regional elections campaign in September, 2013, even though CCAA had provided a plan and a design of the playground, and could have built it, were it not an illegal construction.

Empowering CCAA as a facilitator of a governance process in an isolated small village is an important step for creating higher sociopolitical legitimacy of this niche project. Such legitimacy, as has been shown by transition research (Smith & Kern, 2009), is important to promote duplication of likeminded projects and actions, and ultimately to build up adaptive capacity. Moreover, niche projects such as CCAA need to be shielded, nurtured and empowered (Smith et al, 2013) as they represent an initiative that facilitates urban and rural connections in a region that is and will be ever more afflicted by social desertification, if nothing is done. This empowerment could also come from the national policy arena, through economic incentives for concurring projects or by land use policy, including the donation of land for experimental projects, as is being implemented by the Welsh government, with its One Planet Development program.

Furthermore, as active members in several national and international networks of environmental initiatives (such as GAIA's network; and the Transition Towns Network in Portugal), CCAA influenced these networked arenas. By intensifying dissemination, these arenas may contribute to sustainable transformations, fighting desertification. Likewise, the scientific arena can also back this transition by developing research on the sustainable relocation of people and land regeneration projects as an adaptation strategy for the region.

To conclude, creating spaces for dialogue between all those engaged in the socio-technical transition for a sustainable Alentejo and representatives from different political arenas (such as the local mayor and regional policy makers) could help pick up the pace of this ongoing transition to a sustainable Alentejo.

Findings regarding responses to social risk and vulnerability in the Alentejo region will be completed with the progress on research direction 2 of this case study, particularly with the results from the ongoing survey to farmers in the region.

Coast of Aveiro

Today, this coastal stretch has 24 626 inhabitants, 11 880 men and 12 746 women. 4543 (18%) had no formal education and 6111 (25%) have only completed 4 years of study (first level of basic education in Portugal). Illiteracy rate is lower than the national average (5,23%) in Gafanha da Encarnação and Gafanha da Nazaré, both are more urban locations closer to the main cities. Southwards, in Gafanha do Carmo and Gafanha da Boa-Hora, mostly rural areas, this rate increases to around 6%, being higher in the latter (6,62%).

Unemployment rate is 13,24% (close to the national average of 13,18%). Concerning population density, this is much higher than national average (115/km2) in the parishes closer to the cities of Aveiro (to the north) and Ílhavo (inland) – Gafanha da Encarnação (566/km2) and Gafanha da Nazaré (1011/km2), and lower to the south – Gafanha da Boa–Hora (Vagueira) is much below the national average with 71 inhabitants per km2.

Urban development has been extensive in the last fifty years. There are a total of 10037 buildings in the coastal stretch alone – most of them (7577) built after 1971 (75%). In the case of Gafanha da Boa-Hora - a parish that includes Vagueira beach -, from the 1490 buildings that exist today, only 215 have been built in 1970, which reveals a very recent urban occupation.

Overall, the coastal stretch has 16569 dwellings, 6445 second homes (39%) and 1100 empty houses. Gafanha da Boa-Hora has 3018 dwellings and 1930 of most of them (64%) are second homes.

Against this socioeconomic landscape, expected climate pressures represent real threats to keeping the status quo of local ways of living, menacing the residents and visitors' safety as well as their economic and cultural activities. We are still analysing the results of this case study and the final research steps are still ongoing (see, chapter 2; section 2.18).

Kakundborg

In this retrospective and ongoing case study, analysis from a citizen summit on climate change adaptation, which took place on March 2011, provides some interesting conclusions on the social relevance of climate change adaptation plans.

Regarding responses to local vulnerability to flooding, two thirds of the citizens were in favor of making a decision now that will allow the coast line to move further into the area and hereby eventually discontinue current activities in these areas such as summer cottages and farming. Half of the participants thought that smaller temporary protective measures should be allowed if they are removed during this century. About one third of the participants wanted a collective solution based on dikes. This results differ from the position of the scenario workshop. The scenario workshop was held for the stakeholders at local level prior to the citizen summit and the local stakeholders were more supportive of various dike solutions. For a collective dike solution, as well as solutions that phase out current activities, around one third of the participants agreed on the condition that the national government should pay the costs. As for the municipality's role it is obvious that there is no desire that the municipality should fund any of the solutions. Of those who favors a phase-out of current activities, about one fourth of the participants wanted the municipality to play an active role as adviser and planner.

There seems to be broad support for a municipal decision to allow the coastline to move inland as the climate changes, and to let exposed areas flood during extreme precipitation. It would be an advantage to make this decision now, in order to allow the citizens and property owners to know what kind of future to plan for. This way, the municipality, landowners and residents would have time to discuss and find workable solutions for the phasing-out of activities and development of the areas. It should be considered how stakeholders can be involved in the process of specifying how a potential phase-out could take place. When the shoreline moves inland, the current natural areas will be affected or lost. It should therefore be considered how the coastal natural areas can spread into the country in tune with this change.

In contrast to current practices and distribution of responsibilities, a significant majority of participants are in favor of helping the individual homeowner with the responsibility of protecting themselves against flooding. Three quarters of the participants thus believes that the Industrial site along the quayside and Kalundborg Port, should have a responsibility to protect the underlying homes. And as for the case example, where the houses are not located behind the industrial areas nine-tenths of the participants voted that the municipality must play an active, outreaching and planning role in relation to the affected homeowners. Two-thirds believe that the municipality should also co-finance climate adaptation solutions for permanent residences.

Overall, analysis, shows that the participants are willing to give the municipality wide responsibility and authority regarding climate adaptation. Most participants are positive towards allowing the municipality to make demands and change the framework and conditions for private home owners, summer cottage owners and farmers. Participants are also willing to accept that the municipality does not make new investments in infrastructure in vulnerable areas.

Moreover, it should be considered how the daily management of natural areas and the upcoming climate change adaptation plan should take into account that almost a third believe that climate change must be exploited, to reestablish nature/wetlands on exposed land that does not necessarily serve to protect other areas against flooding. Nine tenths of the participants favor an overall plan for the development of the municipality's coastline. The plan should contain decisions about where, and where not, areas should be protected and how. About half see it as the municipality's role to undertake this planning, while approx. one third believe that the state should have the coordinating role. An equally clear trend is found in the participants' attitude to the municipality's approach to climate change adaptation. Nine out of 10 citizens believe that it is not enough to wait to adapt to the climate changes, as they appear or the national legislation dictates action. They believe that the municipality on its own initiative must act now and prepare long term plans that take into account the expected climate changes.

There is a strong desire among participants to continue to participate in the planning of climate change adaptation in the municipality. The interest is distributed evenly over the various dialogue methods. The high number of votes for several citizen summits can be interpreted as an expression of satisfaction with their experience during the citizen summit. Almost all participants indicate that their knowledge about the consequences of climate change has increased, and four out of ten say their knowledge has increased a lot.

On this basis it can be concluded that a citizen summit - besides collecting opinions- is able to distribute knowledge about current and complex issues. These method will also be applied in another BASE Case Study – Cascais, in Portugal, and has been scheduled for September, 2014.

More than two-thirds report that they have changed their attitudes during the process up to and during the citizens summit. In other words, it is possible - through structured information and dialogue - to give people an opportunity to rethink and develop their views on an informed basis. The vast majority of participants believe that climate change will affect them or their loved ones, and just over a third call for more information and advice from the municipality.

Conclusion

The 3 case studies referred in this section present very different findings and ways of dealing with climate impacts and building up local adaptive capacity and gradually decreasing social vulnerability. The Alentejo case study needs a large support base that empowers innovation projects and influences local actions to approach social vulnerability and promote adaptation. Preliminary results show that though desertification is a recognized problem in this region, where rural population is mostly over 40, and rural exodus has been an historical trend; climate change and its potential to aggravate further desertification is not yet perceived as a real threat. In the Aveiro case study, local stakeholders seem to be well aware of the threats of coastal erosion, but not necessary of climate change and the decision to hold the coast line is met with the attribution of responsibility for action to national and local administrations, while as at the same time, participation in decision-making faces diverse bottle-necks which make it harder for joint dialogues and planning initiatives to take place. The Kalundborg case study moves in a very different direction, as local residents and stakeholder groups have engaged in a constructive dialogue that highlights numerous possibilities for adaptation planning. Both

Alentejo and Aveiro could benefit from participatory and deliberative governance process that facilitate responses to current and future climatic change impacts and jointly promote efficient adaptation processes. Therefore BASE research integrates participatory decision-making tools and methods, such as the Scenario Workshop and Adaptation Pathways. In Kalundborg on the other hand, this dialogue is already ongoing and the case study continues with a strong stakeholder engagement. Further results should provide interesting developments in the three case studies, highlighting how different levels of participation can promote efficient strategies to address social vulnerability and the design and implementation of climate change adaptation plans.

3.2.4 Population Dynamics

By Ines Campos

Drawing from preliminary results of BASE Case Studies, we find it relevant to discuss population movements that may occur as a response to climate change impacts.

In recent years, literature has been concerned with the effects of climate change in population distribution and mobility (Tacoli, 2009; McLeman and Smit, 2006; Grothman and Reusswig, 2006) as responses to environmental pressures in some geographies and has increasingly emphasize differentiated capabilities and vulnerabilities of countries and population groups in relation to climatic impacts (i.e. industrialized versus developing countries; high income versus low income communities; etc.). Particularly, when migrations are considered there is an emphasis on specific impacts, namely droughts and famines caused by physical and climatic changes; as well as coastal erosion, flooding and other extreme events related to rises in sea-level rise (Tacoli, 2009; McLeman and Smit, 2006). Yet, research also signposts that migrations in response to these impacts seems to be highly conditioned by previous established migration patterns (Henry et. al, 2003; Perch-Nielsen, 2001). Empirical studies point to temporary dislocations rather than permanently changing locations (Burton et al. 1993; Perch-Nielsen, 2004). For instance, studies on migration patterns due to extreme events (i.e. hurricanes, cyclones, tsunamis or earthquakes) indicate that populations tend to simply retreat to relief sites and after some time return to rebuild their livelihoods (McLeman and Smit, 2006). Overall, there is insufficient research to support the prediction that climate change impacts will influence a stronger tendency for permanent migrations, and more so on the socioeconomic and political consequences of the phenomena. Moreover, there is a focus on two types of impacts (drought and sea-level rise), while migrations or temporary dislocations may be also influenced by other impacts (increase in temperature; heat waves; public health issues; to name a few). Subsequently, the study of correlations between population movements and climate change is still a developing field (McLeman and Smit, 2006; Biermann and Boas, 2010; Tacoli, 2009).

Though BASE case studies in Europe have not been looking specifically at possible population movements, preliminary results in some case studies indicate that BASE research may potentially add to this literature, as local stakeholders deal with the possibility of relocating.

In an interview meeting with local business owners and residents, the president of the local beach business association said – *"(…) for the moment I'm still a beach business owner, my place is still there, still.*" Though relocation is not an accepted possibility among this group, who believes the government should intervene and protect their livelihoods, these stakeholders feel very much threatened by the current receding of the coast line, and are well aware that unless there is an action plan for the future, they may be left without a beach and deal with recurrent flooding events in their shoreline residencies. Therefore, they are willing to do whatever they can to promote political action. As one of the most outspoken group members referred – "*We want to do something, to do lobby, to make sure this is not forgotten, to make sure solutions are put in place*."

Our Scenario Workshops (see chapter 2, section 2.1.8) have provided the opportunity for kickstarting the process of long term adaptation planing. However, the biggest challenge will be at the implementation stages. In the follow up interviews, when asked what they had considered to be the most and less positive outcomes of the Scnenario Workshop, all participants considered that the most posive outcome was to have in the same room a representative group of the relevant stakeholders in the region co-creating an adaptation plan. They considered that the less positive aspect was that it would be difficult to actually implement the plan. Workshop transcripts have also highlighted core barriers at the financial and political levels for implementing adaptation actions. These transcripts are presently being analysed. Yet, most local stakeholders experience some form of resource dependency, as their livelihoods are dependent on local economic activities. As explained in the introduction to this section, vulnerability is also conditioned by the "resource dependency" of a community:

"*Resource dependency relates to communities and individuals whose social order, livelihood and stability are a direct function of their resource production and localized economy* (Adger, 2010: 352)"

Particularly in coastal areas, it has been noted that communities can be dependent on various degrees on local ecosystem resources (Adger et al., 2003; Adger et al. 2008). The consequences of such dependency report to income and social stability, as well as migration patterns of communities (Adger, 2010). However, these findings draw mostly from coastal cases studies in developing countries (Allen, 2006; Adger, 2010; Armitage, 2005). Yet, as exemplified with preliminary analysis of the findings of the Aveiro's coast case study, there seems to be a similar type of dependency on local resources, particularly in populations engaged in fishing and tourism related activities.

Concerning other type of population movements, we haven't find empirical studies looking into the intentional relocation of people in areas where lands have been abandoned, as a strategy that targets the negative local impacts of climate change. In one of BASE European case studies – Adaptation to Drought in Alentejo - this possibility, which we have called "intentional migrations", was suggested by local stakeholders (researchers and politicians) as a strategy against future drought scenarios.

Alentejo is a region in the South of Portugal (see section 2.1.1 – Alentejo Region). In the Participatory State of the Art of Adaptation in Alentejo -, which took place November, 20th, 2013, a group of researchers and political advisors working with environmental and climate change policy, was invited. Throughout a day of presentations of existing research on impacts and adaptation actions, followed by a joint discussion, the state of the art of adaptation to climate change in Alentejo was elaborated. One of the adaptation actions put forward in this session, was promoting the "intentional migration" of new residents that could contribute to counter rural desertification.

Alongside this event, BASE analysis of a local adaptation project in Alentejo – the Convergence Center -, has identified a group of young families who moved to the region from urban areas with the intent of contributing toward a project against land and human desertification in rural Alentejo. Results from 17 in-depth interviews to the Convergence Group members (conducted between July and September, 2013) and a three-day project retrospective workshop (2nd to 4th of November, 2013) indicate that these people were motivated to move to the area because they wanted to live in a rural setting and wanted to contribute to local development, by experimenting with ecological alternatives for agriculture production and irrigation systems. BASE retrospective analysis of the group's work has concluded that this is pilot adaptation project, where the key action is an "intentional migration".

Corroborating existing literature on migration, our research in Alentejo and Aveiro, points to the possibility of population dynamics as responses to environmental, social, political and economic challenges. Much like in previous research, decisions to migrate appear as the product of a complexity of interdependent causes (Adger, 2000; Adger et.al 2002; Tacoli, 2009).

A key lesson we may draw from the current knowledge is that the possibility of migration as a response to climatic impacts, and in general the possibility of adaptation, should be considered in light of a societal transformation to more sustainable socio-ecological (Folke et al, 2002; Gallopín, 2006; Nelson et al. 2007; Adger, 2001) and socio-technical systems (Figueiredo and Pereira, 2011; Geels, 2010; 2011). Not surprisingly, from multiple perspectives, studies of environmental or climate related migrations always draw on the same key conclusion – climate alone is generally not the cause for permanent relocation (Adger et al, 2008; Lutz, 2004).

Overall, preliminary case study research indicates that adaptation, particularly as it implies a radical change of living conditions, should not be understood simply as a response to an external shock, but as a strategy wherein collective pathways promote more sustainable socio-technical and socio-ecological systems. Therefore, multilevel governance approaches to adaptation planning (Bulkeley and Betsill, 2013; Hobson and Niemeyer, 2011) and the influence of deliberative governance processes (Dryzek, 2010) in adaptation planning and preferences may play a central role when the dislocation of populations is a possible action (Agarwal et al. 2012; Bates et al., 2013; Schmidt et al., 2012; Plummer, 2013; Coshet et al. 2006). From this perspective, we understand population movements in European adaptation case studies as embedded in political; socioeconomic, and governance issues.

3.2.5 Governance

By Anne Jensen and Milla Mäenpää

Introduction

The governance of adaptation addresses the ways that approaching and managing the impacts of climate changes is governed and organised in policies and politics. Governance of climate adaptation is thus more specifically the policy response to (including policy actions) manage the complex relationship between physical impacts from changing climate, normative judgments among citizens/civil society, business actors and policy makers of climate impacts and needed/appropriate responses, and elements characterizing the exposure, sensitivity and capacity of adaptation. As discussed in the introduction of this chapter, adaptation is closely linked to the vulnerability of systems, i.e. the complex interactions of ecologic, social, political and economic processes and structures connected to climate changes, and thus to the adaptive capacity of governance systems.

Climate change happens due to processes that are governed at national and international level and which are amplified by global trends such as globalisation, population growth and increased mobility, consumption, trade and production patterns and technologies (Moss, Edmonds et al. 2010), as well as carried out locally by citizens, businesses, cities and other governance actors. Likewise, adaptation as well as mitigation of climate change are addressed at European and national policy levels while the management of impacts of climate change is implemented in concrete actions, i.e. adaptation to climate changes happens locally as well as through policies at multiple levels (Kern and Bulkeley 2009). However, the local scale of actions is prominent for adaptation due to the actual changes of water technologies, transport systems, land use and planning systems, etc. which are at the core of adaptation and which involve local costs of non-adaptation and local conflicts. Moreover, at local scale the cross-sectorial aspect of adaptation requires actions that challenge sectorial boundaries and requires a re-thinking of sectorial planning and policies.

In this perspective, we in this chapter discuss the multilevel character of adapting to climate changes and the aspect of climate policy integration, illustrated by examples from the case studies.

Multilevel perspective – for management of adaptation

Viewing the policy integration as a vertical issue across governance levels, i.e. EU, national, regional and local levels, is a challenge. The relationship between different governance levels is a very complex issue to study. The nature of the relationship and distribution of power is usually defined by other issues than climate policy. Moreover, the power and responsibilities of integration may differ depending on the stage of the policy integration (formulation of policy, planning state, implementation of measures) (Persson 2004).

In literature of climate change adaptation governance, it is seen that there is a need for national level intervention and consistent guidance (Vink et al 2013, Biesbroek et al 2010). It can be seen as a question of both knowledge and power (Vink et. al 2013). It is clear that nor local actors, nor governmental level act alone to achieve an effective adaption to climate change. Understanding the interaction and linkages both between different levels of governance and between different actors (sector, non-governmental stakeholders) is needed to support the adaptive capacity of the governance as a whole (OECD (2010). The measures needed are often implemented by local and regional actors and the impacts of both climate change and measures are felt locally (OECD 2010). More information transmission, learning and co-operation occur horizontally when stronger linkages between cities, regions and national governments are being developed (Bulkeley and Moser 2007).

In the BASE project, we try to address at the governance level, the competences concerning adaptation measures and regulations concerning climate adaptation policy actions. Drawing from very preliminary results of BASE case studies, we demonstrate that there is a clear need for coordination and co-operation for successful policy integration. The national level steering is important but regional and local actors are often the ones to plan and implement adaptation measures, especially, if there is no financial support at the national level for implementation.

Kalajoki Case

Kalajoki river basin is named among the 21 national significant flood risk sites (based on Floods Directive) in Finland because rare floods might cause severe risk to human health (e-g for example threatening hospital facilities). From the local point of view, climate change is not observed as a major concern in Kalajoki area. The extreme flooding and weather conditions have not been frequent and local people are not very concerned with climate change. The risk of climate change impacts (i.e. flooding) has come more obvious to local farmers and residents who live near flood areas, not because of expected or realized impacts of climate change, but because of changes in national policy concerning the supplementation: the recent reform of flood compensation system shifts more responsibility from government to the private sector. This seems as one of the main drivers for implementing the adaptation measures in Kalajoki case area.

The **flood risk management** planning unit is the river basin, whichencompasses several municipalities and regional administrative units at the area. For cooperation between the authorities, **a flood management group** has been designated to Kalajoki area. The flood management group is composed of regional authorities, municipalities and regional rescue services. The flood management group sets the objectives for flood risk management and approves the the measure, their prioritisation, estimated costs, parties which have shown interest in implementing the measures and the financing possibilities.

Implementation of adaptation measures depends on the nature of the measure, but most of them are of the municipalities' responsibility. Implementation of measures is uncertain: FRM plans are not directly binding and the national financial support has been cut substantially. The misfit between planning and implementation is obvious. The motivation to implement the measures depends on other motivation and drivers than climate change adaptation or risk such as the changes in insurance system.

Climate Policy Integration – adaptation policy in a case study perspective

The literature on environmental policy has for decades addressed how the complex nature of most environmental problems involve different sectors, policy areas and academic disciplines, as well as a complex mix of policy actors, ranging from businesses and industries over citizens to policy institutions and business/civil society associations. Consequently, the need for integrating concerns for environmental policy issues in other sectors is stressed as a major challenge, determining the success of environmental policy (Lafferty and Hovden, 2003).

Climate change policy integration is defined according to process and outcome, and according to different dimensions, and different approaches to EPI fuel differing notions of CPI. In this chapter, we take on a definition of CPI that follows from the work on climate policy integration outlined in wp2.

Analyzing climate adaptation policies and strategies in case studies, we also confront the issue of policy integration. The complexity of climate change underscores a need for bringing climate adaptation out of the position as one among many pressing environmental policy areas, and engage measures and decision making across a range of sectors and levels of policy; in other words, climate policy integration must be promoted to enhance adaptation (see BASE D2.1), however in the face of only emerging robust conceptualizations of climate policy integration (Adelle and Russel 2013). Following the literature on EPI that stresses how ’the concept [of CPI] clearly implies a relatively strong revision of the traditional hierarchy of policy objectives’ (Lafferty and Hovden, 2003: 2), a basic defining feature of CPI is the inclusion of and coordination with climate adaptation policy objectives/issues in other policy areas (Mickwitz, Aix et al. 2009), emphasizing the need for recognition of adaptation objectives in all stages of policymaking at all relevant levels and in all relevant sector policies.

Mickwitz, Aix et al. (2009) define climate policy integration (CPI) on the basis of the classic definitions provided by e.g. Lafferty and Hovden (2003), thus stressing the assimilation of the aims and objectives of climate change policies into all stages of policy making and into all relevant policy areas (Mickwitz, Aix et al. 2009). Moreover, Mickwitz et al stress that CPI can be measured through the extent to which specific criteria are met (Jordan and Lenschow, 2008; Mickwitz and Kivimaa, 2007). Building on the literature of environmental policy integration, three dimensions of climate policy integration are at the centre (Adelle and Russell, 2013; Jordan and Lenshow, 2008; Lafferty and Hovden, 2003): soft vs stronger instruments, i.e. implementing CPI via instruments along the continuum from coercive instruments based on regulation and control to more voluntary instruments based on incentives; normative vs rational motives for CPI, i.e. whether the driving motive is that CPI is good per se or that CPI is argued with respect to overarching policy objectives and benefits; and horizontal vs vertical CPI, i.e. that climate policy objectives and issues are considered across sector policy areas or that climate policy objectives are integrated at all relevant levels of policy making. In addition, CPI may be seen as a process of policy making or an outcome/output of policy making, linking to above three dimensions. In working with the BASE case studies, CPI follows Adelle and Russel (2013) in addressing CPI as a process of climate policy making.

Concerning the vertical and horizontal dimension of CPI, Kok and de Coninck (2007) demonstrate how the inter-linkages between climate adaptation policy and other policy areas, including land use, energy and water, embed opportunities for enhancing adaptation and adaptive capacity. However, existing (international) policy institutions are often not ‘designed to promote mainstreaming’ (Kok and de Coninck, 2007:588). In the case studies, different policy institutional assessments offer varying options for policy integration, in sector polies as well as in local/regional case studies. With the emphasis on integration of climate policy objectives in processes of policymaking, CPI has a strong element of policy learning, often in the face of only partially availability of the relevant knowledge (Jensen, van Bommel et al. 2013), involve policy learning, enhancing or building sector capacities for addressing or managing climate policy issues (Hertin and Berkhout, 2010). While climate mitigation studies repeatedly point at the urgent need for not only adjustments and incremental policy learning, but for fundamental social, economic and political transitions, it is however en open question whether climate adaptation issues can be managed through a re-articulation of policy-making with inclusion or repositioning of other forms of knowledge than were previously dominating, i.e. a reframing of policy making.

In WP2, a parallel conceptualization of CPI produced the following foci for analyzing CPI in the case studies:

- CPI as a process vs. an output: Is policy integration conceptualised as a process or as an output?
- Point of intervention: Which stage in the policy process is addressed in the policy intervention?
- Hard vs. soft policy instruments: Which policy instruments are employed to achieve CPI?
- Policy integration vs. sectoral integration: Is CPI addressed in an overarching way, or by means of sectoral policy integration?
- Vertical integration of different governance levels: How is CPI thought to be achieved across the different levels of governance?
- Integration achieved by centralised or diffuse means: How much discretion is granted to sectoral policy makers?
- Logic of intervention: Is climate policy integration approached from the perspective of an institutional, political, or cognitive logic?
- Policy integration and participatory policy making: Which role does participation play in the approach?

City of Copenhagen

In the Copenhagen Strategy for Climate Adaptation, the concern for adapting to the impacts of climate change is specified, mainly focussed on water management (waste water and rain water), but equally addressing a range of other policy areas. In this sense, climate adaptation issues appear at different stages of the policy process where integration of adaptation issues are included in the process rather than seen as an outcome of the policy process; the anticipated outcome is adaptation across the relevant sectors. In other words, the strategy of Copenhagen aims to make adaptation an issue which is considered on equal basis of other basic issues in a number of urban policy areas. Significantly, adaptation is promoted by leading politicians and senior officials, and backed by funding, including for developing innovative solutions to adaptation.

The policy issues mentioned in the strategy and subsequently reflected in urban policies include *regeneration* and *urban development* with a focus on addressing adaptation issues as an aspect of the future green city and of promoting sustainable neighbourhoods; *business development* and *green growth* strategies focussed on developing and supporting clean tech industries within adaptation technologies; promoting *green spaces and green structures* in management of nature and green areas, assisting local retention of water; adjustment of *transport infrastructure* to accommodate increasing amounts of surface water; enhancement of *dikes* in the coastal management; *engagement of citizens and businesses* in autonomous adaptation actions in management of residential housing; and assimilating climate change as a cornerstone in formulating Copenhagen’s *urban identity*.

For most areas, the adaptation issues are included in the planning process, i.e. are integrated in the planning requirements. This means that they can be enforced while the planning actions and the adaptation policy actions in many cases are equally dependent on the active engagement of citizens and/or businesses active involvement. In addition to the element of engaging citizens in, for example, local neighbourhoods, and including climate change in the urban identity, the logic of intervention consist of a mixture of political, institutional and cognitive.

Moreover, in relation to the major plans concerning cloudbursts and wastewater management, the planning process is legally mandated to be based on citizens involvement, while Copenhagen however promotes its policies also through involving local knowledge and engagement and through creating ownership to the adaptation actions. Participation is thus among the policy instruments that Copenhagen utilises to achieve its strategic adaptation objectives.

3.2.6 Economic Vulnerability

By Volker Meyer and Jenny Troeltzsch

According to the definition that risk is a function of probability and consequences (see e.g. Knight 1921), economic risk due to the impact of climate change related extreme events can be expressed in terms of annual average damage (or losses, costs) due to climate change or hazardous events (i.e. probability * damage).

Damage itself is a function of hazard intensity, exposure and vulnerability. Hazard intensity refers to characteristics of the hazardous phenomenon itself (e.g. flood, earthquake, drought), exposure refers to the location and number of people or economic assets in hazard-prone areas, and vulnerability refers to their susceptibility to suffer damage and loss, for example due to unsafe housing and living conditions (see also IPCC 2012). All three elements can be altered by adaptation (i.e. explicit risk management interventions).

Combining these definitions risk (due to climate change extreme events) can be expressed as:

Risk = f (hazard probability, hazard intensity, exposure, vulnerability, adaptation)

hazard damage

Looking more into detail within a typology of damages, the damages, losses or costs can be differentiated into the following categories (Meyer et al. 2013):

- **direct costs**, i.e. damages to property due to the physical contact with the hazard, such as physical destruction of buildings, inventories, stocks, infrastructure or other assets at risk (Smith and Ward, 1998);
- **business interruption costs**, e.g. when people are not able to carry out their work because their workplace is destroyed or not reachable due to a hazard;
- **indirect costs**, i.e. losses induced by either direct damages or business interruption costs (Przyluski and Hallegatte, 2011). They can occur inside or outside of the directly impacted

area and often with a time lag. These losses include for example induced production losses of suppliers and customers of companies directly affected by the hazard and;

- **intangible costs**, which refer to damages to goods and services which are not measurable, or at least not easily measurable, in monetary terms because they are not traded on a market (also referred to as non-market values or costs) (Smith & Ward 1998). This contrasts to tangible costs that imply an existing market for tangible assets, or the goods and services derived thereof. That in turn allows them to be easily expressed in monetary terms. Intangible effects include e.g. environmental impacts, health impacts and impacts on cultural heritage (see also chapter on social and environmental risks).
- **Risk reduction or adaptation costs** can be regarded as part of the total costs of natural hazards and climate change adaptation and are thus considered an essential cost category (Bouwer et al., 2011).

In the current state the case study baselines, there is not yet detailed information on economic risk due to climate change. What exists so far for each case study is an indication of the "hazard"-component, i.e. the primary physical impacts, and the "exposure"-component of risk, i.e. the sectors which are mainly impacted. **Table 3.2.1** gives an overview of the physical impacts and impacted sectors in the BASE case studies.

Table 3.2.1: Primary physical impacts and impacted sectors in the BASE case studies according to BASE typology and case study living documents (status: 19/02/2014)

Primary physical impacts	**Case studies**	**Impacted sector**	**Case studies**
Extreme temperatures	• Jena	Agriculture	• Dartmoor • Green roofs • South Moravian region • Ústí region • Danish rural municipalities • Kalajoki river basin • Kalundborg
Water scarcity	• Iberian peninsula • South Moravian region • Ústí region	Biodiversity & Ecosystems	• Copenhagen • South Devon Coast • Dartmoor • Green roofs • South Moravian region • Ústí region
Flooding	• Copenhagen • Prague • South Devon Coast • Dartmoor • Iberian peninsula • Venice • Danish rural municipalities • Timmendorfer Strand • Jena • Kalajoki river basin • Kalundborg • Leeds	Coastal & Marine systemes (incl. Coastal Urban areas and coastal management)	• South Devon Coast • Venice • Kalundborg

Coastal erosion	• Copenhagen • South Devon Coast • Timmendorfer Strand	Energy	
Droughts	• Iberian peninsula • South Moravian region • Ústí region	Health	• Iberian peninsula
Soil erosion	• South Devon Coast • Dartmoor	Transport	• Copenhagen • Prague • South Devon Coast
Vector borne diseases	•	Production systems and physical infrastructure	• Copenhagen • Prague • Jena • Kalajoki river basin • Kalundborg • Leeds
Extreme weather events (storm, ice and snow	• Copenhagen • South Devon Coast • Dartmoor • Green roofs • Kalundborg	Water Resources	• Prague • Dartmoor • Iberian peninsula • South Moravian region • Ústí region • Kalajoki river basin
		Tourism	• South Devon Coast • Dartmoor • Venice • Green roofs • Timmendorfer Strand • Kalundborg

So far only very few of the case studies describe monetary damage estimates or even risks:

- In the case study Jena, damages of one past flood event in 2013 are reported to be 3.4 m EUR.
- For the Leeds case study it is stated in the case study living document that "the Leeds city centre is likely to be affected by a 1 in 20 year flooding risk from the River Aire. A 1 in 20 year risk of flood would incur approximately £400 million of direct economic losses and affect 120,000 passengers travelling from Leeds Rail Station per day (Leeds City Council, 2007)."
- The most comprehensive risk estimation so far is provided for the Kalundborg case study: "The accumulated cost of damages to private properties by 2090 are estimated by a private consultancy, NIRAS, to be approximately 242 million Euro (Municipality of Kalundborg, 2011)."

For the Timmendorfer Strand case study a damage potential analyses has been developed. Two extreme flooding scenarios have been analysed, storm surges of 2.50 m and 3.00 m above mean sea level. For the lower scenario ca. 500 inhabitants would be affected, for the higher scenario ca. 2,000 inhabitants. The total estimated damages are 48 mio. Euro for the lower scenario and 117 mio. Euro for the higher scenario. For both scenarios the main damage components are building damages with ca. 58% of the total damage. Further relevant damages are loss of value especially for not offered tourism services like hotels, holiday apartments and restaurants, fixtures in buildings, equipment, vehicles and damages at transport infrastructure. (Reese 2003).

A more detailed description of the expected economic risks will follow in Task and Deliverable 5.2.

Conclusion

The previous pages have reported on the preliminary findings of the 26 BASE case studies: 22 in Europe and 4 in other continents. The document reports on how the work developed so far has been coordinated and harmonized within seven subgroups (including the international case studies). Yet, though BASE has 22 case studies in Europe, this document reports on 24, only because the Iberian case study includes an agriculture, a heath and a water resources research focus. Therefore, the case is subdivided in this report to fit the different subgroup sections where it is integrated, namely the agriculture, the health and the water resources subgroups.

Chapter 1 provides a brief overview of the socio-economic scenarios for each European country most allied with the RCPs BASE is using. Climate scenarios were obtained for different European regional area and included several climatic factors decided for each case study region (this data was sent to all case studies that requested this information). Moreover, climate scenarios were also obtained (using an average precipitation and temperature) at the local level just for case studies considered “large”. Because the timings of case study research and the development of the new socio-economic scenarios were not synergitic during the kickstarting year of WP5, not all BASE case studies have used this scenarios, though “large” case studies can still be updated to include the new data.

Chapter 2 offers a thorough description of the main expected impacts at the case study level, and of potential adaptation actions, but also of methodological approaches, models and instruments used; as well as preliminary findings and expected results.

The agriculture and forestry subgroup, though integrating a considerable diversity of case studies in terms of expected impacts, geographies and local socioeconomic and political characteristics, is using similar methodological approaches and draws from a shared pool of research questions, agreed upon by all partners. This shared research framework focusses on identifying local impacts and perceptions of such impacts, prioritizing potential adaptation actions; and collecting data on costs and benefits. Attention is also on issues of participation and multilevel governance.

This shared outlook has been developed through a continuous dialogue between partners, and it is operationalized largely by using common tools. Specifically, a literature review on adaptation in agriculture and forestry; a common conceptual framework for describing local impacts (namely, drought; flooding and its consequences to soil erosion and agriculture productivity); and identical questionnaires applied in all case studies.

Similarly, the coastal group has set up a common framework that has included research questions, methodologies and models being applied to each case study. Early findings show increased comparability within the coastal group case studies, not only due to their socioeconomic, political and geographic characteristics, but also due to common methodologies and highly comparable early findings. For instant, preliminary results show that the Aveiro case study faces a considerable governance challenge that is mirrored in the local municipalities’ ability to plan adaptation. Deliberative governance, institutional dialogue and participation have been identified has key barriers to adaptation planning, more so than financial constraints in a country (Portugal) dealing with large public budget cuts due to the financial and economic crises. Using the Scenario Workshop method and Adaptation Pathways is a research option to support local adaptation planning. In the South Devon case overcoming governance constraints and providing spaces for dialogue seems to be equally important in promoting local adaptation planning and implementation, though further work will provide a clearer insight on the governance issues for this case study. Both in the Kalundborg and Timmendorfen cases, local support, institutional dialogue and deliberative governance processes have been central for supporting local action. Yet, economic assessments are also fundamental in public debates on adaptation options. Therefore, the coastal group case studies are gathering data on costs and benefits to support a comparative analysis of potential adaptation actions, both within each case study, and at the group's scale.

The Biodiversity and Ecosystems Services subgroup has three cases studies at different stages of climate adaptation. Two of these are national parks, where climate strategies have been developed but little implementation has taken place. A key task for this subgroup has been to identify risks and vulnerabilities, but also adaptation barriers and opportunities. The Green Roof case study stands out for being one without any adaptation strategy, where participatory approaches to building local adaptive capacity are crucial.

The cities and infrastructures is the largest subgroup of BASE case studies, and includes large cities, such as Copenhagen, and Prague, as well as medium and smaller cities, such as Rotterdam; Leeds; Jena and Venice, and Cascais. Early findings show some cities have already adaptation plans and have implemented adaptation policies, such as Prague and Venice. Cascais has by now a considerable report on preliminary findings that highlighted prioritized measures (which are being assessed economically), but has also shown the importance of a robust strategy to promote institutional dialogue and local participation in adaptation policy and planning. Notably, and in line with recent literature (Measham et al., 2011), Cascais' early findings show that adaptation practice in not yet embedded in municipal planning. While the municipality has an adaptation plan, it has not been integrated in the municipality's annual plans and therefore it is marginal in relation to other planning priorities. This conclusion is supported by findings from a statistically representative survey to the municipality's technicians and by the results of a qualitative approach based on a set of workshops involving both municipality technicians and local residents. Other case studies, such as Rotterdam; Leeds and Copenhagen, are using the IO-model for economy wide effects, and are expected to provide interesting comparative analysis.

The Health group has three large case studies – UK; Exeter and Madrid. Much like the other groups, this subgroup has been in a continuous dialogue to align and harmonize its research approaches. All cases will provide data on costs of and benefits of potential measures that may respond to the health challenges of expected climatic impacts at the local level, this work is still in progress and will be reported in D. 5.2. Preliminary results show already for the case of Madrid, local perceptions on the most relevant health impacts and the most affected population groups. This case highlights the vulnerability of specific social groups to health hazards due to climate change. Stakeholder meetings have also highlighted measures perceived as priority which will be assessed economically.

Regarding the water resources group, which consists of a large case study (Iberian), the Kalajoki river basin and the Lake Ijsselmer case studies. Research frameworks, approaches and methodologies have been designed together by the partners involved. Though the Iberian case study has its focus on the Tagus River Basin of Spain and Portugal, it integrates both urban areas, rural and agriculture areas and is interlinked with health issues which are approached in detail by the Madrid health case study. The Kalajoki case study, though focusing on the use of water resources and the threats of flooding, is strongly interlinked to agricultural activities at the river basin and to the farmers' responses to climate change policy and adaptation actions. Finnally, in Lake Ijsselmer the two main objectives are guaranteeing flood protection and freshwater supply taking into account the uncertainties with regard to climate change and socio-economic developments. Both the Iberian and Kalajoke case studies, though different in their scope and socioeconomic, political and geographic characteristics, have set the grounds for future comparability, as they will be modeling climate change impacts and exploring adaptation measures with stakeholders trough participatory methods, and will provide data on costs and benefits of different adaptation measures. The Lake Ijsselmer case study is specifically concerned with the actual implementation of climate adaptation strategies and is concerned with developing governance arrangements that are able to deal with climate change policies and support implementation. Consequently, this case study may be more comparable with other case studies where the focus is in designing or experimenting with modes of governing climate change adapatation, particularly case studies of the cities and costal groups.

Finnaly from the international case study group, key lessons on adaptation policy preferences, perceptions, policy design and implementation can be drawn for European case studies, as is illustrated with the overviews of cases such as the US East Coast, Cuba or the Mekong.

Finally, chapter 3 explores in greater depth thematic comparisons between some case studies, explicitly regarding perceptions, motivations, drivers for adaptation, and responses to risk and uncertainty, in relation to ecological, social, political and economic dimensions. Drawing from preliminary results of some studies, namely Cascais, Coast of Aveiro; the Iberian Peninsula; Kalajoki and Timmendorfer Strand, this section has highlighted findings regarding local perceptions to climate change impacts and the relevance of adaptation.

A few general conclusions can be drawn from the texts in chapter 3. Some case studies begin to higlight the need for a more dynamic and efficient science-practice interface, as well as the importance of economic assessments of possible adaptation measures as a valuable tools to support decision making and trigger local action. Conversely, in some case studies reported in this chapter, climate change appears as a variable that will aggravate an already existent local problem (such as desertification, flooding or coastal erosion). Thus, this short summary of preliminary findings poses a few questions – is climate change really a driver for local action? Or is it locally perceived as a factor that will aggravate other problems, such as coastal erosion or flooding? Further research will produce a clearer picture of what are the real drivers for adaptation and how the problem of climate change is locally perceived and governed through adaptation plans and their implementation.

Due to the existing variety of case studies and to assure future comparability of results, we are presently developing a framework that classifies BASE case studies in 3 catergories: Small, Medium and Large Scale. This classification framework will be already available for deliverables 5.2, 5.3, 5.4 and 5.5.

This case study segmentation arises as the previous (Retrospective and Prospective) didn’t encapsulate the true diversity in BASE, nor allowed for a proper harmonization and comparison between case studies regarding scientific expectations and resource inputs. The current segmentation is in place in order to clarify the role of each case study under BASE research goals and promote better management of resources. Small case studies refer to case studies which are mainly focused on delivering new insights into past events and for which a minimum input of MM is advisable for case study owners. Medium case studies refers to the larger group of BASE case studies for which a certain degree of Participatory Tools, Economic Assessment and upscalling data is required. Large case studies are those studies for which there are resources under BASE to apply fresh scenarios and full scale economic assessment methodologies, as these are the key for the upscalling of results at the local level. The use of Participatory Methodologies is also crucial at this scale.

Overall, Deliverable 5.1 provides an overview of where we are at in case study research and sets the contextual background for the following WP5 deliverables and their associated tasks.

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