

LOGO/PICTURE

Subgroup: Coastal

Case-study: **Kalundborg**

The Danish Board of Technology, Denmark

Date

**Case study developed by:**

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**Project:**

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**Date of release:**

XX/XX/XXXX

**Purpose of this document:**

"The Case Studies Living Document (CSLD) will be the document that each case study leader will use to share the information that (i) characterize and give context to its case study, (ii) the goals within BASE, (iii) the methods used and mainly (iv) a synthesis of the results that that case study is providing to BASE project. This will allow the CS leader to understand how its own case is going (having a good overview), but also (v) will allow the sub-group to which the case study belong to know what is happening and what can be done (mainly on synergies and so on) as well as to (vi) WP4 & 5 coordinators to use that information to report (including each WP task leaders). These living document will also (vii) allow WP6 & 7 partner to know the information."

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## 1. General Case Study Description

### Location

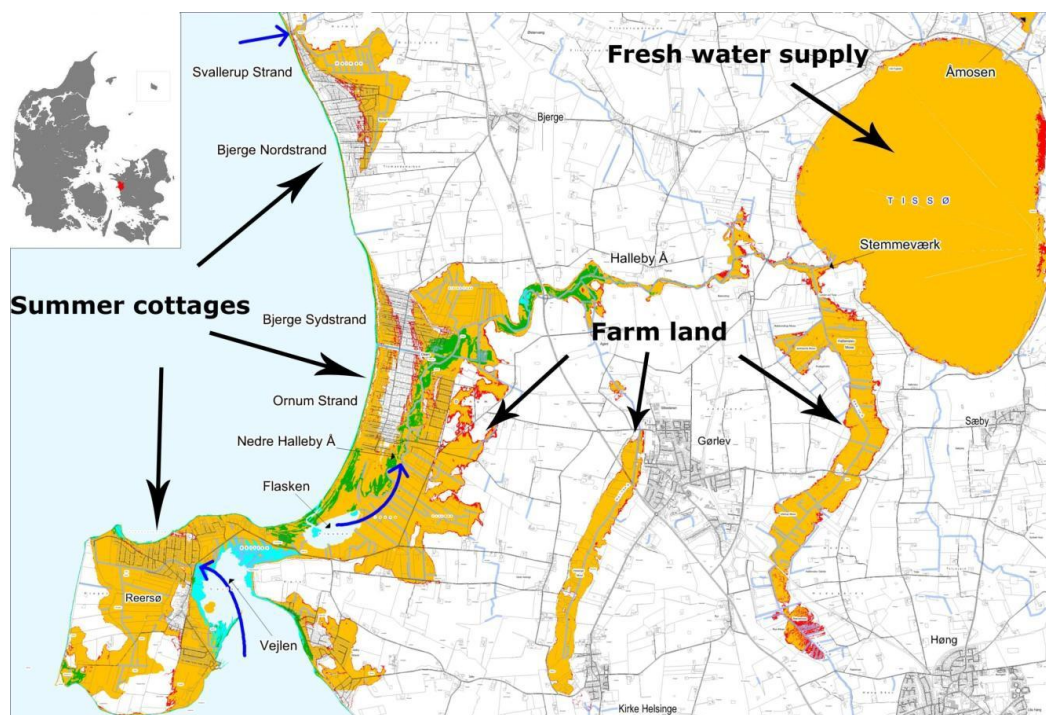


Fig. 1 Salt water flooding in 2090. *Source:* Map produced by the Municipality of Kalundborg

Notes: <sup>a</sup> light blue: (80 cm above current sea level) areas expected to be permanently flooded by 2090.

<sup>b</sup> green: (150 cm above current sea level) areas currently flooded at 100-year incidents.

<sup>c</sup> yellow: (210 cm above current sea level) areas expected to be flooded at 20-year incidents in 2090.

<sup>d</sup> red (230 cm above current sea level) areas expected to be flooded at 100-year incidents in 2090.

<sup>e</sup> blue arrows: point at the locations where the water will enter first.

### Case Study Summary

(Máx 500 words)

Even though there was no command from The Danish State on the municipalities to make climate adaptation plans back in 2009<sup>1</sup>, the municipality of Kalundborg already considered making a climate adaptation strategy. However they did not plan to make it a very detailed one.

On this background, The Municipality of Kalundborg joined the EU-Interreg project 'BaltCICA' from 2009-2012. The BaltCICA project was set out to finding ways of dealing with climate changes in the Baltic Sea Region. Through the use of climate change scenarios adaptation, measures were to be 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 GEUS<sup>2</sup>. 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 finished but because of requirements from the Danish government, it will have to be finished in 2013.

## Brief General Information on Climate CHANGE and related issues

(Máx 2000 words) *Please state which is the European climate zone of the case study and insert any information regarding the current available information regarding the case-study, namely expected impacts, scenarios.*

### Case study area description

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 less frequently. However, due to climate change this is anticipated to 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 surface-water interests, tourist and cultural assets.

The land behind the coastline has delta-like characters which makes the area vulnerable to extreme weather conditions. The area also includes infrastructure such as roads, sewerages, water supply and draining assets. The case study area has a coastline and lowland, which are threatened by sea level rise 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 exemplarily Danish rural area, and there are many more like it along the Danish coastline. 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

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<sup>2</sup> Geological Survey of Denmark and Greenland

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, Bjerger Sydstreand, Bjerger 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 Vejen is particularly vulnerable, at the mouth of the stream called Nedre Halleby Å, currently almost unregulated and with a delta and lagoon-like character.

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 precipitation from 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, Bjerger Nordstrand and Bjerger Sydstreand 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 Bjerger Sydstreand 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. Although this scenario is not pictured on the map below. 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).

### Climate scenarios

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, 43% increase in winter precipitation, 15% reduction of summer precipitation and 20% increase in 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 in particular 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

### Existing Information on Case Study's adaptation history

**(Máx 2000 words)** Please insert a Short resume of the Case study existing information related to Climate Change Adaptation (*major goals, plans, measures and timelines already defined or implemented*), *important Milestones in its “Adaptation Journey”* as well as *relevant state-of the art regarding the implementation of Adaptation Strategies and Specific Measure*

### The Kalundborg adaptation history

Because of the participation in the BaltCICA project, the Municipality of Kalundborg has already taken steps towards defining the goals and priorities of adaptation to climate change. This has, 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). However, these strategies do not impose any obligation on municipalities to make their own strategies, nor do they provide municipalities with much information on how to proceed with such strategies. The situation changed somewhat when a new center-left government won the general election in September 2011. In autumn 2011 the new minister of the Environment announced that all municipalities have to make a climate adaptation strategy within the next two years (by 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. It is required that the climate adaptation strategy is 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 (kommuneplan)<sup>3</sup>.

The Danish state will provide data and maps for the municipalities to use in the mapping of risks<sup>4</sup>. In addition the Government has published a guide for the municipalities on how to make climate adaptation strategies in practice<sup>5</sup>.

### **Regional (Zealand) climate strategy**

The 17 municipalities in the region of Zealand have developed a climate strategy. The plan runs from 2009-2013 and is divided into 8 activity themes. In the making of the strategy the Municipality of Kalundborg served as part of the steering group. The objective of the strategy is to provide an overview of the existing challenges and the available strengths with which to meet them. In addition the strategy seeks to contribute toward a further strengthening and coordination of the municipal and regional climate efforts<sup>6</sup>. The goals of the strategy is for a 20% reduction in CO2 emissions and to reach at least 20% of energy from renewable resources in 2020 in accordance with EU's climate goals<sup>7</sup>. The regional climate strategy is non-binding for the municipalities involved, but calls for cooperation in the region on the climate area.

### **Municipal (Kalundborg) climate change adaptation strategy**

Under development, to be presented before the end of 2013 as required by The Danish Government. Impact/Inputs from the participatory process will be analysed once the strategy is completed.

### **Connection with other research projects:**

(Please list and shortly describe previous or on-going research projects directly related with the Case Study) Please write the name and summary of the project, relevant partner institutions, year of beginning and end of project)

<sup>3</sup> Kalundborg Kommune 2013:10 (udkast til klimaplan Kalundborg)

<sup>4</sup> Regeringen & KL 2012:7 (aftale om kommunernes økonomi)

<sup>5</sup> Miljøministeriet/Naturstyrelsen 2013 (klimatilpasningsplaner og lokalplaner – Vejledning)

<sup>6</sup> KKR & Region Sjælland 2009:5 (region sjællands klimaplan)

<sup>7</sup> KKR & Region Sjælland 2009:9 (region sjællands klimaplan)



## Case ID, Typologies and Dimensions

Having in mind the following BASE Objectives; Categories of Case Studies, please fill in the following table.

### BASE OBJECTIVES

1. Compile and analyze data and information on adaptation measures, their effectiveness. (...)
2. Improve current, develop new and integrate methods and tools to assess climate impacts, vulnerability, risks and adaptation policies (...).
3. Identify conflicts and synergies of adaptation policies at different levels of policy making with other policies (including climate mitigation) within and between sectors. (...)
4. Assess the effectiveness and full costs and benefits of adaptation strategies to be undertaken at local, regional, and national scales using innovative approaches (mainly by integrating bottom-up knowledge/assessment and top-down dynamics/processes) with particular attention on sectors of high social and economic importance.
5. Bridge the gap between specific assessments of adaptation measures and top-down implementation of comprehensive and integrated strategies.
6. Use and develop novel participatory and deliberative tools to enhance the effective use of local contextualized knowledge in adaptation strategies to assess perceptions of adaptation pathways and their co-design by citizens and stakeholders.
7. Disseminate findings by sharing the results of the project with policy-makers, practitioners and other stakeholders. (...)

### CASE STUDIES CATEGORIES

- A. Public administration (municipality, regional, national, european)
- B. Research and education Centres (universities, research centres, projects and groups, schools)
- C. Public companies
- D. Companies (farms, SMEs, big businesses)
- E. Social enterprises (cooperatives, non profit companies, woofing farms, etc)
- F. Consortiums (partnerships, campaigns),
- G. NGOs (environmental NGO, local development NGO, charities, etc)
- H. Transition Initiative
- I. Ecovillage
- J. Informal groups, Movements

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 <sup>8</sup>
Denmark, Kalundborg	Objective 1 Objective 2 Objective 3 Objective 4 Objective 5 Objective 6 Objective 7	Example: Companies (Farms)	Rural Urban Coastal River Basin	Local Regional National Transnational European /Global	Bottom-Up Top-Down	Retrospective Prospective	2009 - 2014

<sup>8</sup> Please insert year of start and year of end of case study.

## Impacts, Sectors and Implementation

Please tick the relevant boxes for impacts and implementation and insert the number 1 for primary sector and the number 2 for secondary sector.

Impacts		Sectors		Implementation	
Primary CC Impacts (Climate-Adapt)	Primary CC Impacts (BASE)	Primary and Secondary Sector (Climate Adapt)	Primary and secondary Sector (BASE)	Implemented <sup>9</sup>	Phase of Implementation <sup>2</sup>
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 Financial Health Infrastructure Marine and Fisheries Water Management Urban	Agriculture Biodiversity & Ecosystems Coastal and Marine systems Energy Health and Social Policies Transport Production Systems and Physical Infrastructures Water resources Tourism	Yes Ongoing No	Assessment Planning Implementation Monitoring Evaluation

## Importance and Relevance of Adaptation

Please tick the relevant box for the case study.

Case developed and implemented as a climate change adaptation measure

Case developed and implemented and partially funded as a climate change adaptation measure

Case mainly developed and implemented because of other policy objectives, but with significant consideration on climate change adaptation aspects

## 2. Case study research Methodology

### a) Research Goals

(Máx 500 words) Please insert which are the General Goals for the case study as well as how will the case study contribute for BASE projects and BASE key research questions.

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 the 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.

<sup>9</sup> When the case study consists of a public administration with a top down approach, implementation can be an approved legislation or regulation. When the case study is about practical adaptation measures like a sand dune, for example, implementation should be considered finished when the dune is built in situ.

Local stakeholders and citizen's assessment of the adaptation strategy results, considering the participatory process they were involved in. More particularly 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?

### b) Stakeholders involved

**(Máx 2000 words)** Please insert any information about the stakeholders involved in the adaptation process with which you will relate to, namely their nature, involvement in the process, etc. If possible highlight the decision-making process as well as the leadership process for Climate Adaptation Strategies. Do Mention if there exists any kind of public engagement and participation within the Adaptation process.

The invited participants in the scenario workshop were local stakeholders with an interest likely to be affected by climate change and could contribute with local knowledge and innovative solutions. The idea was that the scenario workshop involved stakeholders from the case study areas with a position in the local community investing them with the power required to push for the implementation of adaptation measures.

#### 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

### c) Methodology

**(Máx 2000 words)** Please insert what will be your research approach regarding this case study, how did you define it (did it include participatory sessions or not) and how you will implement it during the BASE Project period.

- DBT has revisited Kalundborg in order to make a retrospective view at the different participatory aspects of the decision making process that was carried out in the BaltCICA project from 2009-2012. Thereby studying whether and how the participatory process has influenced the final climate adaptation plan.
- In the BaltCICA project a scenario workshop and a citizen summit were participatory methods chosen to build up a deliberative decision-making process
- The scenario workshop was designed to involve local stakeholders in the development of different possible land uses and adaptation measures.
- The scenario workshop involved stakeholders from the entire municipality

- Prior to the workshop development of future scenarios to raise awareness and local stakeholders who were invited to participate were identified.

#### Citizen summit

- The citizen summit was designed to consult ordinary citizens about their views on the abovementioned possible futures, adaptation measures and principles for an adaptation strategy.
  - In order to make a retrospective analysis of the decision-making process existing data from the participatory process has been used together with the adaptation plan which consists of 3 elements; the plan itself, a supplement to the general municipal plan (which is an adapted version of the plan itself), and so called 'action description', which is a specific list of adaption measure proposals. This material has been supplemented by focus group interviews with a broad selection of local politicians, officials, stakeholders and citizens who have been involved in the climate adaptation process. In a few cases the focus group interviews have been supplemented with individual interviews.
  - The stakeholders were selected among those who took part in the scenario workshops in 2009. To address how citizens think the input from the voting at the summit is reflected in the adaptation plan the citizens interviewed were selected among those who participated in the citizens' summit 2011. The interviews were divided into 3 focus groups: farmers, environmental NGOs and residents including summer house owners. The interests of the specific stakeholder groups were used in relation to the focus on the adaptation plan.
- Note: Partners/Case Studies using PRIMATE tool will be using CBA (to prioritize) and/or MCA (with stochastic PROMETHE II) and the Monte Carlo Uncertainty Analysis, so please check these boxes.

<b>METHODS to be used in Case Studies<sup>10</sup></b>	<b>YES // NO</b>
<b>A) Methods for prioritizing adaptation options</b>	
Cost-Benefit Analysis (CBA)	
Cost-Effectiveness Analysis (CEA)	
Multi-criteria Analysis (MCA)	
Analytic Hierarchy Process (AHP)	
<b>B) Quantification of impacts and relationships between factors affecting adaptation</b>	
Causal Diagrams	
Influence Diagrams	
Process-based Modelling	
Welfare variation analysis under restrictions	
<b>C) Uncertainty and sensitivity analysis</b>	
Probabilistic multi model Ensemble	
Monte Carlo simulations ( PRIMATE uses this method)	
Real option analysis	
Climate risk management process	
<b>D) Participatory Methods</b>	
Scenario Workshop	Yes (retrospective)

<sup>10</sup> For descriptions and references of the Methods please refer to Milestone 8. For data requests from specific Work Packages please refer to Deliverable 4.1

	analysis)
Participatory Cost Benefit Analysis (PCBA)	
Participatory add-ons to CBA	
Participatory add-ons to Multi Criteria Decision Analysis	
Participatory add-ons to Adaptation Pathways	
Other (add extra lines if necessary):	

#### d) Case study Timeline



The case study was carried through from 2009 – 2012, and it is this period that is being examined, along with future developments. In 2009 BaltCICA was initiated by climate modelling and followed by a scenario workshop which took place in autumn 2009. The scenario workshop took place over two days with three weeks in between.

In 2010 DBT and the municipality of Kalundborg elaborated the adaptation options developed at the scenario workshop. The administration and politicians developed adaptation options for other parts of the municipality vulnerable to future flooding and alternative guidelines for an adaptation strategy were identified. A citizen summit with 350 participants took place in March 2011. Citizens deliberated and voted for general adaptation guidelines for the options developed at the scenario workshop for the case study area, and for other parts of the municipality. In 2011, the results were analysed, debated by the politicians and the administration started drafting up an adaptation strategy. The draft was partly based on the results from the citizen summit, further assessments of climate impacts in the municipality and on general guidelines from government agencies and ministries.

In 2013 Kalundborg Municipality completed a climate change adaptation plan.

#### The climate adaptation plan

- 2009 climate modelling
- 2009 Scenario Workshop
- 2010 Elaboration of adaption options
- 2011 Citizen Summit
- 2011-2012 Adaptation strategy
- Kalundborg adaptation strategy to be completed in December 2013
- Data collection process to begin in February 2014 with individual and focus group Interviews

#### e) Collaboration with other Partners and Case studies

#### Collaboration with BASE case studies (see list in EMDESK):

Case: \_\_\_\_\_; Person: \_\_\_\_\_

Case: \_\_\_\_\_; Person: \_\_\_\_\_

Case: \_\_\_\_\_; Person: \_\_\_\_\_

Case: \_\_\_\_\_; Person: \_\_\_\_\_

Case: \_\_\_\_\_; Person: \_\_\_\_\_

Case: \_\_\_\_\_; Person: \_\_\_\_\_

**Collaboration within BASE partners/researchers** (EX: for a specific competence):

Name: \_\_\_\_\_; Partner: \_\_\_\_\_

Name: \_\_\_\_\_; Partner: \_\_\_\_\_

Name: \_\_\_\_\_; Partner: \_\_\_\_\_

Name: \_\_\_\_\_; Partner: \_\_\_\_\_

Name: \_\_\_\_\_; Partner: \_\_\_\_\_

Name: \_\_\_\_\_; Partner: \_\_\_\_\_

Name: \_\_\_\_\_; Partner: \_\_\_\_\_

f) Research Outputs

**a. Scientific Publications**

- Interim reports + final case study report for D5.5 (Month 30)

- Scientific papers: #

Provisional Title: Climate Adaptation Governance - Theory; Concepts; and Praxis in Cities and Regions. HafenCity University; Hamburg

*(add more papers in case you need)*

**b. Other Publications**

- Books/Books Chapters: # 1

Provisional Title: \_\_\_\_\_; Month/Year: \_\_\_\_/\_\_\_\_

**c. Other**

- Scientific conferences: # \_\_\_\_

Provisional Title: \_\_\_\_\_ Conference: \_\_\_\_\_ Month/Year: \_\_\_\_/\_\_\_\_

Provisional Title: \_\_\_\_\_ Conference: \_\_\_\_\_ Month/Year: \_\_\_\_/\_\_\_\_

- Invited seminars, presentations at local events, etc...



### 3. Participation in Climate Change Adaptation

#### Process overview

(Please describe the use of Participatory Methodologies within your case study, namely its integration in the overall Research Methodology explained earlier in the CSLD, the rational behind it and key expected outcomes – Máx 1000 words)

Distinguish between the case itself and the research we conduct.

Since the Kalundborg case is retrospective, one of its main aims is to document the participatory process in the BaltCICA project, and thereafter study whether and how the participatory process has influenced the municipality's final climate adaptation plans.

#### Participation in the Process Phases

(Please uncover the role of all participants in the process of implementing adaptation measures. The adaptation implementation has been divided into four phases for purposes of ease: 1) Initiative/decision to act, 2) Development of potential adaptation options, 3) Decision-making, and 4) Implementation. The process phases are to be filled out with information corresponding to each participant. I.e. if experts were not consulted in the 'decision-making' phase, then describe why they were not included. It is also important that a wide array of participants is described, including those that were excluded from parts of the process. )

Make a bullet point for each of the five participant categories below (and distinguish between for example different stakeholder or expert groups) and be as descriptive as possible how, why/why not were they involved.

#### Process phases:

##### 1. Initiative/decision to act

Stakeholders

Citizens

Experts

Politicians

Officials/legislators

Politicians and officials from the Department of Engineering & Environment had realized that "the weather" in itself was an imminent issue and it was only a matter of time before they had to address the challenge. The municipality lacked proper tools to meet the challenges BaltCICA was regarded as an opportunity to prepare the staff and to gain knowledge on climate change and insight into GIS modelling.

##### 2. Development of potential adaptation options

Stakeholders

Citizens

Experts

Politicians

Officials/legislators

### 3. *Decision-making (decision on adaptation plan)*

## Scenario workshop

Four to six months prior to the scenario workshop maps pointing out the effects of severe floods and other climate change impacts in 2090 were prepared. Thereafter the preparation of the scenarios began. The scenarios used at the scenario workshop explained the effects of having chosen different strategies to deal with future flooding. The scenarios are written in a journalistic style made to provoke a debate amongst the stakeholders and, thus serve as a starting point for the development of adaptation options at the scenario workshop.

Three future scenarios were developed:

- A 'laissez-faire' scenario based on the assumption that is in not desirable to do anything to alleviate the impact of future climate changes, beyond what is within immediate economic reach.
- A 'protection scenario' based on an attempt to protect current land uses as much as possible against the consequences of climate change. This includes residential areas, infrastructure, commerce and agriculture. Initiatives will be launched in order to protect existing economic interests, even if this has negative consequences for the environment and nature.
- An 'adaptation scenario' based on the need to adapt to future climate changes rather than fight against them. Current land uses will be re-evaluated and adjusted to the changing environment,

The three scenarios are used as an attempt to describe the pros and cons of the various adaptation options involved and can be used to discuss the possible effects on the local stakeholders and the entire community. The scenarios were sent to the participating stakeholders approximately three weeks prior to the workshop.

The working methods used in the two days scenario workshop alternated between group work and plenaries. The programme was structured around three consecutive phases: the *Critical analysis phase*, the *Visionary phase* and the *Implementation phase*. Groups of four to six participants representing different interests with presumably conflicting interests were brought together. There are pros and cons for of this procedure.

The form and rules of the scenario workshop are there to ensure that everyone is heard, that all ideas are included in the debate and that the stakeholders work towards formulating an action plan.

*Critical analysis phase* (day 1) – The task is to provide both positive and negative criticism to the scenarios based on the views, knowledge and experiences of the participants. The task does not involve choosing the best scenario or access which is the most probable as they are not predicted. The scenarios are there to inspire criticism and lead, which can lead to the development of new visions and adaptation measures.

*Visionary phase* (day 1) – The purpose of the visionary phase was for the groups to develop their own visions for the future based on the knowledge gained from the previous phase. The participants could make up their own future scenarios by including elements of the pre-constructed future scenarios.

In the three weeks in between the two workshop days, the results of the first workshop day was analysed and the visions developed in the different groups were merged into four different vision. Prior to day two the participants received the four

visions, and they were invited to state in advance which of the visions they would prefer to elaborate on during the second day of the workshop.

*Implementation phase* (day 2) – The purpose of the implementation phase was to produce an actions plan for each of the four visions by taking into consideration how to implement a vision in real life. During this process a number of barriers became apparent including economic, cultural, social, organizational, political or technical. The actions plans were drawn out along a timeline displaying who was responsible for what and when.

The outcome of the scenario workshop was four different visions, arguments for and against these visions, plans for the implementation, a long list of technical issues to be clarified and a clearer sense of the political choices involved in the identification and implementation of the adequate adaptation measure.

The four different visions developed were:

1. Transforming the area into a nature area
2. Phasing out vulnerable properties but allowing interim protection
3. Establishment of onshore dykes and river dykes
4. Construction of large offshore dykes

## Developing adaptation options for the citizen summit

After the scenario workshop in Kalundborg different visions drawn out by the stakeholders were developed. The consultancy firm NIRAS estimated the practical viability, the environmental consequences and economical costs of implementing the adaptation options in the visions. Technical experts within the municipality were also assessed. Simultaneously, discussions about adaptation challenges and options in other parts of the municipality began between the municipality and DBT. DBT assisted the administration with clarification of the adaptation options available and identified the political choices involved in choosing one adaptation measure over the other. DBT encouraged the municipality to identify the political decisions that had to be taken in order to make an adaptation strategy. The politicians were presented to the concept of the citizen summit and gave their input to relevant questions to address. They acted the idea that citizens could be consulted, when it came to political decisions they were responsible for. They saw a consultation as a possibility to examine public acceptance of political actions that were expected to be unpopular.

### Citizen summit

On March 5<sup>th</sup> 2011, 350 citizens participated in the citizen summit in Kalundborg. The citizens were chosen to represent the demographic distribution in the municipality with regards to age, gender and geographical residency. 7000 randomly selected citizens in the municipality received an invitation to the citizen summit. Five hundred were selected out of the positive responses.

A set of 19 questions were developed, divided into six thematic subjects:

- Personal experiences with flooding and demographic data
- Vulnerable rural areas (such as the case study area (such as the case study area)).
- Kalundborg City
- Dividing responsibilities between citizens and authorities.
- Involvement of citizens in planning for climate adaptation

The participating citizens were provided with information material with background information about potential economic and environmental consequences of the different adaptation options. Three weeks prior to the citizen summit the participants received an information booklet of 32 pages developed by DBT in close cooperation with the Kalundborg administration. The 19 questions were not made publicly known in advance in order to avoid citizens making up their minds prior to the deliberation. Different speakers were invited to introduce the main discussions presented in the information material in order to prompt deliberation among the citizens.

### **Deliberation and voting**

The 350 citizens were divided into tables of five to seven people, where a programme divided into six thematic sessions was led by a head facilitator and group moderators. Each thematic session was introduced by the facilitator and a short presentation by an invited speaker. Computer animations of potential future flooding produced by the Municipality of Kalundborg were also presented. The Citizens voted on alternative answers to a total of 19 questions. The participants then engaged in moderated discussion at their tables, which purpose was to give all participants time to listen to other opinions and reflect prior to voting. In advance of the summit, moderators were trained to provide facilitation at the tables. The thematic session concluded with citizens casting their votes anonymously on one to five questions. The results were presented instantaneously on a large screen.

### **Interpretation of results**

To the question addressing the preferred development of the case study area, two thirds of the citizens voted in favour of making a decision now that will allow the coastline to move further inland, and thereby eventually discontinue current activities in these areas such as summer houses and farming. About one third of the participants wanted a collective solution based on dykes. These results differ significantly from the results from the scenario workshop, where local stakeholders were more supportive of various dyke solutions. These results point out the importance of careful consideration as to when and how which stakeholders and citizens should be included in a planning process.

To the question; 'Should the municipality have the authority to alter the status of exposed summer cottage areas, so they can be transformed, in the long term, into nature areas with periodic and permanent flooding?', 85% of the participants answered in favour, 10% against, and 5% 'don't know'. Three quarters of the participants felt that private industry at the harbour area in Kalundborg City shares the responsibility of protecting it from future floods; almost all participants voted in favour of letting the municipality make heavier demands as to the handling of precipitation on private properties; three quarters voted in favour of not establishing new infrastructure (such as sewer systems) in areas prone to future flooding; eight out of ten authorised the municipality to earmark farmland for occasional flooding in the event of heavy precipitation, in order to protect other vulnerable areas such as Kalundborg City and summer house areas from flooding; nine out of ten wanted coastal planning to be more centralized; and nine out of ten wanted the municipality to make a long-term climate adaptation strategy based on the current expectations of climate change, rather than acting only when problems arise or legal obligations to act are imposed.

### **Towards a climate strategy and its implementation**

The Kalundborg administration has processed a draft of a climate adaptation strategy. The strategy includes an analysis of expected climate impacts and vulnerable

During the writing of the adaptation plan stakeholders were not consulted again. The interviews with the stakeholders confirmed that they did not carry out any lobbying after the citizens' summit. When the adaptation plan entered into the formal public consultation phase "hearing some of the organizations submitted response to some points.

#### **Stakeholders**

Citizens

Experts

Politicians

In 2012 the new centre-left government introduced a law, which stated that all Danish municipalities would have to prepare a climate change adaptation plan before the end of 2013.

The municipality has been able to incorporate local views and suggestions into their short- and long-term adaptation planning and policy work.

Officials/legislators

#### 4. Implementation

Stakeholders

Citizens

Experts

Politicians

The actual implementation and adaptation action of the climate plan has yet to come.

Officials/legislators

### Participation Experience

(Please report with regards to your case study and the implementation of Participatory Methodologies using a traditional SWOT analysis – Strengths; Weaknesses; Opportunities and Threats)

Strengths	Weaknesses
<p>Framed the work for formulating the adaptation plan.</p> <p>Certain controversial issues are only brought forward in the plan because the topics have matured through the process.</p> <p>Raise awareness on climate change among stakeholders, citizens, officials and politicians.</p> <p>Feelings of joint responsibility regarding precautions and adaptation measures (also amongst citizens).</p> <p>Views from different stakeholders resulted in a handful of very different proposals dominated of current interests among the stakeholders.</p> <p>Abortive or futile adaptation projects could be avoided.</p> <p>The citizens are consulted before the adaptation plan is prepared.</p> <p>Participants in the citizen summit take all stakes and considerations into account, and discuss the best solution for the municipality as a whole.</p>	<p>Requires resources (costs).</p> <p>What happens after the citizen involvement could have been clearer. More political involvement so they are more committed and better coordination between other sectors and activities in the municipality.</p> <p>Citizens feel there is no substance in the strategy plan- feel let down by the municipality.</p> <p>Difficult to include all affected citizens in the citizen summit as it encompasses climate adaption in the entire Kalundborg Municipality.</p>

Opportunities	Threats
<p>Prepare staff and gain knowledge on climate change and insight into GIS modelling and obtain funding for necessary equipment.</p> <p>Citizen summit as an opportunity to try out new ways of citizen dialogue and receive concrete and tangible results immediately by voting.</p>	<p>Creates unrealistic expectations among citizens in regard to how much the municipality will be able to help and support citizens that are threatened from climate change.</p> <p>Farmer: False expectations to which solutions are chosen to implement. Feels they have set the stage for one solution and then the municipality chooses a different solution.</p>

The involvement of stakeholders and citizens was carried out before the climate adaptation plan was prepared.

## Learning through Participation

In order to capture how participation could improve the climate change adaptation process, please report with regards to your case study:

a) Your view whether and how participation influenced the strategies and measures decided in your case?

Participation has been central in

The adaptation plan states that the purpose of the citizens' summit was to get the views on climate adaptation of the citizens and use these results in the further work with adaptation. It was emphasized both among officials and politicians in the municipality as well as among the citizens and stakeholders that the thorough participatory process created a feeling of joint responsibility to meet the challenges of climate change. Adaptation is now on the agenda and the interviewed stakeholders expressed that the process has created a more pragmatic view on the long-term consequences on climate change;- that not everything will be protected.

b) How you think the participatory process in your case could be/have been improved?

- A key challenge with regard to implementing the local adaptation plan is (the lack of) resources.

c) Any novel (use of) participatory methods observed in the case studies

- The participatory process did succeed to influence the municipal adaptation plan: The process contributed to frame the work of formulating the adaptation plan and the participatory process is explicitly described in the plan and results from the process are referred to in regard to various issues in the plan.

The adaptation plan often refers directly to voting results from the citizens' summit. One example is the sensitive issue of priority between protection of farmland and the development of wetland nature areas. One way to protect areas from flooding caused by cloud-burst or rivers is to allow the water to flood farmland and thus hold up the water before it reaches inhabit areas. Hereby the municipality can also create more wetland areas and thus improve the nature environment. Such measures are mentioned in the plan and specific farmland areas are pointed out. Here the plan refers closely to the voting results at the citizens' summit and hereby the municipality uses the participatory process as an opportunity to present these delicate issues. The interviews with officials and politicians confirmed that the participatory process gave the municipality a mandate (and the courage) to be more specific in addressing these kinds of issues.

- Results from the stakeholder scenario workshop were used for the citizen summit. The results from the citizen summit were used in the preparation of the adaptation plan.
- The themes at the citizens' summit clearly show that climate adaptation has to do with *political choices* and is not only a matter of finding the "right" technical solutions.



## 4. Climate Change Adaptation Measures and Strategies

### a) Adaptation Measures under analysis in your case study

(Please identify your Adaptation Measures considered in this case-study and provide a short description of each)

Adaptation Measure(s):

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_
- 4) \_\_\_\_\_

Short description for each Adaptation Measure (Máx 50 words):

### b) Adaptation Measures selection and data availability prior to BASE

(Please describe how and why where these specific measures selected for further research and analysis under BASE and what is the baseline data already available for each specific adaptation measure. Máx 500 words)

### c) Full description of Adaptation Measures

(Please provide a full description on each of the Adaptation Measures regarding this 21 leading questions under. If more than one Adaptation Measure please copy paste the structure provided.)

#### Process

- I. Would, or at which part would, institutions and private stakeholders implement the measure autonomously to adapt to climate change (Adaptive capacity)?

(fill with your answer)

- II. Does the measure initiate further activities for adaptation to climate change? (Y/N)

- a. If Yes, please name which

- III. Does adaptation aim for flexibility and reflexivity (i.e. the ability to change as CC and other factors develop)? (Y/N)

IV. Is the measure effective under different climate scenarios and different socio-economic scenarios? (Y/N)

V. Is the adaptation measure iterative? (Y/N)

VI. Does the measure contribute to overall sustainable development, alleviate already existing problems and bring benefits for other social, environmental or economic objectives than adaptation (no regret measures)? (Y/N)

a. Please describe briefly how

(fill with your answer)

VII. Can adjustments be made later if conditions change again or if changes are different from those expected today? (Y/N)

### Outcome

#### **Relevance and effectiveness of adaptation measures**

VIII. How important is the climate change threat addressed by the measure? What economic values, ecosystem functions and socio-cultural values are at stake, and to what extent are they affected by climate change impacts? Is there an indication of overriding public interest, e.g. critical infrastructures, public health?

(fill with your answer)

IX. What portion of the targeted potential damages can be avoided by implementing the measure? (0-100%)

### **Efficiency**

- X. How high are the benefits of the measure relative to the costs? Are the costs justified by the benefits  
(Please refer to results of economic evaluation in chapter 5)

(fill with your answer)

- XI. What are the costs of the administrative implementation of the measure? Are there potential funding under the umbrella of other European policies(eg. CAP/Cohesion policy ?

(fill with your answer)

- XII. Does the measure give an incentive for innovation to different actors (e.g. SMEs) / can it deliver a competitive advantage for the local economy? (Y/N)
- XIII. Does the measure have effects on employment? (Y/N)
- XIV. How long is the time-lag between implementation of the adaptation measure and the effect of the measure? \_\_\_\_\_
- XV. What is the timeframe during which the measure will have an effect? \_\_\_\_\_
- XVI. Does the measure create synergies with mitigation (i.e. reduce GHG emissions or enhance GHG sequestration)? (Y/N)
- XVII. Does the measure alleviate or exacerbate other environmental pressures? (Explain briefly)

(fill with your answer)

### **Equity**

- XVIII. What are the impacts on different social or economic groups, are there expected impacts on

(fill with your answer)

particularly vulnerable groups? (distributional impact)

XIX. Does the measure enhance well-being and quality of life (e.g. in the urban environment)? (Y/N)

## 5. Impacts, Costs and Benefits of Adaptation measures

### Introduction

The Municipality of Kalundborg joined the EU-Interreg project 'BaltCiCA' from 2009-2012. The BaltCiCA project was set out to finding ways of dealing with climate changes in the Baltic Sea Region. Through the use of climate change scenarios adaptation, measures were to be 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 GEUS11. 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 finished but because of requirements from the Danish government, it will have to be finished in 2013.

### Economic assessment

In the retrospective case of Kalundborg Municipality three future scenarios attempt to highlight what the consequences will be of responding to deal with future climate change in different ways. The three future scenarios are: a baseline or 'laissez-faire scenario', a 'protection scenario' and an 'adaptation scenario'.

The 'laissez-faire' scenario is based on the assumption that is in not desirable to do anything to alleviate the impact of future climate changes, beyond what is within immediate economic reach. The 'protection scenario' is based on an attempt to protect current land uses as much as possible against the consequences of climate change. This includes residential areas, infrastructure, commerce and agriculture. Initiatives will be launched in order to protect existing economic interests, even if this has negative consequences for the environment and nature. The 'adaptation scenario' is based on the need to adapt to future climate changes rather than fight against them. Current land uses will be re-evaluated and adjusted to the changing environment,

In a meeting between Kalundborg Municipality and the consultancy firm NIRAS the 12th of April 2010, it was agreed that NIRAS should assist with analysis which act as the foundation for the further scenario work. NIRAS have produced background material, which describes the four different scenarios and the expected consequences, with a

<sup>11</sup> Geological Survey of Denmark and Greenland

description of the 24 different concrete solution ideas. NIRAS's analysis are based on IPCCs A2 scenario. For the A2 scenario in Denmark the predicted climate change for precipitation up to year 2090 include:

- 43 % increase in winter precipitation, 15 % decrease in summer precipitation, 20 % increase in extreme rain events, no significant change in groundwater level in the case study area.

The consultancy firm, NIRAS, have made an economical assessment for the three scenarios.

## Method

The consultancy firm has chosen the following analytical approach and defined the task as the basis for the impact assessment:

- The impact assessment is based on the four scenarios, including a wide range of effects from the 0-scenario and/or possible planned measures to counter the effects.
- Each effect or measure has a number of physical effects which depend on the underlying assumptions in the model.
- The temporal scale is taken into account of the flooding compared to an overall estimated (aggregated) consequence of a 80-100 year time period.
- The model is a simple either-or model, where each solution or measure is analysed separately.
- The consequences of the flooding from sea level rise are analysed separately. The synergies between sea water, surface water and changes in ground water level is not taken into consideration.
- Each physical consequence has an economic consequence as each measure is associated with a cost. The damage costs and costs of implementation are presented without a discount rate but presented with either undiscounted fixed or annual values.
- For each scenario the economic consequences of the effects of the 0-solution and other measures are analysed. In the 0-solution operation loss of agricultural land are not accounted for.

## Calculations of damage costs

### 0-Scenario- 'laissez-faire scenario'

The 'laissez-faire scenario' can be defined as the consequences on water supply, infrastructure, residential areas, nature, landscape which follow the expected climate change, if nothing is done to mitigate the consequences.

In 2090 the damage costs of residents and summer cottages are estimated to a minimum of 110 million DKK every 10 years due to extreme sea level events. The total undiscounted risk weighted damage costs from 2010 to 2090 is estimated to 250 million DKK for summer houses, 800 mill. DKK for residents and 50 million DKK for farm property.

The consultancy firm NIRAS have analysed the economic assessment of roads affected by flooding. The damage costs are dependent on flood duration, associated with time loss due to waiting time, detour etc. during the time the road is flooded. There are therefore large uncertainties in the calculation of the concrete Costs connected to the building of a new road is between 5 to 7 million DKK per km.

Coastal erosion will affect summer cottages, farmland area and protected nature areas in the case study area. It is estimated that approximately 12 ha farmland corresponding to a cost of approximately 2 to 3 million DKK and a small nature area which has not been priced, will be lost.

The accumulated cost of damages to private properties by 2090 is estimated by NIRAS to be approximately 242 million Euro (Municipality of Kalundborg, 2011).

The outcome of the scenario workshop was the development of four different visions:

1. Transforming the area into a nature area
2. Phasing out vulnerable properties but allowing interim protection
3. Establishing onshore and river dikes
4. Construction of large offshore dikes
5. Of the four visions, protection based on offshore dykes and transforming the area into a nature area were the most radical and controversial solutions in the eyes of the Kalundborg administration.
6. After the scenario workshop a consultancy firm, NIRAS, were involved in estimating the economic costs of implementing the adaptation options in the visions drawn out by the stakeholders.

<b>0-scenario</b>		
<b>Impacts</b>	<b>Nothing is done (0-scenario)</b>	<b>Costs in year 2090 (undiscounted)</b>
<b>Water supply</b>		
Approach to groundwater changes	No impact	
Approach to fresh supply water changes	5 mill m3/year water reduction in the obstruction process	45 mill DKK yearly
<b>Infrastructure and buildings flood</b>		
Summerhouses (number affected)	Permanently not usable: 503; Not usable every 10 years: 1078; Not usable every 20 years: 1368; Not usable every 40 years: 1520; Not usable every 100 years: 1700	750 mill DKK
Residential (number affected)	Permanently not usable: 112; Not usable every 10 years: 175; Not usable every 20 years: 190; Not usable every 40 years: 204; Not usable every 100 years: 215	950 mill DKK
Farms: Production/farmhouses (number affected)	Permanently not usable: 10/2; Not usable every 10 years: 25/7; Not usable every 20 years: 27/8; Not usable every 40 years: 44/10; Not usable every 100 years: 44/11	Not calculated
Roads	Road by Gørlev every 10 years	Not calculated
Reersø not accessible during periods	Daily	Not calculated
Coastal erosion	Loss of area: 0,12 km <sup>2</sup> farm land; 0,09 km <sup>2</sup> nature; 0,14 km <sup>2</sup> built areas; buildings lost: 9 summer houses	2-3 billion DKK (only farm land)
<b>Changes in environment and nature</b>		
Affected Natura 2000 areas	Tissø will lose species; Reduction or loss of dune by Flasken; Marsh moves into the land; inland beach becomes lagoon	
Nutrient leaching from agricultural soils	Not evaluated	
<b>Landscape changes</b>		
New permanent wetlands	Because the areas along rivers and the coast will not be able to be used for agricultural purposes, the areas will change character and become wetlands and meadows.	
New summer cottage areas	Not relevant	
View of dikes	Not relevant	
Loss of recreational value	The recreational areas will change character from a summer cottage areas to a nature area.	

## Scenario B- Gradual Adaptation

The planned actions are defined as a number of diverse initiatives, which all aim at built-up areas are protected in the short term but in the long run at converted for the benefit of environmental restoration. Reersø, Bjerger Sydstrand and Bjerger Nordstrand are protected so they are converted in 70-100 years. The consequences of changed water supply, infrastructure, settlements and the environment, nature and landscapes is assessed as a result of each of the actions planned separately, while the other measures are kept constant. Synergies between different initiatives were not analysed.

The impact assessment is based on the 0-scenario and describes the effect of individual adjustments for the 0-scenario and the related financial consequences.

For each action, a rough estimate of the related costs, as well as the saved damage costs is calculated. An overview can be seen in the table below.

Scenario B - Gradual adaptation			
Scenario	Description	Requirement for calculating the costs of action	Saved damage costs
Local dikes	Construction of natural/artificial dikes by Mullerup, Dabldy Strand and Ornum to protect the areas Bjerger Sydstand, Bjerger Nordstand and Reersø. The dikes will be phased out after 70-100 years. The overall idea is that the built area will be protected on a short time scale but not on the long time scale for the benefit of restoration.	Total construction costs for the dikes = 161 mill DKK. Total costs for pump systems are estimated to 100 mill DKK.	The dikes can withstand a 100 year scenario, and the damage costs connected will be saved. The undiscounted damage costs is 1,7 billion DKK. Based on the yearly undiscounted accumulated damage costs will exceed the construction costs by 2045. (Farmland is not included)
Dike road	Construction of a dike road/bridge to Reersø in 3.8 m DVRm.	Construction of 4.5 km dike with a road (10 km width with bicycle lane). Total costs = 63 mill DKK	More information required
Vulnerable houses on stilts	The most vulnerable houses and summer houses (Bjerger Sydstand) are moved up on stilts.	The most vulnerable houses are those that in 2090 will be flooded every 10 years. The additional costs of building on stilts is app. 690 mill DKK. In addition there are new construction costs.	480 mill DKK (farms not included)
Vulnerable houses on Bjerger Sydstand get moved	The most vulnerable summerhouses are moved into the country side. Replacement areas for those areas which will be lost the next hundred years are pointed out.	The total additional costs is 38 million DKK plus costs for new construction.	
Bjerger sydstand houses are demolished	The most vulnerable summer houses are demolished	38 mill DKK. In addition the value of the summerhouses are lost.	488 mill DKK are saved in damage costs by the demolition of houses and summer houses
Tissø is closed with countercurrent lock by Halleby Stream	Tissø is held free of salt by the help of a lock by Halleby Stream where	3-5 mill DKK	The maintenance of process water supply gives spared damage costs to 45 mill DKK yearly in 2090
Tissø is closed with a lock by Lille Åmose	Tissø is closed with a lock, Lille Åmose will function as a rainwater reservoir.	Implementation costs regarding the adjustment of the work is estimated to cost between 3-5 million DKK. Assuming that a new pumping station and supply conduit estimated to cost 16 mill DKK including 20% uncertainty.	Saved damage costs are app. 34 mill. DKK yearly in 2090.
Store Åmose and Bøstrup Mose as rainwater reservoirs.	Used as rainwater reservoirs to minimise flooding by the coast	The total costs are app. 1.8 mill DKK yearly	Calculations of the saved costs require detailed hydrological analysis
Reestablishment of streams	The natural course of streams are re-established	Information is needed for which streams to re-establish	



New artificial water reservoirs	Costs in the form of lost soil rents 3.1 mill DKK yearly		
Helsingør river valley as permanent wetland	Conversion to a permanent wetland	Total costs app. 0.6 mill DKK yearly	Calculations of the saved costs require detailed hydrological analysis

### Scenario C- The protection scenario

The planned protective measures either involve the creation of two large sea dikes from Reersø to Mullerup Havn to the south and Svallerup Strand to the north, or the establishment of new coastal dikes along most of the coastline and onshore dikes along most of Nedre Halleby Å.

The impact assessment is based on the 0-scenario and describes the effect of individual adjustments for the 0-scenario and the related financial consequences.

For each action, a rough estimate of the related costs, as well as the saved damage costs is calculated. An overview can be seen in the table below.

#### Scenario C - Protection with dikes and pumps

Scenario	Description	Requirement for calculating the costs of action	Saved damage costs
Construction of two sea dikes	Built-up areas, summerhouse areas, farmland, infrastructural areas and natural and environmental areas shall be maintained as it is today on short and long term. This will be done by the construction of two sea dikes in the north and south of Reersø.	Total costs of dikes and locks are estimated to 0.6 billion DKK.	Saved damage costs by avoiding flooding of summer houses and homes is app. 1 billion DKK (undiscounted). Securing process water feed gives saved damage costs to app 45 mill. DKK yearly
Dikes close to shore	Coastal areas, farmland and summer house and residential areas are protected by constructing dikes and pumps.	Total implementation costs calculated to app. 110 mill. DKK. The implementation of a new outlet is estimated to costs between 5-10 mill DKK. Total implementation costs of pump systems is app. 100 mill DKK.	Total saved damage costs is app. 1.7 billion DKK. The yearly undiscounted accumulated damage costs will exceed implementation costs by 2044. In 2044 it will be beneficial to build dikes and pump stations.
Onshore dikes and new canal	Establishment of stream dikes combined with coastal dikes to control the drainage of areas around canal. Stream dikes will be established and the inlet from Tissø will be controlled so the drainage can be controlled by pumping stations.		

### Economical background data sent out to the participants prior to the citizen meeting

Prior to the citizen meeting held in March 2011, the participants received background information including an economical assessment based on societal and construction related costs of different adaptation strategies for the case specific areas of Reersø/Tissø. The purpose of the economic data was to prepare the citizens for the discussions and voting during the citizen meeting.

Below is a summary of the economic data the citizens received prior to the citizen meeting.

The total costs of an 80 cm sea-level rise in the period 2010 to 2090 are estimated to 1.8 billion DKK. In addition direct and indirect costs are associated with damage on roads and delay etc. Even more, environmental problems are not priced. The participants received an economic estimate of the costs of the four alternative solutions for adaptation in the area, which were developed at the scenario workshop. The alternative solutions included:

1. Offshore dikes
2. Large dikes on the coast and land
3. Phasing out of vulnerable areas with human settlement during this century
4. Quicker conversion to natural areas (no temporary protection)

### Solution 1: Sea-dikes

Table 1 Economic considerations associated with solution 1

Solution 1	Costs	Saved damage-costs (including water abstraction)
Offshore dike with high water level locks	0.6 billion DKK	2067: 0.6 billion DKK 2090: 1.1 billion DKK
Offshore dike with locks and pumps	0.61 billion DKK	2067: 0.61 billion DKK 2090: 1.8 billion DKK

### Solution 2: Large dikes on the coast and land

Table 2 Economic considerations associated with solution 2

	Construction costs	Total saved damage-costs
Coastal dikes	127 million DKK	2045: 280 billion DKK 2090: 1.8 billion DKK
Dikes along Nedre Halleby Stream	39 million DKK	
New outlet for Nedre Halleby Stream north Bjerge Sydstrand	5-10 million DKK	
Counter-current lock in Nedre Halleby Stream	3-5 million DKK	
4 pump stations in connections with coast dikes	5-30 million DKK	
<b>Total costs</b>	275 million DKK	

### Solution 3: Phasing out of vulnerable areas with human settlement during this century

The overall idea is that exposed property will in a controlled manner be phased out the next 50 to 100 years in favour of a gradual adaptation to water and wetland areas. The solution will on a longer time scale mean that the value costs protected in solution 1 and 2 will be lost. This raises the question of compensation as the owners are gradually prevented in protecting their property.

### Solution 4: Quicker conversion to natural areas (no temporary protection)

The aim of this solution is to take advantage of climate change in order to strengthen nature in the landscape. This solution implies that exposed property will be phased out. The solution will mean that the value costs protected in solution 1 and 2 will be lost.

The results and recommendations from the citizen meetings did not have direct influence for the municipality's strategy and implementation of climate change adaptation. From the beginning it was made clear to all participants that input from stakeholders and citizens was to be part of the decision making process on equal footing as other input.

### **Climate Strategy and its implementation - Climate Change Adaptation Plan for Kalundborg Municipality**

In 2013 the Kalundborg administration finished a climate adaptation strategy for the municipality to map the future flood risk from rainfall, sea and ground water in order to take account climate change adaptation in the forward planning. The plan also identified physical actions where either the risk of flooding is high or where the socio-economic values at stake are so high extra effort to protect the area is necessary.

To identify the areas which should be prioritized for the implementation of climate change adaptation in the Kalundborg the municipality created a risk-based methodology to qualitatively assess flood risk based on hydrological models, land-use data and socio-economic data.

In order to meet the local council's overall goal of adapting to climate change is most appropriately the municipality want to focus efforts on the areas at greatest risk. The municipal effort can thereby focus on the areas where there is the most need. The municipality have identified a list of physical areas out of a 12-year municipal perspective. Because not all flood-prone areas can be protected during the 12 year planning period, it has been necessary to prioritize the choice of areas to focus on. In the prioritization of the areas, following criteria have been used:

Risk of flooding, property price, connection with other plans and projects and special values for the municipality. To support the planning and prioritization three types of maps have been made for Kalundborg:

- Flood mapping
- Value cost mapping
- Risk mapping

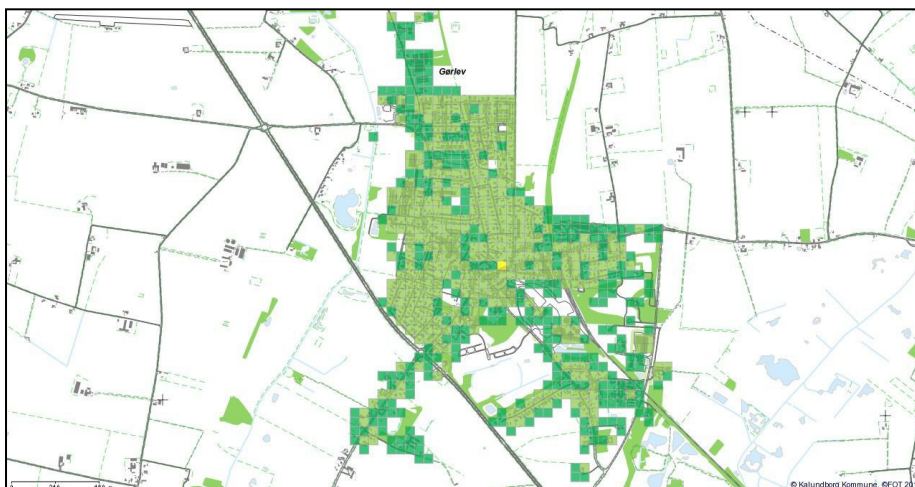
The flood mapping visualizes where the damage will occur. The value mapping shows which values will be affected. The risk mapping combines the two maps to one map, and visualized how the planning can be prioritized, partly based on where the risk is the biggest and partly on where the areas with the most value are located.

As a consequence of flooding the largest socio-economic loss is typically connected to damage costs of buildings. In the case of Kalundborg, property values are the only parameter incorporated in the climate adaptation plan's value mapping. A cost value map was constructed, which shows where the concentration of property values is greatest for the areas, threatened by flooding.

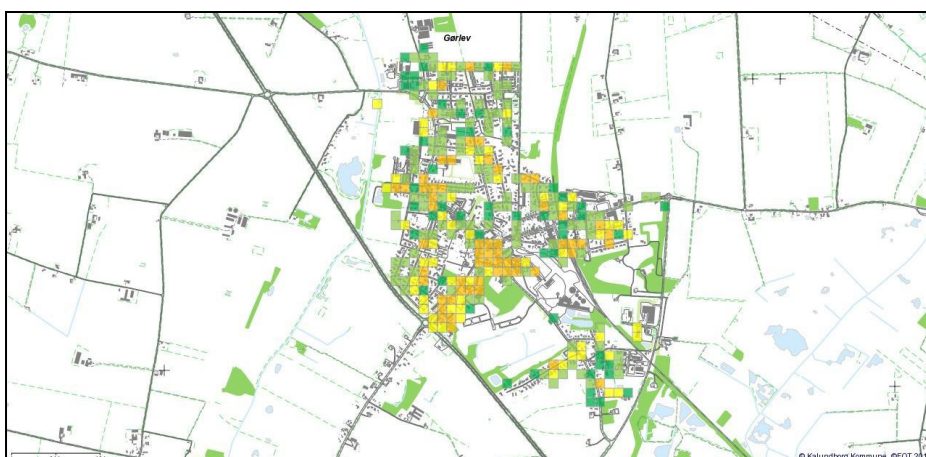
Results from the citizens meeting in 2011 (BALTCICA) showed, that the majority of the citizens feel, that the municipality should engage in dialog with landowners regarding climate change and adaptation, and should contribute with knowledge, expertise and help with financing. The value mapping insures that the municipality's efforts are optimally prioritized.

The risk map is generated by combining the flood map for a 5-, 10-, 20-, 50- and 100-years event for storm-surge and a 50-year event for cloudburst with the value map. A weighted map which shows the total risk is produced, where by the risk is either very high or the threatened property values are very high. On the basis of this map the effort areas are selected.

The figure below shows a value-map for Gørlev. Dark green: values up to 2 mill. DKK; light green: values between 2 mill. DKK and 4 mill. DKK; yellow: values between 10 and 20 mill. DKK.



The figure below shows a risk map for Gørlev. Dark green: low risk; light green: medium low risk; orange: medium risk. Areas with no colour are not at risk of being flooded from the sewer system, to the minimum a 100-year rain event in 2050.



### **Identifying effort areas**

The effort areas are identified based on the risk map linked to other plans and projects in the municipality and areas with special "value".

As previously discussed, the municipality choose to include only property prices in the economic valuation. Population density, for instance, has not been part of the valuation, which mean that an area with big private properties has been valued the same as densely populated areas with small houses even though flooding will affect a higher number of people.

Several places in the adaptation plan the "special values" of the municipality are highlighted. These are among others; nature protection areas, the cultural environment, preserve buildings, strategic infrastructure and important companies, technical installations and official buildings. Nevertheless, as the municipality choose to include only taxable value of property in the calculation of value maps, the special values did only have a minimum of impact on the selected "action areas". It should be observed here that for example important EU-preserved nature areas threatened by flooding has not been selected as "action areas" although it is mentioned in the adaptation plan that it should be assessed whether it is possibilities to place new areas with threatened tidal meadows further inland.

Issues regarding which actions should be taken to protect preserved “nature against nature” seem to be a grey area in legislation.

## 6. Implementation Analysis

The aim of this section is to establish whether adaptation measures can be implemented in the real world context of case studies, and what the key obstacles and opportunities are in doing so. To ensure the answers provided in this section are comprehensive and in line with WP2 and WP7, a checklist is provided below with the main factors that all case holders need to consider in their answers if relevant to the implementation of your case study.

### Checklist

When answering the main questions below ensure you consider each factor listed in the checklist below that might have had a role in the implementation of your case study work. Write in the table how important each factor has been to the implementation of your BASE work and adaptation in general at your case study; where 1 = unimportant, 2 = slightly important, 3 = Important, 4 = Very important, and 5 = Critical). The checklist might not be all-inclusive, so feel free to discuss other factors that are not listed.

Key factors:	Rank from 1 – 5
i. <b>Knowledge and information about climate adaptation</b>	
ii. <b>Actors</b> (e.g. leadership, perceptions, understanding of climate adaptation, participation, decision making, stakes, conflicts/synergies)	5
iii. <b>Framing of climate adaptation</b> (e.g. as sustainability concern, (urban) planning or environmental issue, disaster risk mitigation topic)	2
iv. <b>Local and regional context</b> (e.g. culture, history, geography, environment, economy)	
v. <b>European, national, regional and local regulatory framework</b> (e.g. be specific about laws, strategies, policies)	3
vi. <b>Institutional context</b> (e.g. integration of adaptation into existing structures/activities/strategies, decision making, conflicts/synergies, governance arrangements, incentives for engagement)	3
vii. <b>Resources</b> (e.g. financial, human)	4
viii. <b>Nature of adaptation measures</b> (e.g. no regret, flexibility, important co-benefits, side-effects)	
ix. <b>Other</b> (specify _____)	

### Summary Information (based on your answers to the questions below)

- a) Specify sectors covered (e.g. coast, city, agriculture):  
Coast/agriculture
- b) Specify adaptation measures covered (e.g. altering cultivation practices, building defences; explain why they were chosen): Coastal defences against SLR and storm-surge. Also, retreating summerhouses (abandoning) is considered as a viable adaptation option, as CBA analyses show they often are not worth “saving”.
- c) Specify climate change impacts covered (e.g. flooding, heat stress, sea level rise):  
Flooding (Storm-surge)/sea level rise (SLR)
- d) Specify main results of activities (e.g. changes, outputs):  
As this was a retrospective case, we analysed the municipality’s adaptation plan, with a view to examine how participation have helped shape and influence the strategy. Also interviews and interaction with local stakeholders have highlighted the impact of participatory methods/processes in the adaptation policies developed.

### Questions

Answer these six questions giving specific evidence and examples where possible. In principle all implementation activities should be included, i.e. adaptation activities supported by BASE partners as well as those by other actors. If it is possible to inform about the implementation of those adaptation measures assessed for task 5.2, it is very important to do so in order to comply with the DoW. The measures covered can be extensive and/or particular to a case study. They can include for example, the development of plans and strategies, vulnerability/risk assessments, economic assessments such as CBA, MCA, the development of participatory processes/public dialogue, through to the implementation of actual measures including physical measures such as engineering developments and land use change, incentives/subsidies for behavioural change, etc. This list is not all-inclusive and is merely a guide. Your own case study may have very different measures. However, **you must be clear what measures you are refereeing to when answering these questions.**

1. How have climate change adaptation measures and strategies been advanced in the case study? Describe the process! *Note:* Retrospective case studies will not answer this question, but have to update their answer to question 1 E of this document on the history of adaptation at their case study. (Approximately 500 words)
2. What and who drives (or enables) the adoption and implementation of adaptation measures and strategies/policies? Please explicitly refer to the factors mentioned in the checklist, highlighting the factor in bold, and be specific about any relevant policies! (Approximately 500 – 1000 words)



Even though there was no command from The Danish State on the municipalities to make climate adaptation plans back in 2009<sup>1</sup>, the municipality of Kalundborg already considered making a climate adaptation strategy. However they did not plan to make it a very detailed one.

On this background, The Municipality of Kalundborg joined the EU-Interreg project 'BaltCiCA' from 2009-2012. The BaltCiCA project was set out to finding ways of dealing with climate changes in the Baltic Sea Region. Through the use of climate change scenarios adaptation, measures were to be 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 GEUS<sup>2</sup>. 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 municipality's adaptation policy was to be made accordingly to national guidelines (Action plan for a climate-proof Denmark), which forced all Danish municipalities to devise a local adaptation plan (regulatory framework) in 2011. Beyond that, the plan was very much spurred by local politicians, stakeholders (farmers, private businesses, interest groups), and citizens (Actors). This happened mainly through lobbying and pushing adaptation politically in order to get it high on the political agenda. The municipality has direct contact on a regular basis with citizens, whom are nervous about current and future storm-surges and the climate developments, as erosion and degradation is already happening. A participatory process leading up and feeding into the adaptation strategy also provided the entire locality with a push towards taking a local debate and raising awareness concerning the local Framing of climate adaptation. The participatory process enabled, in other words, the local discussion to developed and become more nuanced. This was done by carrying out a scenario workshop with relevant local stakeholders and later organising a citizen summit where ordinary citizens were consulted on the results of the scenario workshop. Our later analysis of the participatory process' impact on the adaptation strategy, showed that ideas and opinions formed at the citizen summit was inducted in the adaptation plan. Some of them were even quite controversial, as they included giving up currently inhabited areas to future natural developments, instead of implementing adaptation actions. However, since this input was an outcome of the citizen summit, it carried a certain level of political legitimacy.

**Framing of climate adaptation:** There are a number of future climate change driven concerns in the Kalundborg municipality regarding disaster risk and environmental impact or degradation. Being a municipality with an extensive

coastline, there are numerous concerns that might drive adaptation in the future. The study area (14.000 hectare) includes, a peninsula (Reersø), a large lake (Tissø - 1233 hectare), a large near-shore and low-lying summerhouse area, permanent habitation, large agricultural areas, nature resorts ("Natura 2000" protected areas), ground- and surface-water interests, tourist and cultural assets. The land behind the coastline has delta-like characters, which makes the area vulnerable to extreme weather conditions. The area also includes infrastructure such as roads, sewerages, water supply and draining assets. The case study area has a coastline and lowland, which are threatened by sea level rise and changes in precipitation. Flooding is already an issue in this area, as it occasionally affects farmers and summer cottage owners. Reersø, being a peninsula, has been cut off to the surrounding world during previous storms, as the only access road has been flooded.

Adaptation planning in the context of municipal Denmark does not have a standardised way of determining the value of protected nature areas, or culturally/historically important areas or buildings. The framing of these within the economic calculations that were executed in Kalundborg, was also discussed in the context of the participatory process. However, the municipality has maintained a conservative position on the subject, choosing not to rate protected nature areas higher. Instead farmland used for agricultural purposes and the local industry have been favoured and the public registry on square meter prices, has been used to target vulnerable areas, economically speaking. Therefore, one of the key drivers in the implementation of future adaptation action will inevitably be housing and land prices.

3. What obstacles were encountered during the adoption or implementation of adaptation measures and strategies/policies? Please explicitly refer to the factors mentioned in the checklist, highlighting the factor in bold, and be specific about any relevant policies! (Approximately 500 – 1000 words)

Amongst the obstacles is the fact that adaptation plans remain plans. Funding or an exact roadmap of how to implement the plan is not provided through the municipality and the Danish government does not require municipalities or someone else to implement certain measures, nor maintaining a level of security that must be observed. A clear indicator of the level of protection is therefore a conceptual obstacle in the adaptation plan.

Another much more tangible obstacle, but perhaps the most severe one, is the ability within the municipality to uphold a high level of technical expertise.

**Resources:** As many other smaller governmental bodies in Denmark, knowhow is build up around one or two key personnel. Indeed, the technical and environmental department team responsible for making the adaptation plan consisted of two employees, where one of them left the position a year after completing the strategy. This left the department with a big challenge and practically had to start all over on many aspects of the adaptation work. How local knowledge is maintained and anchored seems to be a key question, especially when dealing with adaptation issues, since these are often quite multifaceted (and multi-disciplinary) and requires great deal of insight.

4. If any obstacles were overcome, how was this achieved? (Approximately 500 words)

Being an area with wide implications, planning for climate change adaptation is a hot political topic. Part of the obstacle in this area is making hard political choices about what to prioritise when adapting to future floodings, and what to abandon. The basis of this was not just down to economic assessments, as local interests and taxpayers are at risk. Therefore, the municipality will have to balance between wanting to uphold a level of security and making



financial priorities, since not everything is 'worth' protecting, a tendency only aggravated by future climate projections. These obstacles were partly overcome when the municipality carried through a large participatory process involving various representative stakeholders in the municipality.

Because of the participation in the BaltCICA EU project, the Municipality of Kalundborg has already taken steps towards defining the goals and priorities of adaptation to climate change. This has been done on the basis of economic and environmental estimations together with the involvement of stakeholders and citizens in the decision making process. The results from the citizen summit (based on the results from a 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. Being a relatively small municipality with limited resources, one of the main barriers that was overcome by joining this process, was simply a lack of administrative resources and political focus. Adaptation was never a topic high on the political agenda, as it was regarded as a more technical subject, where the municipality serves as technical aides to the land and homeowners, whom are required to pay for the adaptation of their own land by law.

5. What are the future prospects of the climate change adaptation activities in the case study?  
(Approximately 200 – 500 words)

Future adaptation advances will highly depend on the political developments, not only locally but also regionally and nationally. The national demand for municipalities to produce local adaptation plans have not been followed up with an implementation plan, nor funding. Therefore, a great deal will depend on each municipality's technical and financial ability to oversee the sought for adaptation actions.

Whether there will be an increased focus on actually implementing the adaptation plan also highly depends on future climatic conditions and particular incidents, such as storm-surges and inland flooding. Saline intrusion is a potential threat and since the city of Kalundborg, with all its vital economic interests and infrastructure, is located on the coast, severe flooding or unnerving projections are bound to spark action.

What is the key message from this case study (and which could work in other cases as well)? Don't forget to consider any specific policy recommendations that arise in your case study! (Approximately 200 – 500 words)

In the process of devising the local adaptation strategy, the Kalundborg municipality incorporated local knowledge, needs and suggestions into their short and long term adaptation planning. Not only did this provide them with valuable knowledge of where the adaptation needs were most pressing and other local comprehension, but it also enabled them to educate or inform the public about possible future consequences of climate change. Furthermore, in a Danish context, long-term planning is quite the challenge with a 4-year political term, and adaptation is not the most popular subject amongst voters. The acknowledgement and incorporation of local views in Kalundborg, through the participatory processes, provided the city council with a mandate to make long-term planning and make some tough choices. However, none of this has manifested itself into action yet.

Participation and involvement is an inherent and embedded part of municipal planning in Denmark. Although open to local interpretation, the Danish democratic and associative tradition prescribes an anticipation of involving affected citizens and stakeholders in planning and policy efforts. This is often the case with long-term planning involving a high degree of uncertainty or risk, as with climate adaptation. Since the regulatory system dictates that political processes are the primary focus of involvement, there are pitfalls for participation, concerning climate change adaptation planning. The type of planning that goes into climate change adaptation is often of a political nature, although it may seem only technical in nature to the people making them.

## 7. Development of new tools for adaptation planning and implementation

(Please describe the development and use of new tools for climate change adaptation planning and implementation which you have used under BASE research project and report on their SWOT analysis and overall feedback. Máx 2000 words)

New tool(s) developed and used during BASE:

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_
- 4) \_\_\_\_\_

Description for each New tool (Máx 50 words/each):

Swot Analysis:

Strenghts	Weaknesses

**Opportunities**

**Threats**

## 10. References