BASE BOTTOM-UP CLIMATE ADAPTATION STRATEGIES TOWARDS A SUSTAINABLE EUROPE

SEVENTH FRAMEWORK PROGRAMME

Subgroup: Coast

Case-study: Timmendorfer Strand

(Ecologic Institute, Germany)

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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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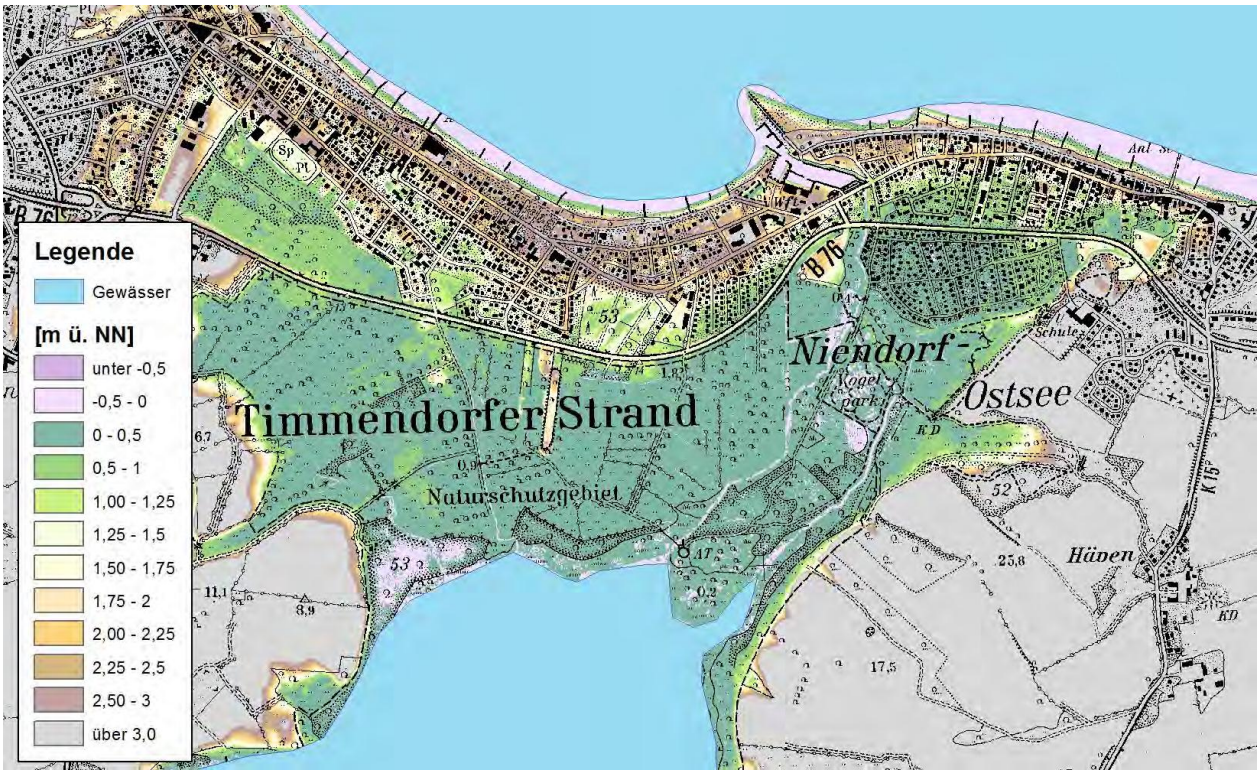
1. General Case Study Description

Location

GPS: latitude 53.9858 / longitude 10.7744
Area: 20,12 km²

IMAGE / MAP / AREA



Case Study Summary

The municipality of Timmendorfer Strand is a German coastal municipality and seaside resort located in the district of Ostholstein, in the state of Schleswig-Holstein. It is located in the interior of the Bay of Lübeck in the Baltic Sea, roughly 15km north of the city of Lübeck 70 km northeast of Hamburg. From 1998 to 2011, the municipality of Timmendorfer Strand developed and implemented a coastal protection strategy using a participatory process. The community is located in lowlands and has around 9000 inhabitants. Tourism is the main economic sector; around 200000 tourists spend their holidays in Timmendorfer Strand with a total of 1.2 million overnight stays.

Already in 1999 first discussion about an integrated flood protection concept for the community of Timmendorfer Strand started. It was agreed that the concept should be accepted by all involved stakeholder. Therefore, analyses of various social and economic parameters were performed. With these data and scientific principles, an innovative method for active public participation (the so-called sensitivity analysis) was applied. The results of this participatory process were used as a basis for a design competition among selected consultants. These three steps (valuation, sensitivity analysis and the competition of ideas) were used for the first time in a participatory ICZM-process. The completion of the project was in 2011 with a total cost of around € 30 million.

The case study, led by the Ecologic Institute, will focus on a cost-benefit analysis of the already constructed coastal defence system. While the costs of the measure can be defined rather clearly, assumptions about the benefits are not as distinct. Data is drawn from statistical sources, but will also be backed-up by literature and experts interviews on a local level.

The study will discuss the perception of climate risks and the adaptation measures developed in Timmendorfer Strand. The focus is on the socio-cultural, ecological and economically motivated reasons that have led the community to engage with adaptation to climate change at all and to implement a particular measure. Different methods of empirical social research yield insights into cultural traditions, local patterns of knowledge and values. Historical development trajectories are shown to influence community values and through these approaches to coastal defense and adaptation to climate change.

Context

The geographic area of Timmendorfer Strand is roughly 2.012 ha. Of this, 609 ha is arable land, 209 ha is developed land, 192 ha are grassland, 186 ha are forested, and 521 ha contain inland bodies of water (Municipality of Timmendorfer Strand 2012).

Focusing on the coastal characteristics, the beach accounts for 37 ha (Municipality of Timmendorfer Strand 2012). The beach itself is largely exposed to the northeast, sandy in nature, approximately 6 km in length and contains shallow waters (Lehners 2011). The larger region surrounding the coast consists of two spit systems, which separate former lagoons from the Baltic Sea. These lagoons now consist of a lake directly south of the main population centre on the coast (the Hemmelsdorfer See) and a drained marsh region that is now cultivated. Tidal ranges in the Bay of Lübeck are minor, in the range of 30cm (barring periods of strong winds where the range can extend from 0.5-1m) (Lehners, 2011). As such, they play a minor role in the hydro- and morphodynamics of the coast, which is determined largely by waves and storm surges. Approximately 18% of the total area of the municipality of Timmendorfer Strand

stands less than 3m above sea level (Hofstede, 2001). In more detail, 0.07 ha are below sea level, 332 m² are below 1m above sea level, 89 ha are between 1-2 m above sea level, 104 ha are between 2-3m above sea level, and 39 ha are between 3-4 m above sea level (Reese & Markau, 2002).

Brief General Information on Climate CHANGE and related issues

Timmendorfer Strand is located at the temperate zone of the Baltic Sea Region and is laying no more than 4 meters above sea level. With respect to climate change, it is mainly threatened from impacts such as sea level rise, storm floods or coastal erosion. From a coastal defense perspective, 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.

Since Regional climate projections are scarce, the official master plan for coastal defense from Schleswig-Holstein uses IPCC-Scenarios combined with regional modeling aspects to generate statements about possible climate change impacts. Sea level und precipitation is expected to rise in the future causing increased hydrological loads on coastal defense measures.

Both coastal ecosystems as well as the population living in coastal with their property values are in threat of climate change effects. In order to strengthen risk awareness of the population, the risk communication shall be intensified (MELUR 2012)

Existing Information on Case Study's adaptation history

Local development and coastal defence in Timmendorfer Strand and Scharbeutz

The last severe storm surge hit the Lübeck Bay in 1872 and flooded the entire coastal lowlands of Timmendorfer Strand and Scharbeutz. Since then, the Baltic Sea coast has experienced minor storm surges only, when compared to the North Sea coast for instance. The reconstruction in the following years was a great trigger of touristic development in Timmendorfer Strand and Scharbeutz as well as in Niendorf and Haffkrug. The main structures by which the coastal resorts are known today date to this period, such as the bourgeois mansions in Timmendorfer Strand (erected beween 1975 and 1892), the promenade in Timmendorfer Strand (from 1895), spa gardens, and hotels (Herde, 2006).

The tree alley on the promenade was originally a measure for coastal defence. However, as memories of the 1872 storm surge faded, coastal defence became less of a concern. By 1908, the first permissions were granted to construct buildings on the foredunes, directly exposed to the sea (Herde, 2006: 14). Defence structures in form of natural beach-ridges were lower than what would be required to withstand the statistical 100-year storm surge, and attempts by state authorities to heighten defences through artificial structures (walls) were turned down by the communities (which are, as described above, the main decision-makers in coastal defence) in fear of reduced revenues from tourism as a consequence of limited sea views and narrowed beaches. (Hofstede, 2004: 235). As sea levels are rising, the need for new measures has become more and more urgent in the past decades.

The ministry (MELUR, then MLR) stepped in 1999 and initiated a pilot of participatory coastal defence 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)[1]. 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. 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).

Connection with other research projects:

RADOST (Regional Adaptation Strategies for the German Baltic Sea Coast (www.klimzug-radost.de/en)

Duration 2009 – 2014

Co-ordinator: Dr. Grit Martinez, Ecologic Institute

The project aims to develop adaptation strategies for the German Baltic Sea region in the dialogue between science, industry, government and civil society. For the project it is equally important to minimise the damage to the economy, society and nature and on the other hand to use the change associated development opportunities in an optimal way. Another goal is the sustainable strengthening of stakeholder networks and communication structures, even beyond the regional bounds.

These goals shall be realized by means of the following five starting points:

- Networking and dialogue constitute the interface between science and application. Problems within and in between the sectors will like this be dealt with as required. Several hands-on projects are organized in order to demonstrate the implementation of measures for climate adaptation.
- Fundamental data is provided by researchers from the natural sciences and engineering. This includes detailed studies of hydrodynamics/the transport of sediment, water quality and ecology as well as biodiversity.
- The socioeconomic analysis looks at the changes to be expected in the regional economic structure due to climate change, with effects on income and employment and costs and benefits of different adaptation options.
- The national and international political exchange includes the nationwide and international transfer of information and experiences as well as the alignment of regional adaptation strategies including the political development on a national and European level.

In addition to research institutions and engineering companies, the core team of 17 partners includes several Federal State authorities and one non-governmental organisation. Furthermore, the project involves a multitude of ovewr

[1]Most (statutory) procedures for integration of public opinion are reactive, i.e. plans have been designed before going into public discussion. The only instruments to enable active participation of the general public are the *ländliche Struktur- und Entwicklungsanalyse (*rural structure and development analysis, *LSE)* in Schleswig-Holstein, and the EU *LEADER+* program (Hofstede, 2004: 236).

150 network partners . The regional dialogue is complemented by an exchange of information on the national and international level involving partner regions in Europe and North America.

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[2]
	[X] Objective 1 [ ] Objective 2	Example: [A] Companies (Farms)	[ ] Rural [ ] Urban [X] Coastal	[X] Local [ ] Regional [ ] National	[X] Bottom-Up [ ] Top-Down	[X] Retrospective [ ] Prospective	1998 - 2011

[2] Please insert year of start and year of end of case study.

	☐ Objective 3 ☒ Objective 4 ☐ Objective 5 ☐ Objective 6 ☐ Objective 7		☐ River Basin	☐ Transnational ☐ European /Global			

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[3]	Phase of Implementation[2]
☐ Extreme 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

[3] 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.

2. Case study research Methodology

Research Goals

For the case study, four main questions can be addressed:

- Which effects and benefits of the coastal defense are appeared through the measure?

  Different relevant benefit components will be included in the analyses. The main benefit is the avoided damage that would be caused by coastal flooding. Due to the increased touristic attractiveness through the beach promenade it was expected that one-day visitors and overnight stays could increase or at least stay stable after the completion of the dike. The analyses will include the assessment of benefits for the local tourism services, such as restaurants, hotels, etc. It needs to be discussed if further parameter can be included, like changes of land prices near the beach promenade.

- Which costs and benefits can be quantified and monetarized?

  The main costs are investment costs at the beginning of the project. The planning of the measure included a participatory process. The costs for implementing this participatory process will be included in the estimation. Furthermore, regular maintenance costs per year will be integrated into the cost analyses. Here, costs for maintenance of the dike for flood protection, but also maintenance of the recreation related area like cycling paths, promenade, etc.
  For estimation of avoided damages caused by coastal flooding, an existing analysis of potential damages can be used (Reese 2003). The data includes damages to buildings, infrastructure, vehicles, gross value and further parameters.
  For the quantification of impacts on local tourism services, the analyses will include the estimation of changes in overnight stays and if possible one-day visitors. As far as data can be collected, the income and turnover of new restaurants directly on the dike and the changes of income/turnover of other restaurants/hotels nearby the dike will be analysed. To exclude changes which are not reasoned by the implemented coastal protection measure, the developments of the touristic services will be compared with the average statistical data for the federal state “Schleswig-Holstein” or other touristic cities or regions at the German Baltic Sea (e.g. Rügen and Usedom).
  It will be analysed, if data on changed land prices near the beach promenade (compared to the whole region and other touristic cities at the German Baltic Sea) is available.

- From a historic perspective, what were success factors?/ What role do socio- cultural values and socio-economic attitudes play in valuing the coastal defense measure?

  For Timmendorfer Strand, congruence can be noted between the interests of coastal protection, adaptation to climate change and tourism development/ associated consumerist values (such as gain orientation, individualist entrepreneurial thinking, and protection of the high standard of living). This can be explained by looking back to the municipality’s socio-economic development path. The storm surge of 1872 and the rapid development of tourism in the early 20th century can be understood as a foundation myth, enabling the community to quickly establish itself as a well-respected spa town and coastal resort. Tourism has always been a key driver of developments and represents the

centerpiece of community identity. 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.

The goals of the case study are to elaborate an adequate baseline study. This includes a detailed cost-benefit analysis. The results from the two tasks feed into the upscaling of the results.

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.*

For the cost-benefit analyses of the measures a limited number of local stakeholders were interviewed. Some of them are part of the local parliament or active member of the community and were interviewed to gather information on the perceptions on effects after implementation of the measure. Other contacted local stakeholders are restaurant owners who are interviewed to gather data on a change of restaurant incomes. Furthermore, the local tourism office and the city council was contacted to gather data for the cost-benefit analyses.

Methodology

Semi-structured personal interviews (approx. 2 hours each)

Random interviews (between 10-20 min each)

Background (document) analysis

Stakeholder Groups:

Elected representatives (mayor/ dean/ deputy)

Knowlegable community members active in comittees, people living in the community for generations (sense of place/„Heimat")

Local enterpreneurs

Economic Approach: Classic CBA

- 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.

METHODS to be used in Case Studies[4]	YES // NO
A) Methods for prioritizing adaptation options	
Cost-Benefit Analysis (CBA)	YES
Cost-Effectiveness Analysis (CEA)	
Multi-criteria Analysis (MCA)	
Analytic Hierarchy Process (AHP)	
B) Quantification of impacts and relationships between factors affecting adaptation	
Causal Diagrams	
Influence Diagrams	
Process-based Modelling	
Welfare variation analysis under restrictions	
C) Uncertainty and sensitivity analysis	
Probabilistic multi model Ensemble	
Monte Carlo simulations (PRIMATE uses this method)	
Real option analysis	
Climate risk management process	
D) Participatory Methods	
Scenario Workshop	
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):	

(Máx 500 words) *Please highlight if you have any special need or focus regarding any of these methods and their use on your case study.*

[4] 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

Case study Timeline

(Please insert and image/graph of the Timeline of your Research Approach, highlighting important milestones and deliverables.)

May-October 2013: preparation of interview trip to community

November 2013: interview trip to community (interviews with local stakeholders)

December-May 2014: Limited number of telephone interviews with local stakeholders, Defining effects which will be included in the cost-benefit analyses, Defining which cost/benefit-components are probably quantifyable.

January – July 2014: Data gathering for the cost-benefit analyses

March 2014 - February 2015: Developing the cost-benefit analyses

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: _____

Research Outputs

a. Scientific Publications

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

- Scientific papers:

Provisional Title: "Results from the cost-benefit analysis at Timmendorfer Strand" (Troeltzsch, Martinez, Stelljes). Month/Year: 8 /2015

(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

The main outstanding aspect of the measure is the participatory approach. This is an example of a planning and executing of a coastal defense measure, where local locals where involved in the planning process.

Initiated by the Schleswig-Holstein State Ministry for the Rural Areas, State Regional Planning, Agriculture and Tourism (MLR, now MELUR) in 1999, the measure took over 10 years to its finalization in 2011. The project followed three steps: assessment of socio-economic values, sensitivity analysis, and ideas competition.

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. Socio-economic parameters, like persons employed, tourist bed capacity, economic assets, or yearly gross value added were evaluated. Around 15% of the area is situated less than 3 m above MSL and therefore flood-prone lowland. In the early years of the last decade, around 5500 people lived in this area and capital assets amounting to 3,423 million were counted (Hofstede 2001). This area was not protected by coastal defense and would have been flooded if a event like 1872 reoccurred. This highlighted the need for coastal protection and was basis for the following sensitivity analysis, the part with the actual participatory approach.

The **participatory approach** was based on the “Sensitivity Model of Prof.Vester ©”, developed to cybernetically evaluate complex systems. With this computer-aided model, possible future developments under different scenarios were simulated at different sessions with stakeholers. At this particular case, nine working groups meetings and two public meetings were held. At the nine working groups or focus groups, more than 50 local stakeholders (from the coastal protection authority, fishermen, tourism representatives, local residents and community authorities) participated. Results from the these meetings are published (in German) by Kaul & Reins (2001). Focus of these meetings was the question of how different coastal protection mesaures would affect the community (system) with the assumption of increasing risks of flooding due to climate change. Thematically these nine meetings were split in two steps. The first step included five meetings, were the ‘system’ Timmendorfer Strand was defined by the participants. Variables were collected and relationships between these variables were disclosed. The second step, including four meetings, was aimed at specific aspects concerning sustainable solutions in coastal protection measures. For example, it was discussed how flood protection measures affect key variables (elaborated in step 1) in Timmendorfer Strand. As results of this approach, the participants supported the results of the sensitivity analysis and recommended a combination of coastal protection and flood defense measures. They also agreed upon further involvement in the process of the implementation of the coastal defense measure. The coastal defense administration valued this approach very positive, because the participants recognized the long-term risk for the coastal area, they accepted responsibility, and they “evolved from skeptics to advocates of an integrated coastal defense concept” (Hofstede 2001: 5).

The results of this approach were basis of a following **ideas competition**, where four engineering offices were asked to develop innovative ideas for the coastal defense measure. The execution on site started in 2006 and was finished in 2011.

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*

Experts & Politicians& Officials/legislators

Authorities in Germany have the "legal obligation" (Hofstede & Schernewski 2005) to protect settled coastlines, for example by building dikes. For the example of Timmendorfer Strand, the municipality was responsible for flood defence - the coastal defence administration only acted as advisor and contributed to the costs (Hofstede & Schernewski 2005). The existing defence structures were seen "rather critical" (Hofstede & Schernewski 2005), since it was estimated that a breaching of the spits will occur with a water level of about 2.1 m above MSL. Results from a study undertaken by coastal defence administration showed that Timmendorfer Strand was not enough protected against future flooding (based on increase of seal level rise in last 100 years, and future projections in the next 100 years by 40-60 cm).

The fact that the last catastrophic storm surge is about 130 years ago and Timmendorf relies on tourism (depending on broad, idle beaches) led to a sceptical view of the local population towards coastal defense. It became clear, that "an appropriate coastal defence solution for the area can only be achieved with active participation and acceptance of the local population" (Hofstede & Schernewski 2005). Therefore a participatory coastal protection process was initiated.

Stakeholders & Citizens

Since the initiative to this process was coming from the authorities (top-down approach), the citizens of Timmendofer Strand were not involved in initiating the participatory process. But because of their fears regarding the attractiveness for tourists (tourism is the most important economic sector in the municipality), they had to be convinced, that coastal protection is necessary.

2. *Development of potential adaptation options*

Stakeholders & Citizens

Stakeholders and Citizens were involved in the development of adaptation measures. During the participation process different versions of the coastal protection measure were discussed (especially differing in the height of the dike). The compromise to build a dike but lower than proposed from the regional government (of federal state of Schlwesig-Holstein) was found together with the stakeholder and citizens. Because for this version the height is so high that tourists can still walk behind the dike and see the sea.

But the actual planning of the measurement was done by landscape architects. The participative process had a strong component of awareness raising and affirmation of proposed coastal defense measures.

Experts & Politicians& Officials/legislators

Experts and Officials were involved in leading the participatory process.

3. *Decision-making*

Stakeholders & Citizens

Suggestions that came from the participatory approach were integrated in the concept of the landscape architects. The suggestions included the landscaping part of the project (e.g. renewing the beach promenade) and the additional attractive dike construction, e.g. glazed retention walls were integrated in the dike so that persons/tourists sitting in the cafes can watch to the sea. These additional investments should help to keep the attractiveness for the tourists.

Experts & Politicians& Officials/legislators

The Mayor of Timmendorfer Strand had the final commitment of the project. But with the participatory approach he ensured public support and the close cooperation with the responsible ministry ensured public funding.

4. *Implementation*

Stakeholders & Citizens

Stakeholders and Citizens were not involved in the implementation process.

Experts

Landscape architects were responsible for the implementation.

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)

Strenghts	**Weaknesses**
Active involvement of the affected.	Compared to the number of please affected, rather low number of participants. Time-consuming procedure. Depending upon volunteers.

Opportunities	**Threats**
Awareness of responsibilities by different stakeholders. Acceptance of possible solutions.	Results of the participatory process may not be conform with the initiators expectation. Cancelation of the process because of not enough participants in the beginning of the project. Cancelation of the process during the project, because of loss of interest.

Based on Hofstede 2001, Hofstede 2004, Kaul & Kreins 2001

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?

Through the participatory process, participants "evolved from sceptics to advocates of an integrated coastal defence concept" (Hofstede & Schernewski 2005). For example the glazed retention walls or the landscaping works would not have been realized without the participation of the citizens.

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

It has been stated that the low number of participants and the time-consuming procedure were critical aspects during the process (Hofstede & Schernewski 2005). Especially through netter time management this process could be shortened and therefore less resource-consuming.

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

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) Coastal defense of Timmendorfer Strand and Scharbeutz
2) _____
3) _____
4) _____

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

The coastal defense measure of Timmendorfer Strand and Scharbeutz was a participartory process. First work started already in 1999 and the last finishing works were done in 2011. The project followed three steps: assessment of socio-economic values, sensitivity analysis, and ideas competition; with the sensitivity analysis as the mean participartory approach.

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)

The Case Study of this existing measure will focus on the cost-benefit analysis. Several Information about the costs of the measure are already available, while benefit information have to be gathered.

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)?

No, there would not have been any autonomous implementation of the measure, since it involved several millions € of investment and had to be approved by state agencies.

II. Does the measure initiate further activities for adaptation to climate change? (Y/N) NO
    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)
Only to a certain degree. In certain parts it is possible to build the defence measure higher; in other areas this is not possible without reshaping the existing measures.

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

Yes, but only to a certain point. The protection measure defends the town only to a certain degree, if sea level rise or storm floods occur in a high magnitude; the measure has to be adjusted.

V. Is the adaptation measure iterative? (Y/N)
(Not sure what an iterative measure is) I would assume that a coastal defence measure falls not under an iterative measure. Although, the planning-process of the measure could be called iterative, since many feedback rounds and discussions with different actors were held.

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) Yes

    a. Please describe briefly how

It does not alleviate existing problems. It may bring benefits for people working in Timmendorfer Strand (this is part of the economic analysis). The landscaping activities have a positive effect for tourists also the characteristic landscape could be kept intact.

VII. Can adjustments be made later if conditions change again or if changes are different from those expected today? (Y/N)
Only to a certain degree. See question III.

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 ?

For the community the measure is very important, because the possibly affected values by a coastal flooding event are very high. Coastal flooding is the most important climate impact in the community. The community was already threaten by extreme flooding. Climate change increases the already existing risk further.
The community is a quite rich touristic city, so the major economic values at risk are valueable buildings close to the coastline, but also human lifes which could be affected by coastal flooding. Of economic interest for the community is also the affected touristic infrastructure because tourism is the main economic sector in the community. So damaged beach promenade, hotels, restaurants, etc. could be problematic for the local economy.

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

The measure can avoid the main flooding damages up to a 100-year event. It is known, that more extreme flood events occurred already in the region (e.g. in the 19th century).

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)

The meausure was a combined measure of a coastal protection measure and a landshaping measure (which included the improvement of the beach promenade). This combined measure shows high benefits concerning coastal flooding . Furthermore, first results show that the restaurants close to the improved beach promenade have a stable or even slightly increased income. Furthermore, the overnight stays in the region have not changed significantly after the measure was implemented, so that the choosen measure is accepted by the tourists. The analysis on property prices at the improved beach promenade show that the increase of property prices compared to other cities at the Baltic Sea is a little higher. (Property prices increased in all analysed areas.) But the reasons for this increase can relate to a lot of different effects, e.g. also increasing demand, etc.

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 ?

No data on administrative costs available. EU-funding was used, via Cohesion policy.

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)

No, the measure protects the local community and economy, but gives no incentive to innovation.

XIII. Does the measure have effects on employment? (Y/N)

During the investment and building period construction companies were in charge of building the coastal protection. During life-time of the measure maintenance at the dike is necessary.

XIV. How is the time-lag between implementation of the adaptation measure and the effect of the measure?

In general no time lag.

XV. What is the timeframe during which the measure will have an effect?

Dikes are long-term investments with a lifetime of around 100 years.

XVI. Does the measure create synergies with mitigation (i.e. reduce GHG emissions or enhance GHG sequestration)? (Y/N)

No.

XVII. Does the measure alleviate or exacerbate other environmental pressures? (Explain briefly)

No.

Equity

XVIII. What are the impacts on different social or economic groups, are there expected impacts on particularly vulnerable groups? (distributional impact)

The highest benefits are shown for the potentially flooded area of the community. The property and building owners in this area have the highest benefits. But also local community members which are not living in the area and are not property owners have benefits, because many people work in the tourism sector which would be essentially affected by a coastal flooding.

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

Yes, via the landscaping measure the beach promenade has a higher amenity value.

5. Impacts, Costs and Benefits of Adaptation measures

(This section of the CSLD follows the Economic Assessment Steps put forward by UFZ and thoroughly described in D4.1, chapter 4. Please check D4.1 for any doubts or questions. In case of duplication of information with previous sections of the CSLD feel free to copy paste.) For more detailed guidance (incl. two examples) please see the above mentioned chapter 4 of D4.1. Please do not hesitate to contact volker.meyer@ufz.de, oliver.gebhardt@ufz or Filipe Alves if you have questions about how to fill out this section.

Step 1 – Preliminary Risk Assessment and identification of adaptation tipping points (max 1500 words)

(some of these questions might be already answered in section 1 – if so, just copy&paste)

What is the climate change related problem/risk you would like to reduce by adaptation?

- Which problems already exist, what is/are the current risk/s?
- Which assets and sectors are at risk under current climate variability?
- Which adaptation or protection measures are already in place? (refer to typology of measures in D6.1, table 2)
- How do these risks presumably change due to climate and socio-economic change?
- What are the main drivers, impacts and affected sectors (refer to BASE impact and sector categories, see also Table 1 of D6.1)
- Which climate and socio-economic scenarios are used?

At the moment the community is already endangered by coastal flooding and storm surge events. The last severe storm surge hit the Lübeck Bay in 1872 and flooded the entire coastal lowlands of Timmendorfer Strand and Scharbeutz. Since then, the Baltic Sea coast has experienced minor storm surges only, when compared to the North Sea coast for instance.

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).

Reese (2013) indicates that the frequency of the storm surge events could increase with sea level rise. Two sea-level rises of 0.30 cm (minimum scenario) and 0.50 cm (maximum scenario) are used which are in line with moderate

(RCP2.6) and medium (RCP4.5 und RCP 6.0)- IPCC projections.[5] For the 0.30 cm-sea level rise: the frequency of the storm surges are increasing by four, so a 100-year event could change to a 25-year event. For the 0.50 m-sea level rise: the frequency could increase by eight.

The tree alley on the promenade was originally a measure for coastal defence. However, as memories of the 1872 storm surge faded, coastal defence became less of a concern. By 1908, the first permissions were granted to construct buildings on the foredunes, directly exposed to the sea (Herde, 2006: 14). Defence structures in form of natural beach-ridges were lower than what would be required to withstand the statistical 100-year storm surge, and attempts by state authorities to heighten defences through artificial structures (walls) were turned down by the municipalities (which are, as described above, the main decision-makers in coastal defence) in fear of reduced revenues from tourism as a consequence of limited sea views and narrowed beaches. (Hofstede, 2004: 235). As sea levels are rising, the need for new measures has become more and more urgent in the past decades.

The measure refers to coastal zones and following impacts from sea-level rise and increased storm intensity: coastal flooding and coastal erosion.

Which adaptation tipping points can be identified?

- Can adaptation tipping points, critical levels for adaptation, be defined for this current strategy? (=when objectives are not met anymore due to changes)
  Refer to otherwise expand on Table 3 of D6.1
- When (roughly) will these critical levels be reached due to climate change or socio-economic change
- Give appropriate period (2015-2030, 2030-2050, after 2050) for each considered combination of climate and socio-economic scenario.

The tipping point of the measure will be reached by an increased number of extreme flooding events, similar to the 1872-event, because the dike is not high enough to protect the community and their values for such an event. The 1872-event reached 3.00m above sea level. As seen in 1872, events can already today reach the tipping point.

Step 2 – Identification of Adaptation Measure and Adaptation Pathways (max 1500 words)

(some of these questions might be already answered in section 4 – if so, just copy&paste)

What are the alternative adaptation measures?

- What are the primary and secondary objectives of adaptation?
- What are potential measures to meet these objectives?
- (refer to typology of measures in D6.1, table 2)
- What is your baseline option (the "business-as-usual"-option)?
  - What is the ambition level of this baseline strategy?: Maintaining current risk levels or current protection levels (implying with CC risks may increase)?
  - Is current backlog of investments for adaptation measures included or excluded?

[5] IPCC-projections (2013) are between 0.26 and 0.98 m sea level rise. For the Baltic Sea also land rise is expected, so that the maximum will probably not be reached at the Baltic Sea.

  - Does it include only planned adaptation or also autonomous, non-planned adaptation?
- Are there complementary measures? Is it appropriate to bundle these measures?

Objectives of the measure are reducing the damages by storm surges by protection of human health and economic infrastructure. Maintaining tourism was a precondition for building the dike, because the community is economically highly relying on the tourism sector. Therefore, the measure had also the secondary objective to maintain tourism.

In the participatory process within the community different dikes were discussed. The major difference between the different versions of the dike was the height of the dike. The biggest fear of the inhabitants and public authority was that tourism activities could be affected, which would influence the economic basis of the community. Another option was to not built the dike at all and therefore to introduce no measure.

In parallel to the realised coastal protection measure, a finishing and landscaping-project was implemented. The finishing and landscaping-project focused e.g. on the improvement of the beach promenade, two new boardwalks – established in the dunes - and recreational infrastructure, e.g. benches, playground. Because the effects of both projects are difficult to divide, both projects are evaluated together.

The business-as-usual option was to implement no further coastal protection (no dike).

What are alternative adaptation pathways?

- What is the “sell-by”-date of the measures or bundles of measures? I.e. when will they – under conditions of climate change – not any longer be able to meet the defined objectives?
- What would be alternative measures or bundles of measures at these “tipping points”?

The effect of the measure is limited to a storm flood with a water level of 2,50 above sea level (a.s.l.) Any time (already today) a higher storm surge can happen. The Storm flood from 1872 reached a water level of 3.00 m a.s.l. Under climate change conditions the quantity of these extreme events could increase.

Alternatives such as a higher dike were discussed in the participatory process before implementing the measure. The local community decided to take this risk in fear of the decreased attractiveness of the coastline for tourists (and therefore to protect their local economy).

Furthermore, a higher dike would also have a certain tipping point, but a lower number of events would reach the relevant intensity.

Step 3 - Evaluation Criteria and Method (max 2000 words)

Step 3a Selection of evaluation criteria

Which evaluation criteria should be used?

- What are the relevant positive and negative properties of the measures (costs and benefits) to be considered in the evaluation process (economic, ecological and social effects)?
- (see D4.1, chapter 4 for examples)
- What is the appropriate unit to measure each of these criteria? Is the performance of the adaptation options measured in qualitative, monetary or other quantitative terms?

In the case study, costs and benefits of the implementation of coastal protection are quantified as far as possible. For two scenarios we calculated costs and benefits. Minimum scenario referred to a sea level rise of 0,30 m and according an increased frequency of flood events, maximum scenario shows a seal level rise of 0,50 m and the following increase in events. In general, the damages of a 2.50 m a.s.l.-flood event can be fully avoided with the implemented coastal protection. The damages from the 3.00 m – a.s.l. event can only partially be avoided by the coastal protection measure.

Benefit:

- Avoided flooding damages (avoided damage per event, for minimum and maximum scenario)
- Change of recreational function, tourism due to finishing and landscaping project:
    - Change of travellers to community -> Change of spendings per day (minimum+maximum scenario based on different spendings per day)
    - Change of turnover of restaurant owners (qualitative)
- Change of property values (minimum and maximum scenario)

Costs:

- Investment and maintenance costs (coastal protection measure + finishing and landscaping measure)

Step 3b Selection of evaluation method(s)

What is the appropriate evaluation method?

- Is it possible to express all relevant cost and benefit criteria in monetary terms?
  (→ cost-benefit analysis)
- Is it possible to express the positive effect (objective) by a single non-monetary indicator?
  (→ cost-effectiveness analysis)
- Are there several relevant criteria which cannot or cannot easily be expressed in monetary terms?
  (→ multi-criteria analysis, PCBA)

As much as possible costs and benefits will be estimated in monetary terms -> cost-benefit analysis.

Further effects will be described qualitative.

Step 3c Weighting of evaluation criteria (applicable only to multi-criteria analysis)

What are the preferences of stakeholders regarding the different evaluation criteria?

- Are there different stakeholder groups with varying preferences regarding the evaluation criteria?
- Which weight do stakeholders and/or decision makers attach to a substantial change in the performance of the adaptation options regarding each evaluation criterion?
  (see D4.1, chapter 4.10.2 for guidance for the Swing-Weight method)

No weighting of evaluation criteria was done.

Step 4 - Data collection (max 2000 words)

What are the costs and what are the benefits of the alternative adaptation options?

- What potential data sources are available, including damage & impact assessment methods or existing CBA studies on adaptation measures?
- If no relevant data sources are available and modelling cannot be undertaken: Which experts can estimate proxies for assessing the performance of measures regarding the respective criterion?
- How do the adaptation options perform with regard to each of the cost and benefit criteria selected in step 3a?

Benefits:

Avoided flood damages: The avoided flood damages was based on a damage potential analysis which was prepared during the preparation of the implementation of the measure. The damage potential analysis included data on damages (in monetary terms) for flood events with 2.50 and 3.00 m a.s.l. The further adjustment for an increase of sea level of 0.30m (minimum scenario) and 0.50 m (maximum scenario) are based on assumptions on the quantity of expected events. The assumptions are based on Reese (2003), on regional definitions of flood events at the Baltic sea[6] and on interviews with local stakeholders in the community.

Change of travellers to community -> Change of spendings per day: For the estimation of an influence of the improvement of the beach promenade with the coastal protection measure and the finishing and landscaping project regional and local statistical data from the community and neighbouring communities are analysed. As comparison basis, statistical data from other relevant/comparable touristic towns at the German Baltic Sea and German North Sea are analysed. The relevant towns for the comparison were identified in the interviews with the local stakeholders and community members.
Data for spending per day are based on published reports for the community Timmendorfer Strand, for the region Schleswig-Holstein and Germany.

Change of turnover of restaurant owners (qualitative): the data on a change of turnover of restaurants and cafes at the improved beach promenade is based on interviews with owners or staff members.

Change of property values: The property value change was analysed based on approximate values for land prices estimated by evaluators (Bodenrichtwerte). Regional data from the Bundesländer Schleswig-Holstein and Mecklenburg-Vorpommern was used.

Costs:

Investment and maintenance costs: Data from the local community and mainly the engineering company (which was responsible for the project) was used. The estimation of the maintenance costs was based on data from the literature.

[6] Regelwerk Küstenschutz Mecklenburg-Vorpommern (2009): Übersichtsheft Grundlagen, Grundsätze, Standortbestimmung und Ausblick

What is the evaluation time frame?

- What is the lifespan of the measure with the longest lifetime?

Dikes are long-term investments with a lifetime around 100 years. For the estimation as time frame 2011-2100 was used.

Which discount rate should be applied?

- Which discount rate is recommended by national guidelines for climate change adaptation measures (or public investments)?
- Is it a linear discount rate or any other type (i.e. declining, hyperbolic, etc.)
- (In addition, for testing the sensitivity of the results with regard to the discount rate(s) used, also apply a low and high discount rate (1% and 5%)).)

The discount rate of the German national guideline of the German Federal Environmental Agency will be used. [7] It is 1.5% for long-term evaluation (more than 20 years). The guideline says that same discount rate should be used for the whole time-period. For a sensitivity analysis the net present value and the benefit-cost-ratio is also estimated for a discount rate of 0 %, 1 % and 5 %.

How to deal with data uncertainty?

- Can uncertainties related to the performance of the measures regarding certain evaluation criteria be described by a range (min-max), a triangular distribution (min, most likely, max) or any other kind of probability distribution?

For the estimation of the costs and benefits a minimum and a maximum scenario was developed, which show the results as a range . The minimum and the maximum scenario are differing from each other: in the impacts of the climate change, change of property value, additional tourism and maintenance costs.

[7] Source: UBA (2012): Ökonomische Bewertung von Umweltschäden. Methodenkonvention 2.0 zur Schätzung von Umweltkosten. Dessau.

Step 5 – Evaluation and Priorization (max 1500 words)

What is the ranking order of alternative adaptation options (measures, bundles of measures or pathways)?

- For cost-benefit analysis:
  What is the net-present value (discounted benefits – discounted costs) of the alternative options?
  What is the benefit-cost ratio?
- For cost effectiveness analysis:
  Which alternative achieves a defined objective at lowest costs?
  What is the cost-effectiveness ratio?
- For multi-criteria analysis:
  Which adaptation option performs best?
  (e.g. for PROMETHEE approach: which option has the highest net flow?)
- What are the uncertainties associated with the performance of the different options?
- Is there and, if so, to what extent uncertainty in the ranking of options?
- Is it possible to determine which option most likely performs best or is it necessary to gather further information to reduce uncertainty (go back to step 4)?

The cost-benefit analysis was executed for the implemented measure of a coastal protection dike in the community. The measure was compared to a Business-as-usual-scenario – with no implementation of the coastal protection measure and the finishing and landscaping project. The two different estimated scenarios differ in the impacts of the climate change (minimum: RCP2.6, maximum: RCP4.5 und RCP 6.0), change of property value, additional tourism and maintenance costs.

The results of the estimation are shown in the following tables.

Discounted costs and benefits 2011-2100, rate: 1,5%	**Min-Scenario (in Euro)**	**Max-Scenario (in Euro)**
Costs		
Investment costs	30.000.000	30.000.000
Maintenance costs	124.870	374.610
Total Costs	**30.124.870**	**30.374.610**
Benefits		
Land value	5.935.961	8.630.542
Additional tourism	44.787.422	71.953.563
Avoided damage	71.531.567	169.559.899
Total benefits	**122.254.949**	**250.144.004**
Net Present Value	**92.130.079**	**219.769.394**
Benefit-Cost-Ratio	**4,1**	**8,2**

Table 1: Net Present Value and Benefit-Cost-Ratio for the discount rate of 1.5%

It can be seen that the investment-upfront costs are the major type of costs and the main type of benefits is avoided damages by storm surges. Also the additional tourism shows substantial benefits. The Net present value is for both scenarios positive and the Benefit-Cost-Ratio is higher than one.

The following table shows the results for the discount rates: 0%, 1% and 5%.

Discounted costs and benefits 2011-2100, rate: 0%	**Min-Scenario (in Euro)**	**Max-Scenario (in Euro)**
Net Present Value	**201.016.061**	**443.375.622**
Benefit-cost-ratio	**7,7**	**15,5**
Discounted costs and benefits 2011-2100, rate: 1%	**Min-Scenario (in Euro)**	**Max-Scenario (in Euro)**
Net Present Value	**118.837.450**	**273.887.896**
Benefit-cost-ratio	**4,9**	**10,0**
Discounted costs and benefits 2011-2100, rate: 5%	**Min-Scenario (in Euro)**	**Max-Scenario (in Euro)**
Net Present Value	**13.326.937**	**62.547.913**
Benefit-cost-ratio	**1,4**	**3,1**

Table 2: Net Present Value and Benefit-Cost-Ratio for discount rates 0%, 1% and 5%

The estimation of the coastal protection measure shows that for all discount rates the Net present value is positive and the Benefit-Cost-Ratio is higher than one.

What are the main lessons learnt from your case study?

- **transferable results?**

The results of the case study are only limited transferable. These can be explained by the local characteristic of the community Timmendorfer Strand. The community is a very much developed and frequented touristic community at the Baltic Sea. The values for land and property are quite high compared to neighbouring and other towns at the German Baltic Sea. Furthermore, the results are based on the combined implementation of the coastal protection measure and the finishing and landscaping-project.

- **lessons learnt with regard to the process of economic evaluation?**

The cost and benefits-analysis shows that the results are very much dependent on the expected climate impacts and uncertainties are incorporated at this stage. For sea level rise certain projections exist, but for coastal flooding the storm intensity is also highly relevant. For changes of storm quantity and intensity no reliable projections are available yet, for Northern Germany results of projections for storm intensity show a range between a decrease and an increase[8].

At the beginning, we tried to differentiate the effects between the coastal protection measure and the parallel implemented finishing and landscaping-project. But this was not possible, because both projects were implemented in parallel and changes could not be differentiated, e.g. stakeholder mainly did not differentiate between the effects of the two projects.

Furthermore, the discussions with local stakeholder and community members were very helpful and essential to frame the case study. The knowledge and experiences of local stakeholders was not only relevant for gathering the relevant data, but also for discussing possible effects and assumptions.

- **feasibility of methods?**

Including the discussed uncertainties, the cost and benefit-analyse seems to show relevant results.

And might have been a useful tool in the process of communicating the project to local community.

- **important data sources?**

Important data source was a damage potential analysis which was prepared before the implementation of the measures and estimated relevant endangered land and buildings by two scenarios of coastal flooding (2.50 m a.s.l. and 3.00 m a.s.l.). The data was then further adjusted to climate impacts.

Furthermore, local and regional data on the tourism in the local community and also cost data from the local community and the engineering office was essential.

[8] Norddeutsches Klimabüro (2015): Norddeutscher Klimaatlas: Sturmintensitäten. http://www.norddeutscher-klimaatlas.de/klimaatlas/2071-2100/jahr/sturmintensitaeten/norddeutschland/mittlereanderung.html

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

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

a) Specify sectors covered (e.g. coast, city, agriculture): Coast, City, Tourism: Timmendorfer Strand is a small coastal town with its main income from tourism.

b) Specify adaptation measures covered (e.g. altering cultivation practices, building defences; explain why they were chosen): For this retrospective Case Study, the implementation of a coastal defense measure was reviewed and analyzed. Special focus lies on the participatory approach during the implementation phase (from 1999-2011). During BASE an additional CBA was undertaken.
Coastal protection including participation process

c) Specify climate change impacts covered (e.g. flooding, heat stress, sea level rise): Flooding, erosion, sea level rise

d) Specify main results of activities (e.g. changes, outputs): The result, which was analyzed, was the implementation of a coastal defence measure (including finishing and landscaping project). Additionally in BASE a CBA was condutcted.

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)

This is a retrospective case study. The implementation of the measure finished in 2011. The process of the adaptation measure has been described in detail in section 3 – participatory approach.

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)

The implementation of the measure was initiated by the regional ministry of the federal state, which is responsible for coastal defence in general. In this specific location of Timmendorfer Strand the community in mainly responsible for coastal defence with the support of the state (**Actors**).

The regional ministry had seen already since longer timeframe the necessity to improve the coastal defence in Timmendorfer Strand. So they initiated a contact with the local authorities to indicate their position of a coastal protection measure. (Hofstede 2014, personal communication). The community is a very well established touristic destination for beach tourism at the Baltic Sea. Also compared to other communities close by, it covers a high amount of values, e.g. private homes and touristic infrastructure such as hotels. The initiative of the regional ministry was seen very critical in Timmendorfer Strand, because the community members feared negative effects on tourism, especially if the sea view was restricted. Therefore, the openness and initiative of the community's mayor was essential for the implementation of the measure (**Actors**). Furthermore, the participatory approach to include the local stakeholders and community members in the discussion and decision was essential to get the local commitment for the coastal defence measure.

Additionally, the regulatory framework on coastal protection was important. In general, coastal protection is in Germany responsibility of the regional governments of the different federal states (**regulatory framework**) – in Schleswig-Holstein it is the Ministerium für Landwirtschaft, Umwelt und Ländliche Räume (Ministry for agriculture, environment and rural areas). But the ministry is only responsible for "Landesschutzdeiche und Regionaldeiche" (that means regional dikes) and the needed coastal defence measure for Timmendorfer Strand was not classified as such a dike. Therefore the responsibility was with the community (this is described in the general plan of coastal defence for Schleswig- Holstein[9]). The **institutional context** of who is responsible for coastal defence was of course important for the implementation of the issue (the ministry usual being responsible for coastal defence, but not in this local level), but is more a basic structure and not a key factor for the success of the implementation.

Even though the responsibility was with the community, the general plan allowed the basic funding for the measure by the ministry. The ministry took over the most part of the finance (also defined by general plan), but the community had to cover a certain share (see Lehners 2011a). The funding from the municipality was the crucial part. The ministry did not cover additional costs for the finishing and landscaping project. These activities were funded by budget from the municipality and funding from EU European Regional Development Fund (Lehners 2011a). (**Financial resources**)

Furthermore, the flood event from 1872 was essential to show the local community the necessity for activities. At that time only few people live in that area, but were flooded completely. A storm surge of this height would have caused extensive damage to the area today (without coastal protection). During the 20th century the effects of this event from 1872 was a bit forgotten. But it was possible to refer to the 1872-event and discussions were not only based on expected impacts and changes. (**Local and regional context – history**)

[9] Generalplan Küstenschutz: http://www.schleswig-holstein.de/DE/Fachinhalte/K/kuestenschutz/generalplanKuestenschutz.html

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)

In the very beginning, the different stakeholders in Timmendorfer Strand were sceptical about the coastal defence measure. There has been no real storm surge problem in that area for more than 100 years, so stakeholders did not see the necessity to invest in coastal defence measures. Especially people working in the tourism sector (for example hotel-owners) feared that the measure would hinder the view to the sea and make the city less attractive for tourists. Since Timmendorfer Strand heavily depends on the tourists as the main income, this sceptical view had to be taken serious by the decision makers. (**Knowledge and information about climate adaptation)**

After the consensus was found that a coastal measure should be implemented, it was a question of how the actual measure should look like (e.g. integration in the landscape, height of dike). Here, a competition between different landscape architects was initiated. This was a very important aspect, because due to this landscaping procedure, the dike is integrated in the landscape of the town and not really visible or noticeable for visitors. Therefore the success of the measure was not only the safety issue, but also the nature of the measure (being integrated in the landscape).

Another issue was of course financial resources. The additional landscaping measures had to be covered in a big share by the community. For the implementation of the measure it was important that the community had the resources and the political will to take over the extra costs. (**Resources**)

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

The obstacles were overcome by the involvement of key actors and the financial support guaranteed by the municipality. This has also been describes in section 3.

But first of all, the ministry started the discussion about the coastal defence measure. Without their concern and **knowledge** about the risks, this process would not have been started. And without their willingness to try new ways of participatory approaches, a discussion was started with rather sceptical stakeholders from the community.

The sceptics of the community members and local stakeholders were taken serious and a participatory approach was initiated including as many as possible local community members and stakeholders. The stakeholders and community members had the possibility to be included in the decision-making process which increased the commitment. The compromise to build a dike but lower than proposed from the regional government (of federal state of Schleswig-Holstein) was found together with the stakeholder and

citizens. Because for this version the height is so high that tourists can still walk behind the dike and see the sea.

Very important to set this topic on the agenda of the community was the former mayor of the town. He negotiated between the ministry and stakeholder from the community. **(resources)**

Furthermore, as reaction to the fear of the tourism sector and as proposed by citizens during the participatory workshops, community decided to integrate and finance more attractive solutions/add-ons in the coastal protection measure, e.g. in some parts of the dike glazed retentions walls are integrated so the guests of bordering cafes can enjoy the sea view. This kind of flexible solutions and add-ons increased the support in the local community. **(nature of measure)**

Parallel to the coastal protection measure and also discussed during the participatory workshops, a finishing and landscaping project was initiated and financed by the municipality. This project included the integration of the coastal protection in the landscape. The project realised boardwalks and wooden benches and seats. The path at the beach promenade was improved. At least partially, the unsurfaced and often wet path was improved to a surfaced path. If the close by restaurants/cafes wished, a transparent wind protection was built which is increasing the comfort for the guests sitting outside. The wind protection was at least partially financed by the restaurant/cafes, but delivered a further benefit.

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

After finishing the measure, there is at the moment no discussion for further coastal protection. But to ensure a wide sandy beach, first constructions of groins in one part of the town have been constructed. After evaluating the success of the groins in means of keeping the sand on the beach it is planned to extend the groins to other parts of the town. Since this is not classified as coastal defence measure, costs have to be covered by the community with no financial support from the state of Schleswig-Holstein.

Additionally, there are intentions to communicate this attempt of coastal protection. For example, upon request, there are guided tours along the promenade or presentations at various events. At least one City at the German Baltic Sea is thinking of implementing glazed retentions walls as coastal defense measure as well.

6. 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)

There are several success factors that derive from this case study:

a. Involve the key stakeholders from the very beginning

The mayor of the town was a key person. With his support for the project, it was possible to get other stakeholder into the discussion.

b. Understand the needs of the stakeholders

It is very important to understand the viewpoint of the different stakeholders and why they might not be willing to cooperate or not support the adaptation measure. In this case, the stakeholder had to be 'convinced' that a coastal defence measure is a reasonable investment.

c. Have financial support

To implement the 'extra' measure (e.g. glazed retention wall and finishing and landscaping project) that ensured the support of the stakeholder, the financial back-up from the municipality had to be guaranteed. This is not in every situation guaranteed but in Timmendorf it helped very much.

d. Use results of damage cost analysis, CBAs as argument

Arguments based on costs and benefits helped to 'convince' the stakeholder. In the case of Timmendorfer Strand the results of a damage potential analysis showed that the values damaged by coastal floodings could be very high. . This helped to raise awareness and was one important part in change the local stakeholders' attitude towards coastal protection.

e. Take your time

The whole process took over 10 years from its start to the implementation. It is important to have time for such a process. On the other side, the long time also might become an obstacle when responsibilities change or the stakeholder and/or public lose interest in that topic.

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

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Annex on cost benefit analyse

Benefit:

- Avoided flooding damages (partially monetary: avoided damage per event, partially qualitative)

The avoided storm surge damages are estimated based on the damage potential study by Reese (2003)[10]. Reese (2013) estimated two scenarios with 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.

	Damages for scenario I (2.50 a.s.l.) (in Euro)	Damages for scenario II (3.00 a.s.l.) (in Euro)
Evacuation costs	71,500	298,200
Damages at buildings	27,751,700	67,254,900
Damages at fixtures in buildings	4,115,300	16,000,300
Damages vehicles	1,334,400	2,376,300
Damages at transport infrastructure	413,700	1,790,600
Damage at recreational areas	500	70,200
Loss of value (not offered services, e.g hotels)	5,615,900	10,329,600
Damages at equipment	8,036,800	17,696,300
Damages at stocks	610,700	1,208,000
Loss of agricultural yields – farmland	0	500
Loss of agricultural yields - grassland	5,900	98,900
Loss of agricultural yields - forest	300	900
Total	**47,956,700**	**117,124,700**

The lower scenario of a storm surge 2.50 m a.s.l. can be fully avoided by the built coastal protection. Because the coastal protection is developed for a 2.50 m a.s.l., the higher scenario can not fully avoided by the established protection. But based on opinion of experts, the damage can be avoided partially. A range between 40 and 60 percent of the damages are assumed to be possible to avoid. Therefore the damages can be reduced in scenario II between 47 and 70 mio. Euro.

[10] Reese, S. (2013): Die Vulnerabilität des schleswig-holsteinischen Küstenraums durch Sturmfluten. Fallstudien von der Nord- und Ostseeküste. Kiel.

Reese (2013) indicates that the frequency of the storm surge events could increase with sea level rise. Two sea-level rises of 0.30 cm and 0.50 cm are used which are in line with moderate (RCP2.6) and medium (RCP4.5 und RCP 6.0)-IPCC projections.[11] For the 0.30 cm sea level rise: the frequency of the storm surges are increasing by four, so a 100-year event could change to a 25-year event. For the 0.50 sea level rise: the frequency could increase by eight.

The frequency of 50 to 100 years is estimated for a storm surge with 2.00 m a.s.l. As assumption, the indication was taken for the scenario I of 2.50 m a.s.l.. For the 1872-storm surge with a water level of 3.00 m a.s.l. an indication as 100 to 500 year-event was assumed.[12] For the sea level rise of 0.30 m the frequency of scenario I could increase to a frequency of 12.5 to 25 year event, for 0.50 m to 6.25 to 12.5 years-event. For the scenario II, a sea level rise of 0.30 m would mean a frequency of 25 to 125 years, for a sea level rise of 0.50 m: a frequency of 12.5 to 62.5 years could be reached. As conservative approach the lower frequency is used for the estimation.

- Change of recreational function, tourism:

The change of the recreational function and tourism at the relevant coastline is estimated based on income effects (costs/benefits) on local tourism infrastructure.

Statistical data on overnight stays in the community showed that the difference between the average of overnight stays (without camping and private accommodation) in the years 2012/2013 (after the dike construction) was slightly higher than before (1.70 percentage) compared to the average of the years 2004 until 2011. To reduce the uncertainties on other influencing factors, e.g. saisonal changes, change of tourism streams. The development of overnight stays was compared with data from other coastal communities. The communities were selected based on the expert interviews, where the experts indicated which are the competitors for Timmendorfer Strand. They indicated island Sylt (with the main town: Westerland) as their major comparison basis[13] but also the communities further east at the German Baltic coast: Boltenhagen, Kühlungsborn and the island of Usedom (with the town: Heringsdorf).

Communities	Location of community	Number of overnight stays Relation between average 2012-2013 and average 2011-2004[14]
Timmendorfer Strand	Baltic Sea, Federal State of Schleswig-Holstein	1.70%
Scharbeutz	Baltic Sea, Federal State of Schleswig-Holstein, neighbouring community of Timmendorfer Strand	10.34%
Westerland	North Sea, Federal State of Schleswig-Holstein	-2.71%

[11] IPCC-projections (2013) are between 0.26 and 0.98 m sea level rise. For the Baltic Sea also land rise is expected, so that the maximum will probably not be reached at the Baltic Sea.
[12] Regelwerk Küstenschutz Mecklenburg-Vorpommern (2009): Übersichtsheft Grundlagen, Grundsätze, Standortbestimmung und Ausblick.
[13] Sylt is an island at North Sea coast but is located in the same German federal state (Schleswig-Holstein).
[14] Data for Timmendorfer Strand, Scharbeutz and Westerland without camp sites, for Boltenhagen, Kühlungsborn and Heringsdorf with camp sites.

Boltenhagen[15]	Baltic Sea, Federal State of Mecklenburg-Vorpommern	11.39%
Kühlungsborn	Baltic Sea, Federal State of Mecklenburg-Vorpommern	11.11%
Heringsdorf[16]	Baltic Sea, Federal State of Mecklenburg-Vorpommern	9.61%

Table 3: Number of overnight stays in selected communities

(Source: Statistisches Amt für Hamburg und Schleswig-Holstein, Sylt Marketing GmbH, Statistisches Landesamt Mecklenburg-Vorpommern)

It can be seen that Westerland as a well-established coastal destination in Western Germany shows a slight reduction of about 2.71 percent. All other communities increased their number of overnight stays. The destinations at the more Eastern Baltic Sea (Boltenhagen, Kühlungsborn, Heringsdorf) show a increase between 9 and 11 percent. These destinations which are situated in the Eastern part of Germany in the Federal State of Mecklenburg-Vorpommern show another historical development. They started their development some years after 1990. The tourism infrastructure in this communities was still established during the 2000er years. Furthermore, the destinations developed their promotion strategy. So for Boltenhagen, Kühlungsborn and Heringsdorf other factors are influencing their development of the number of overnight stays during the analysed time period. Scharbeutz as neighbouring community of Timmendorfer Strand also increased their number of overnight stays by 10 percentage. In expert interviews it was mentioned that Scharbeutz also developed and renovated their beach promenade, but if these activities can explain the increase of 10 percentage keeps unclear.

For the monetization of the change in number of overnight stays, spendings for guests staying overnight was taken as indicator for the income effect for the local community. Therefore, an analysis of existing studies[17] was realized. The results are shown in the following table.

Location	Spendings per guest staying overnight (in Euro, per day, per person)	Source
Germany[18]	116.00	DWIF (2010)[19]
Germany[20]	131.60	DWIF (2010)
Germany[21]	72.10	DWIF (2010)
Germany[22]	45.60	DWIF (2010
Germany	98.00	DZT(2010)[23]

[15] Data for 2008 is missing for Boltenhagen, Kühlungsborn and Heringsdorf. The average 2004-2011 was estimated without the year 2008.
[16] The data consists of the numbers for the three neighbouring towns: Ahlbeck, Bansin and Heringsdorf.
[17] Partially made available by the local community.
[18] Average of commercial accommodation, private accommodation, camp site
[19] DWIF (2013): Ausgaben der Übernachtungsgäste in Deutschland. Schriftenreihe des dwif e.V., Heft Nr. 53/2010.
[20] Commercial accommodation
[21] Private accomodation
[22] Camp sites
[23] DZT (Deutsche Zentrale für Tourismus) (2010): Qualitätsmoonitor Deutschland-Tourismus. Ergebnisse 2009/2010. Frankfurt/Main.

Baltic Sea coast (without large cities)	60.00	NIT (2013)[24]
Federal state of Schleswig-Holstein	96.40	DWIF (2010
Federal State of Mecklenburg-Vorpommern	102.20	DWIF (2010
OstseeFerienLand (Baltic SeaHolidayLand)[25]	53.00	NIT (2014)[26]
Timmendorfer Strand	70.00	HTC (n.d.)[27]

Table 4: Spendings per guest staying overnight

The different studies show a focus on different locations (from total Germany, to a questionnaire in the community of Timmendorfer Strand). Furthermore, they differ in their included type of accommodation or the type of accommodation which is typical in the region, e.g. in the OstseeFerienLand-region there are many tourists on camp sites, therefore the spendings for overnights stays are compared to the other data relatively low. Based on the characteristic of the different studies, it was decided to use a range of 60.00 to 96.40 Euro per day per person.

Based on the change in overnight stays (Difference between average 2012-2013 and average 2004-2011) (increase of number of overnight stays: 15.241) and the decided range of 60.00 to 96.40 Euro per day per person an increase of spending per year between 915,000 and 1,470,000 Euro per year was estimated.

As a further cost/benefit type was the change of turnover of restaurants analysed. Because of the integrated finishing and landscaping-project the beach promenade especially at the district: Niendorf improved which means e.g. there are more possibilities for outside seating, there was additional wind protection realized[28]. The data on change of turnover was elaborated by interviews with restaurants in Niendorf. Only a limited number of restaurants was able and willing to report any changes. Changes were only described in relative term (change to previous years). The answers ranged from no major changes to an increase of turnover of 5 percent. Because only data and experiences for two years after the dike construction are available, it needs to be said that it is difficult to estimate a clear indication. Also the interviewees mentioned that they have e.g. more space for outdoor seating or the seating is more oriented to the seaside, but there might also be other reasons for the change, e.g. good weather during the peak-season. Because the data is relatively qualitative and no absolute values can be estimated, the estimates can not be included in the quantitative cost-benefit-analysis. Furthermore, an additional inclusion of this data would be a double-counting to the estimated spendings of overnight stays.

- Change of property values

In Germany, approximate values for land prices are estimated by evaluators. The procedure is slightly different in the different German Federal States. The Federal State of Schleswig-Holstein, where Timmendorfer Strand is situated,

[24] NIT (Institut für Tourismus- uund Bäderforschung in Nordeuropa GmbH) (2013): Landesweite Gästebefragung Schleswig-Holstein 2013 (GBSH 2013).
[25] The OstseeFerienLand are different smaller communities at the Baltic Sea in the Federal State of Mecklenburg-Vorpommern, which are promoting their destination together.
[26] NIT (Institut für Tourismus- uund Bäderforschung in Nordeuropa GmbH) (2014): Gästebefragung OstseeFerienLand 2013. Repräsentative Befragung von Übernachtungsgästen im OstseeFerienLand. Ergebnisbericht Status 03.02.2014. Kiel.
[27] HTC (n.d.): Betroffenheitsanalyse Fehmarn-Belt-Querung- Schienenhinterlandanbindung.
[28] Partially payed by the restaurant/café owners.

publishes maps[29] with the detailed indication of the values. It has to be said that the values are only a rough indication. For Timmendorfer Strand the data was analysed for the community district Niendorf, where with the improvement of the beach promenade major changes are actually seen[30] (Gartenweg, Grüner Weg, Strandstr.(odd numbers)). The data of Niendorf was compared with the coastlines area where no major changes can be experienced (Rodenbergstr., Strandallee) and with the area in Niendorf but which are not lying directly at the coastline (Strandstr. (even numbers)).
Furthermore, a comparison with the neighbouring community of Scharbeutz and with different cities in the more Eastern coast of the Baltic State (in the Federal State of Mecklenburg-Vorpommern: Kühlungsborn and Heringsdorf[31]). In the Federal State of Mecklenburg-Vorpommern the approximate land values are estimated only in general for different types of land, e.g. land for private homes in a good location/medium location, land for different uses, etc. We base our analysis on the assumption that the coastline is a high value area and take the type of approximate land value with the highest values.

Beach promenade Niendorf		**Difference 2012-2010 (max) (in Euro/m²)**	**Difference 2012-2010 (min) (in Euro/m²)**	**Relation (in %) 2012/2010 (max) (in Euro/m²)**	**Relation 2012/2010 (min) ((in Euro/m²)**	**Relation 2010/2008 (in Euro/m²)**	**Relation 2008/2006 (in Euro/m²)**
Gartenweg	1,2,3,4a, 5b, 7, 8,	310	190	54,39%	33,33%	8,57%	16,67%
Grüner Weg	all (1-6a)	310	190	54,39%	33,33%	8,57%	16,67%
Strandstr.	49, 51, 53a?, 53b, 55, 57, 59, 63, 63a, 65, 67, 69, 71, 73, 77a, all odd numbers until 119	310	190	54,39%	33,33%	8,57%	16,67%
Strandstr.	odd numbers: 121-131	190	145	38,00%	29,00%	0,00%	7,53%
Comparison							
Other parts of Timmendorfer Strand		**Difference 2012-2010 (max)**	**Difference 2012-2010 (min)**	**Relation (in %) 2012/2010 (max)**	**Relation 2012/2010 (min)**	**Relation 2010/2008**	**Relation 2008/2006**
Strandstr.	even	120	85	33,33%	23,61%	24,14%	11,54%

[29] Data from previous years (e.g. 2006 and 2008) is published as tables where for every street and street number, the value is indicated.
[30] In the other parts of the coastline, the dike is very much hidden in the already previous existing dunes.
[31] In Mecklenburg-Vorpommern the available data was very limited. Therefore no further communities could be included. Also for Kühlungsborn and Heringsdorf only limited data only for some years are available (Kühlungsborn: 2008, 2010, 2011, 2012; Heringsdorf: 2008, 2010, 2011).

	numbers: 62-130						
Strandstr.	even numbers: 50-60	145	105	31,87%	23,08%	0,00%	13,75%
Rodenbergstr.	even numbers: 1-61	225	-	32,14%	-	3,70%	28,57%
Rodenbergstr.	odd numbers 2b-30	120	-	24,00%	-	3,09%	24,36%
Strandallee	196, 198, 200	60	45	14,81%	11,11%	6,58%	8,57%
Scharbeutz (coastline)		**Difference 2012-2010 (max)**	**Difference 2012-2010 (min)**	**Relation (in %) 2012/2010 (max)**	**Relation 2012/2010 (min)**	**Relation 2010/2008**	**Relation 2008/2006**
Strandallee	89-98a	140	105	50,91%	38,18%	1,85%	8,00%
Strandallee	99-117	150	140	57,69%	53,85%	18,18%	7,32%
Strandallee	118-127	75	-	20,00%	-	-16,67%	0,00%
Strandallee	128-141	100	-	20,00%	-	11,11%	0,00%
Strandallee	134	135	65	55,10%	26,53%	11,36%	7,32%
Strandallee	143	155	-	28,44%	-	0,00%	17,20%
Strandallee	144	100	-	20,00%	-	11,11%	0,00%
Strandallee	145a	40	-	10,53%	-	0,00%	8,57%
Strandallee	146	155	-	28,44%	-	0,00%	-
Kühlungsborn		**Difference 2012-2010 (max)**	**Difference 2012-2010 (min)**	**Relation (in %) 2012/2010 (max)**	**Relation 2012/2010 (min)**	**Relation 2010/2008**	**Relation 2008/2006**
land for private homes		0[32]		0,00%		246,15%	
Heringsdorf							
land for private homes		0		0,00%[33]		25,00%	

Table 5: Analyses of approximate land prices in Timmendorfer Strand, Scharbeutz, Kühlungsborn and Heringsdorf.

It can be seen that for the relevant area in Niendorf the highest change between 2012 and 2010 can be calculated with more than 50% increase in percentage and also the highest increase in total numbers. Only the changes in Scharbeutz are reaching also the substantial increase of more than 50 percent. Because it seems to be most suitable

[32] For Kühlungsborn and Heringsdorf no ranges are available.
[33] Because for Heringsdorf no data for 2012 is available, the relation between 2011 and 2010 was calculated.

and not so much differing from the development in the other areas, the difference of the average of the different streets between the beach promenade in Niendorf and other areas in Timmendorfer Strand will be used. The average change additional increase in Niendorf is between 100 and 146 Euro/m^2 (see following table). The relevant area at the Niendorf beach promenade is only about 30mx2km which results in an area of 60.000 m^2. The estimation for the 60.000 m^2 shows a value increase between 6 and 8.8 mio. Euro.

	Difference 2012-2010 (max) (Euro/m^2) (average average of different streets)	**Difference 2012-2010 (min) (in Euro/m^2) (average average of different streets)**
Beach promenade Niendorf	280	178,75
Other parts of Timmendorfer Strand	134	78,33
Difference	**146**	**100,42**

Table 6: Difference in land value between Niendorf and other parts of Timmendorfer Stranf.

Costs:

- Investment and maintenance costs

The total investment costs are estimated for the dike (coastal protection) project with 18 mio. Euro, from which 3.5 mio. were paid by the local community. The other share was mainly financed by the Federal State of Schleswig-Holstein.

In parallel to the realised coastal protection-project a finishing and landscaping-project was implemented. The finishing and landscaping-project focused e.g. on the improvement of the beach promenade, two new boardwalks – established in the dunes - and recreational infrastructure, e.g. benches, playground.

Because the effects of both projects can not be divided. The costs of 12 mio. Euro are also included here. 6 mio. Euro were financed by the local community, the other half was mainly paid by EU funds.[34]

Data on the maintenance cost could not be get from the local community. Therefore data from the literature were taken and for the 6 km-coastline at Timmendorfer Strand a total value of 2.500 to 7.500 Euro per year. The estimation is based on maintenance costs from the literature which vary between 0.08 and 0.25 Euro/m^2.[35]

[34] Lehners, C. (2011): Engagement of local stakeholders – experiences from Timmendorfer Beach, Baltic Sea, Germany.
[35] Bronstert (2004); Dehnhardt & Meyerhoff (2002).