*Schwarzer, Schrottke & Stattegger (eds.):*
*From Brazil to Thailand – New Results in Coastal Research*
***Coastline Reports 16 (2010)**, ISSN 0928-2734, ISBN 978-3-9811839-9-3*
*S. 101-103*

# Costs of sea-level rise under different climatic and socio-economic scenarios: an application of the DIVA model

Heike Munderloh

Christian-Albrechts-University of Kiel, Germany

## Abstract

The world's coastal zones are due to a high population and a high concentration on material assets among the most vulnerable areas in the world to a, through climate change altered, sea-level rise. To better protect these potential endangered areas vulnerability assessments are necessary to evaluate the potential risks, impacts and costs of climate change. In this work the DIVA model version 2.0.2 was applied to indentify the potential costs of sea-level rise under different climatic and socio-economic scenarios. The DIVA runs were made for Germany, the Netherlands and the United Kingdom with the IPCC SRES scenarios A1FI, A2 and B2. The results outline the need for adaptation under all three scenarios with highest values in the A1FI and the lowest in the B2 scenario. They clearly show that the costs will rapidly increase at least after 2070 without adaptation. The results also outline the huge benefit of proactive adaptation compared with reactive adaptation. Even if the DIVA model is a global model the results are in a logical context to the physical and socio-economic conditions of the countries and scenarios applied and provide useful insights on the vulnerability for long-term coastal management even on smaller scales.

## 1 Introduction

The coastal zones contain a large part of the world's population. Daschkeit and Sterr (2003) indicate that around 50 % of the world's population lives within 50 km of the shoreline. These areas also have a high concentration on material assets with large socio-economic relevance. Therefore and due to an, through climate change altered, sea-level rise the coastal regions are among the most vulnerable areas in the world. New estimates about sea-level rise indicate that it possibly could rise between 0.55 m and 1.40 m until 2100 (Rahmstorf et al. 2007). To better protect these potential endangered areas vulnerability assessments are necessary to evaluate the potential risks, impacts and costs of climate change. Until now there are numerous concepts of vulnerability assessments available but they are mostly static and do not take into account the dynamic feedback between various coastal processes, their socio-economic consequences as well as the way humans respond in form of adaptation. They are also mostly performed to inform local and national decision-makers rather than to provide comparable data for regional and global purposes. The relatively new DIVA model addresses some of these limitations as it is a global and dynamic tool to assess the vulnerability on different scales taking into account adaptation.

## 2 Methodology

In this work the DIVA (Dynamic Interactive Vulnerability Assessment) global impact and adaptation model version 2.0.2 was applied. This model is part of the DIVA tool which consists of a global coastal database, the integrated model (figure 1) and a graphical user interface. The DIVA model consists of various modules which provide knowledge about the coastal sub-systems. They are linked to each other as well as to the database.

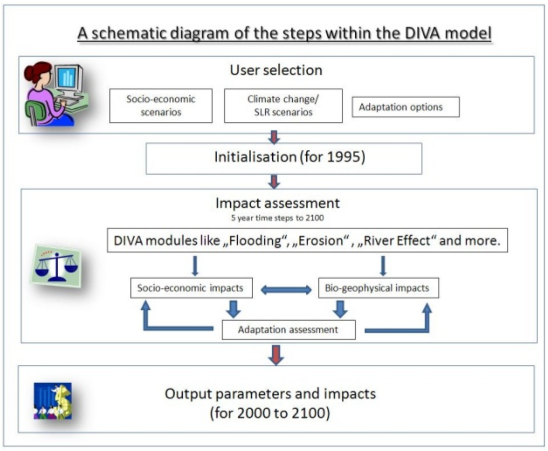


Figure 1: Schematic overview of the DIVA model

The cases in DIVA are a combination of the selected SRES based scenarios (A1FI, A2 and B2) in land use, population and economic concerns, the climate scenario, the input data and the selected adaptation option. Next to the three SRES scenarios three different adaptation options have been applied: Costs-benefit-analyse based adaptation, full adaptation and no adaptation.

Within this work the following output parameter are used:

1. Total costs compounded of total adaptation costs and total residual damage costs.
2. Total adaptation costs compounded of sea-and river dike costs, and costs for beach-, wetland-, and tidal basin nourishment.
3. Total residual damage costs compounded of costs for land loss, migration, salinity intrusion as well as sea- and river floods.
4. Number of people actually endangered by flooding.

These output parameters were applied for Germany, the Netherlands and the United Kingdom and for a time frame from 2000 until 2100.

## 3 Results

The results clearly show that without any adaptation the costs and the number of people at risk will increase rapidly at least after 2070 (figure 2). This applies for all countries and in all scenarios. With adaptation however the damage costs and the number of people at risk will decrease significantly. The two adaptation scenarios are used as a proactive adaptation option and the no adaptation scenario as a reactive adaptation option. The results show the benefit of proactive adaptation versus reactive adaptation (figure 3).

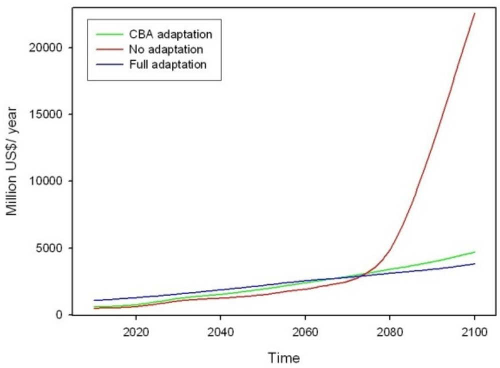


Fig. 2: Trends of total costs in Germany in A1FI

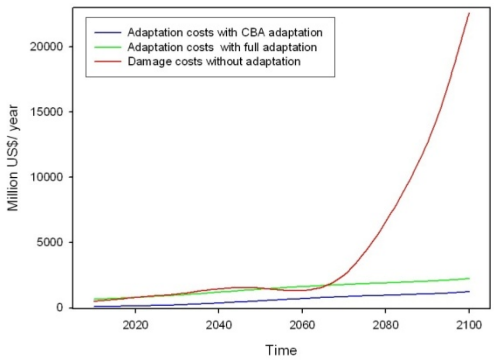


Fig. 3: Proactive versus reactive adaptation

The main trends between the scenarios are nearly the same but the costs will be highest in the A1FI scenario and lowest in the B2 scenario. The main contributors to the damage costs are salinity intrusion into deltas and estuaries, sea flood costs and within the no adaptation scenario migration costs. The main contributors to the adaptation costs are sea dike costs, beach and tidal basin nourishment. The percentage distribution of the contributors is extremely different between the countries reflecting the different physical conditions and main hazards.

The A2 scenario is not the most vulnerable scenario for the three countries studied in this thesis despite its high population growth because these countries have a declining population.

The most vulnerable country in this work based on size, population and GDP compared to the costs is the Netherlands followed by the UK and lastly Germany.

## 4 Discussion and conclusion

The results reflect how the projected future the socio-economic- and the climatic development in the countries together with climate change contribute to the impacts to climate change. They outline the large impact of different socio-economic developments and show that the impacts of sea-level rise are only detectable after 2030. The results also show that even if a country have a high adaptive capacity like all three countries used in this work the protection level will fall over time if they are not adjusted to climate change which will lead to an increase of impacts and costs.

For the interpretation of the DIVA results there are three key limitations to be aware of. Firstly, the DIVA model is a global model. Due to a spacious data resolution DIVA is not suitable to be used on smaller scales than on country level. Secondly, there are more adaptation options available than implemented in DIVA and thirdly, the assessment of DIVA is limited because it only represents a subset of possible impacts. Besides these limitations the results are in a logical context to the physical and socio-economic conditions of the countries and scenarios applied and yield information about the nature of the most serious impacts, about the possible affected land area, and about the number of people at risk as well as about vulnerable hotspots.

## References

Daschkeit, A. & H. Sterr (2003): Klimawandel in Küstenzonen. In: UWSF 2003b (3): 199–207.

Rahmstorf, S., A. Cazenave, J. Church, J. Hansen, R. Keeling, D. Parker & R. Sommerville (2007): Recent climate observations compared to projections. In: Science 315: 1529–1532.

## Acknowledgement

The work has been carried out within my diploma thesis supervised by Prof. Dr. A. Vafeidis.

## Address

Heike Munderloh
Christian-Abrechts University of Kiel - Department of Geography
Ludewig-Meyn-Str. 14
24098 Kiel, Germany

heike_munderloh@web.de