Status Report

ANALYSES OF PREVIOUS VULNERABILITY STUDIES IN THE PILOT SITE “GERMAN BIGHT COAST” (TASK 27)

April 2005

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Summary of Contents:

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<table>
<thead>
<tr>
<th>Title</th>
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<tbody>
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<td>CAU Kiel</td>
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<td>H.-J. Markau, S. Reese</td>
<td>CAU Kiel</td>
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SUMMARY

Some 24% of the total land mass of Schleswig-Holstein are coastal lowlands susceptible to be flooded in the course of extreme storm surges. In order to evaluate and assess the risks of these flood prone areas, three vulnerability (analyses) (in Engl. meist assessments) (VA) at different scales were carried out.

The first VA was an IPCC study at a very broad scale, the so-called macro-scale. The objective of this screening approach was to determine the socio-economic values existing within the countries which could become affected by a sea-level rise. For the coast of Germany the study was carried out from 1994 to 1997.

The Department of Coastal Defence in the State of Schleswig-Holstein assigned the Research and Technology Centre in Buesum with the second VA, a meso-scale valuation of the overall damage potential for the flood prone coastal areas of Schleswig-Holstein. Even though this study was applied as a development of a long-term strategy, some results were considered questionable.

That was the reason why the State Department of Coastal Defence initiated another detailed VA, the micro-scale risk evaluation of flood prone coastal lowlands in Schleswig-Holstein (Acronym: MERK).

Besides the aim to validate the meso-scale results the general objective was the development of a methodology which can be implemented into an Integrated Coastal Defence Management Scheme. Furthermore, a transferable instrument for the detailed identification and evaluation of all elements at risk, the damage potential, was to be developed. For that purpose eight representative municipalities at the North- and Baltic Sea coast were selected as study areas.

The vulnerable tangible and intangible structures were identified and evaluated within the scope of a micro-scale valuation analysis. For the first time such a micro-scale approach for a coastal area was elaborated and performed in Germany. Compared to macro and meso-scale studies, these micro-scale, object-orientated approaches are superior because of their high preciseness.

Furthermore, the micro-scale level is advantageous and preferable for the support of concrete coastal defence measure planning. A disadvantage of this procedure is that it is quite time-consuming and cost-intensive. To minimize the costs for further studies it is intended to develop and improve routines for standardisation within the scope of a future project.

A subsequent comparison with the results of the earlier meso-scale study, also carried out for the Schleswig-Holstein region, showed significant differences. Both under- and overestimations have been identified in the range of factors from 1 : 2.9 to 1 : 0.5. Nevertheless, the absence of a uniform tendency of the differences did not allow the determination of a mathematical adaptation function.

The described methods developed within the scope of this MERK project present the theoretical background for the management of natural hazards and can be used for problem-oriented approaches in the future. Prototype tools were provided, but need a more profound analysis regarding their future implementation into practice.
CONTENTS

Document Information ii
Document History ii
Disclaimer ii
Summary iii
Contents 1

1. Introduction ...................................................................................................................... 2
   1.1 Objective of the status report ............................................................................... 2
   1.2 Background .......................................................................................................... 2

2. Vulnerability Assessments and scales .............................................................................. 2
   2.1 Assessment levels ................................................................................................ 2
   2.2 Characteristics of the assessment levels .............................................................. 3

3. Vulnerability Analyses in floodprone areas ..................................................................... 3

4. VA in the investigation area St. Peter-Ording .................................................................. 5
   4.1 Meso-scale VA in St. Peter-Ording ..................................................................... 6
      4.1.1 Methodology to evaluate the damage potential ...................................... 6
      4.1.2 Results of the valuation analysis ............................................................ 9
   4.2 Micro-scale VA in St. Peter-Ording .................................................................. 11
      4.2.1 Valuation methodology ........................................................................ 11
      4.2.2 Results of the valuation analysis ............................................................ 16
      4.2.3 Damage estimation - methodology ......................................................... 17
      4.2.4 Damage estimation - results ................................................................. 19

5. Comparison of the results of different assessment levels ............................................... 19

6. References ...................................................................................................................... 22

Tables
Table 1   Assessment levels (after Markau & Reese, 2003) ........................................ 2
Table 2   Vulnerability Analyses and their Characteristics (Source: after Berger, 2001) .. 4
Table 3   Damage potential at the North-Sea and the Baltic Sea Coast of Schleswig-Holstein (main catagories; after Hofstede & Hamann, 2000): .................................................................................................................. 10
Table 4   Damage potential in St. Peter-Ording (meso-scale; after Hamann & Klug, 1998) .............................................................. 10
Table 5   Data sources for the micro-scale evaluation ...................................................... 11
Table 6   Damage potential in St. Peter-Ording (micro-scale; Reese et al., 2003) .......... 17
Table 7   Tangible and intangible damages in the flood prone area of St. Peter-Ording (Monetary values in thousand Euro; after Reese et al., 2003) .............................................................. 19
Table 8   Comparison of the meso- and micro-scale results (after Reese, 2003) .......... 20

Figures
Figure 1   Characteristics of the assessment levels ........................................................ 3
Figure 2   Tangible values in the flood prone area of St. Peter-Ording ......................... 17
Figure 3   Depth-damage-functions .............................................................................. 19
1. Introduction

1.1 Objective of the status report
With this status report methods, data requirements and results of previous Vulnerability (Analyses) Assessment (VA) especially in the study site St. Peter Ording (German Bight Coast-Task27) will be described. Thus the main focus will be VA in coastal areas, which were carried out in the past.

1.2 Background
24% of the total area of Schleswig-Holstein, the most northerly Federal State of Germany, is coastal lowland which could become flooded during extreme storm surges. Flood protection for this coast is therefore mandatory. Regarding this, the Department of Geography of the CAU Kiel has carried out different VA on different scales, e.g. the so called MERK-Project (Micro-scale risk evaluation of flood prone coastal lowlands in Schleswig-Holstein).

2. Vulnerability Assessments and scales

2.1 Assessment levels
For risk handling in the framework of natural hazard research, levels and scale of assessment have to be determined. Three levels can be distinguished, Macro-, Meso- and Micro-scale (Table 1).

Table 1 Assessment levels (after Markau & Reese, 2003)

<table>
<thead>
<tr>
<th>Assessment level</th>
<th>Macro - scale</th>
<th>Meso - scale</th>
<th>Micro - scale</th>
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<td>Regarding level</td>
<td>(Inter-) national</td>
<td>Regional</td>
<td>Local</td>
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<td>Decision level</td>
<td>(Inter-) national policy</td>
<td>Flood defence schemes</td>
<td>Defence measures</td>
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<tr>
<td>Investigation area</td>
<td>German Coast</td>
<td>Coast of Schleswig-Holstein</td>
<td>Selected areas</td>
</tr>
<tr>
<td>Examples</td>
<td>IPCC</td>
<td>Valuation study S-H</td>
<td>MERK</td>
</tr>
</tbody>
</table>

Macro-scale studies are used for nationwide investigation areas. At this level, political goals and general guiding principles for decisions are derived. The Intergovernmental Panel on Climate Change (IPCC) initiated the first vulnerability study on the macro-scale. The objective of this screening approach was to determine the socio-economic values existing within the countries which could become affected by a sea-level rise. For the coast of Germany such a study was carried out from 1994 to 1997 (Ebenhoeh et al. 1997).

Meso-scale methods are applied on regional scales. Due to the comparatively large study area, macro- and meso-scale studies are based on aggregated data. The results are therefore not well suited to generate specific coastal defence measures. The main objective of macro and meso-scale studies is the development of long-term strategies. An example for the meso-scale level is the valuation study for Schleswig-Holstein (Hamann & Klug 1998). In this study, the overall damage potential for the flood prone coastal areas of Schleswig-Holstein was determined.

Micro-scale studies are focused at community level and thereby on all the potentially vulnerable objects such as buildings and infrastructural assets or motor vehicles in a flood prone area. Analysis for such small areas can achieve a high level of precision and accuracy. Micro-scale studies are however costly in terms of time and money. MERK was the first micro-scale assessment in Schleswig-Holstein (Reese et al. 2003).

1 The Project MERK was initiated and funded jointly by the Ministry of Rural areas in Schleswig-Holstein and the Federal Ministry of Education and Research (Germany). The main objective was to develop an integrated methodology for future planning in the coastal zone based on risk-analysis.
2.2 Characteristics of the assessment levels

Figure 1 shows the characteristics of the different assessment levels and approaches. It becomes apparent, that micro-scale methods can achieve a high level of precision. Thus, it is possible to identify the actual existing conditions in the areas at risk on the basis of field work and surveys. This object-related approach is however costly in terms of time and money. Hence, micro-scale methods are only feasible on a local level. With the increasing size of the investigation areas, the expenditure and accordingly also the precision of the VA decreases, since methods on the meso- and macro-scale are generally based on aggregated data.

The selection of the appropriate method has to ensure a maximum level of precision considering the available resources. Meso-scale analyses might be supplemented by micro-scale data e.g. in terms of key parameters or categories such as the exact number of inhabitants.

![Characteristics of the assessment levels](image)

**Figure 1  Characteristics of the assessment levels (after Reese, 2003)**

Consequently, the selection of the assessment methodology is based on the following criteria:

- Objectives and framework of the investigation (e.g. strategy planning, measures);
- Spatial dimension of the investigation area;
- Available resources (time, budget, manpower...);
- Data availability.

3. Vulnerability Analyses in flood prone areas

There are two main trends concerning the assessment of vulnerability in flood prone areas: While some studies deal with the assessment of protective measures at the coast and along rivers (e.g. Klaus & Schmidtke, 1990; Penning-Rowsell & Chatterton, 1977), others concentrate on the impacts of a sea-level rise in the context of climate change (research) (Table 1; e.g. Fankhauser, 1995; Turner et al., 1995).

In case of valuation of special protective flood measures the possible damages were determined on a micro-scale basis (cp. Reese et al., 2001) and on a meso-scale basis for long-term strategic planning.
(cp. Colijn et al., 2000). The majority of the existing studies consider the damage potential as an indication for the vulnerability exclusively.

Generally, extreme events such as storm surges or river floods are considered as the triggering events.

**Table 2  Vulnerability Analyses and their Characteristics (Source: after Berger, 2001)**

<table>
<thead>
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<th>Motive</th>
<th>Scale</th>
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<td>Micro-scale</td>
<td></td>
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<td>Meso-scale</td>
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<td>Macro-scale</td>
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</tbody>
</table>

**Climate impact research**

**Planning of concrete measures**

**Study, Region**

- HARTJE et al., 2001, Sylt
- MOTOR COLUMBUS, 1986, Hamburg
- REESE et al., 2003, different study areas at the North and Baltic Sea coast of Schleswig-Holsteins
- BALL et al., 1991, South Coast (GB)
- BATEMAN et al., 1991, East Anglia (GB)
- HAMANN und KLUG, COLLIN et al. 98/00, North and Baltic Sea coast of Schleswig-Holsteins
- KIESE und LEINWEBER, 2000, Lower Weser region
- KLASS und SCHMIDTKE, 1990, Wesermarsch
- OSSAM, 1995, Mecklenburg-Vorpommeren
- MURL, 2000, Rhein in Nordrhein-Westfalen
- BEHNEN, 2000, German North- and Baltic Sea coast

The triggering element in the context of climate impact research is a long-term sea-level rise. Purpose of these studies is to assist political decisions regarding strategies and measures of adaptation to SLR (cp. Berger, 2001).

According to the different problems and applied methods, the studies mentioned above differ significantly in some extent in their results and methodologies. Table 2 indicates the motive, the choice of the assessment level as well as the investigated damage categories for different selected studies.

Due to the obvious lack of accordance of the various methods the demand for standardised approaches becomes apparent. This deficiency underpins the request to develop general and practical VA methods within Floodsite.

**Previous coastal risks studies in Germany**

In order to analyse the hazards in coastal areas the IPCC installed the Coastal Zone Management Subgroup (CZMS) in 1990. The Common Methodology, a macro-scale procedure to determine the vulnerability of coastal zones by a sea-level rise (IPCC CZMS 1992) was later adopted for the German coastal zone (cp. Behnen, 2000; Sterr et al., 2000). Based on this standardised methodology numerous country specific studies were carried out (cp. Carter et al., 1994; Dennis et al., 1993; Klein & Nicholls,
1999; Turner et al., 1993; Yohe et al., 1995) as well as further development of existing methods has taken place (cp. Cline, 1992; Fankhauser, 1995; Harvey et al., 1999; Nordhaus, 1991).

In the course of the debate about climate change Germany launched the research program “climate change & coast” in 1991 (cp. Sterr et al., 1996). The research focus plan, presented in 1994, contained the following objectives:

- Analysis and classification of coastal sections depending on the degree of exposure against climate change respectively the conservational aspect (area worth to be protected)

This goal was pursued with the hazard and vulnerability assessment for the German North and Baltic Sea coasts and was based on the IPCC Common Methodology (cp. Ebenhöh et al., 1997). The focus of this macro-scale approach was the appraisal of socio-economic impacts of a climate change to coastal regions (cp. Behnen, 2000; Daschkeit & Sterr, 1999; Knogge, 1998).

To evaluate the socio-economic consequences on a regional level and more precisely meso-scale methods are more appropriate (cp. Knogge, 1998a). In Germany the study for the Wesermarsch Region serves as a reference study for meso-scale approaches (cp. Klaus & Schmidtke, 1990). Based on official statistics this study tried to determine how losses of assets and added value can be reduced if specific dike constructions will be carried out.

Several other regional studies, assessing the damage potential and the damage expectation along rivers and at the coast, followed and were also based on this methodology (cp. Hamann & Klug, 1998; Kiese & Leineweber, 2000; MURL, 2000; Osam, 1995). In addition to the mentioned German macro-scale coastal vulnerability analyses, different interdisciplinary interconnected projects were carried out in the framework of the research program “climate change & coast”. To cite just two examples, the project network “KLIMU (Klimaänderung und Unterweserregion; cp. Elsner & Knogge, 2001) and the case study „Island of Sylt“ (cp. Daschkeit et al., 2002), were engaged with the vulnerability of coastal areas.

While the „KLIMU-project“ determined the socio-economic impacts in the event of a dike breaching on a meso-scale, the “Sylt study “ chose a micro-scale approach to estimate the possible consequences of climate change (cp. Hartje et al., 2001).

Since micro-scale studies are extremely time-consuming, these detailed methods have been applied only rarely (cp. Motor Columbus, 1986; Reese et al., 2001). Nevertheless it is an important and suitable tool to assist decisions in case of concrete measures.

In the scope of the research project MERK a micro-scale, object-orientated approach was also chosen. Within this project both the damage potential and the damage expectation were evaluated (cp. Reese & Markau, 2002; Reese et al., 2003).

4. VA in the investigation area St. Peter-Ording

As described in chapter 3.1 vulnerability studies on all three assessment levels were carried out for the coast of Schleswig-Holstein.

Comparing the macro-scale IPCC study with the meso-scale valuation analysis for Schleswig-Holstein the common ground is the application of the so called “Wesermarsch-methodology”. This method estimates the socio-economic damage potential on the basis of official statistics and indicators. However, the results of the two valuation studies reflect different spatial resolutions due to the difference in assessment levels

Due to the low spatial resolution of the macro-scale analysis no results could be derived specifically for the municipality of St. Peter-Ording. Thus only the methodology and results of the meso- and micro-scale studies will be discussed in detail.
4.1 Meso-scale VA in St. Peter-Ording

From the case study results it soon became clear, however, that the data, aggregated on the basis of statistical information at county level, were not specific and conclusive enough for the regional authorities to consider in detail the existing coastal defence and adaptation schemes. Therefore, it was decided that a more detailed analysis should be carried out at a meso-scale level for the state of Schleswig-Holstein. This region was chosen for two reasons. First, it comprises all types and elements of vulnerable coastal systems in both the North Sea and the Baltic Sea region. Second, the state authorities were in the process of revising and adjusting the coastal defence master plan for the next 30 year period and were thus particularly interested in taking results from a specific vulnerability assessment for the state into consideration.

In the following chapter the meso-scale approach will be illustrated in detail. Since in this study the possible damages were not evaluated the focus will lie on the damage potential.

4.1.1 Methodology to evaluate the damage potential

To estimate possible damages knowledge about the objects and assets at risk is required. Consequently, prior to the estimation of the possible damages an inventory, a valuation analysis, needs to be carried out. In this context damage potential is not defined as damages or possible damages, but as the sum of existing monetary and non monetary values/objects, which could suffer damages in case of an event.

Different studies were used to develop the method for the assessment of the damage potential (Ball et al. 1991, Behnen 1996, Karas et al. 1991, Klaus & Schmidtke 1990, Penning-Rowsell et al. 1992). The numerous studies differ in their scales of interest and detail, in their database as well as in their methodology.

For Germany Klaus & Schmidtke (1990) delivered a meso-scale expert opinion (cost-benefit analysis) for coastal defence works in the “Wesermarsch area”, Lower-Saxony. Within the project EUROflood this method was extended to a decision support system for Regional Scale Analysis with the aid of a GIS (Gewalt et al. 1996).

This pilot study approach (Wesermarsch) was used as a methodological guide for the coastal defence valuation study that was carried out in the German Federal State of Mecklenburg-Vorpommern. For reasons of comparison, the method was used also in Schleswig-Holstein.

The basis of the meso-scale methodology in Schleswig-Holstein is the assessment of the damage potential of the coastal lowlands by means of key parameters and socio-economic variables taken from municipality-based official statistics. The sectoral assets in the investigation areas were evaluated on the basis of socio-economic data from population statistics, agricultural statistics, statistics of dwellings, etc. The use of aggregated data from official statistics imposes certain restrictions such as the spatial preciseness of the valuation. Using standardised data sets has the advantage that results can be compared and data can easily be updated respectively continued. Hence it appeared reasonable to refer to the so called “Wesermarsch-Methodology”. But nevertheless, the method had to be partly modified due to different boundary conditions and the different data base.

The applied method can be classified into different working steps:

1. Identification and compilation of monetary and non-monetary assets for the entire municipality by means of statistical data and key parameters,
2. Creation of spatial reference of assets (combination with land use types),
3. Calculation of assets for the areas at risk (based on municipality values)
4. Breakdown of assets to separate flooding units
5. Vertical breakdown of assets (elevation/height zones)
For these purposes topographic and thematic data and information from different sources was compiled and processed with a GIS in order to create a homogeneous database.

Analogous to the term damage potential the term asset comprises the entirety of all monetary and non-monetary values protected by coastal defence system. Besides the tangible or material assets the population is a priority category.

Additional to the estimation of the different monetary asset categories details about the socio-economic structure, especially the number of inhabitants at risk and the number of potentially affected employees are also of great interest in coastal defence planning. On the basis of the data primarily obtained from the Schleswig-Holstein Statistical Office the socio-economic elements (inhabitants, dwellings, infrastructure), the local production facilities (capital, land) and the current economic results (gross value added) of the areas at risk were determined.

According to Klaus & Schmidtke (1990) the total assets, i.e. all the protected economic values per municipality, were calculated by the combination of parts of the statistical database with key parameters and indicators derived from Federal and State statistics. The total assets consist of the capital assets of the different economic sectors (fixed assets), stock value, dwelling assets including household goods, assets of motor vehicles, livestock, as well as the land value of agricultural areas. In the framework of the project a master thesis was also produced, which included a detailed assessment of the main damage potential categories (dwellings & private inventory; Reese, 1997).

The results of the study were compared with the results determined after the “Wesermarsch” method and used to optimize the meso-scale methodology. The precise approach calculating each single damage potential category will be explained in the following.

**Housing Capital**

While quantitative details about the number of inhabitants and dwellings could be taken directly out of the official statistics, the housing capital respectively the monetary value of the residential buildings had to be calculated by a separate procedure because immediate monetary statistical details were not available. On the basis of the number of dwellings and inhabitants per municipality the number of dwellings per capita was determined. Subsequently this value was put into relation with the corresponding value at federal level. This ratio served as an indicator for the estimation of the housing capital per capita in each municipality. The federal housing capital per capita could be taken from the federal statistics (corresponding data for the State of Schleswig-Holstein was not available). It was calculated on the basis of the gross tangible assets (total value Federal Republic of Germany, Annual statistics of the Federal Statistical Office, 1996), the total population and the number of dwellings in Germany (Old Federal States). The indicator “dwellings per capita” was accordingly modified and assigned to the specific municipalities. The combination of the calculated municipality based housing capital per capita with the number of resident population allowed an estimation of the housing capital in the municipalities (Klaus & Schmidtke 1990, p. 54).

**Private Inventory / Household goods**

To assess the monetary value of the private inventory a rough estimation method was used due to a lack of precise data about the existing assets within each household. The ratio between the household goods and the housing capital was as an indication. Since the “Wesermarsch” method provided only a very rough estimation, in case of the assessment of the private inventory the authors reverted to the results of a micro-scale analysis, carried out in the framework of the meso-scale project. This analysis has drawn a comparison between the meso and micro-scale method and was based upon empiric collected data in the municipality (Reese, 1997). Insurance (average monetary value for private inventory = approx. 615 € per m² living area) and detailed survey data was used to calculate a more precise ratio between the household goods and the housing capital. The micro-scale analysis generated a ratio of 40% (private inventory to housing capital). This value was then applied to the meso-scale method.
Gross fixed assets

Within the scope of the analysis of the local production facilities and factors the resources labour, capital and land were investigated according to the “Wesermarsch” study. Information about the distribution of places of work and employees in the municipalities were derived from the used statistics (places of work and employees in the municipalities of Schleswig-Holstein on 25.05.1987, results of the census; employees subject to social insurance contribution on 31.12.93, Special preparation of the State Office of Statistics Schleswig-Holstein).

The valuation of the factor capital is based on the combination of the number of employees with the figures of the national accounts (Federal respectively State statistics). The exposure of the capital is largely dependant upon the sectoral structure of the assets. Hence, the gross fixed assets were evaluated separately for ten economic sectors and substitutional for the invested capital. The initial point of the assessment is the consideration, that the capital equipment of each work place varies significantly dependent on the economic sector. Klaus & Schmidtke (1990, p.68) recommended to calculate a sectoral average value for the superordinate area (State or Federal level). The sectoral capital intensity can be taken from the national accounts and combined with the specific number of employees of each municipality to determine the capital equipment. The resultant overview about the capital stock of the ten different economic sectors gives an idea of the distribution of one of the main monetary components (source: Counting of the work places within the census of 1987; sectoral capital intensity of the State Office of Statistics – 1991).

Stock value

The stock value or stock of the economy isn’t separately disclosed for each economic sector in the State and Federal statistics, but only overall in the context of the reproducible gross tangible assets for the Federal Republic of Germany (Statistical Yearbook, Federal Statistical Office, 1996). Thus, the determination of the stock value had to done by means of the assignment of the stock-gross fixed assets ratio (capital stock without dwellings) from the federal to the municipality level. From the figures of the Federal statistics results a ratio of 6.64 % which was applied to calculate the stock value of the municipalities in the study area.

Motor vehicle assets

The motor vehicle stock is not differentiated after municipalities, but is only statistically recorded on the district level. Hence, the number of motor vehicles respectively the monetary value of them had to be assessed also on the basis of a particular ratio. The relation between the inhabitants of the municipality and the total population in the administrative district served as one indicator to determine the motor vehicle assets of the municipalities. Due to the lack of knowledge about the use and spatial distribution of the motor vehicles all passenger cars and powered two-wheelers were assigned to the private households. The motor vehicle assets were calculated only on the basis of the mentioned private vehicles, because commercial vehicles were assigned to the fixed assets of the economy. Within the “Wesermarsch” study (1990) an average passenger car value of approx. 5,100 € and a two-wheelers value of around 1,000 € was assessed. Taking the annual price increase into account, the motor vehicle assets of the municipalities could be determined.

Livestock assets

To evaluate the livestock assets the municipality results of the livestock count 1994 (work report of the State Office of Statistics) and the producer and wholesale prices for the farming in Schleswig-Holstein were used. Even though the livestock statistic is very detailed, the study considered only the total number of cattle and hogs due to the meso-scale approach and the low relevance of the other species. Accordingly the valuation was carried out on the basis of average values. A cattle was estimated with around 700 €, resulting from an average purchase price of approx. 140 € per 100 kg with an average weight of 500 kg per cattle. The monetary values for hogs were assessed in a uniform manner.
Land value
The determination of the monetary value of the agricultural land was carried out following the “We-
sermarsch” method. Statistics of land use and purchase prices of agricultural properties were used. The
latter are disclosed nature-spatially differentiated and can reflect the different quality of the soil to a
certain extent. Purchase prices are affected by social and economic conditions to a great extent. Hence,
the specific soil quality, based on the official soil quality assessment of the agricultural land within the
investigation area was also considered.

Traffic infrastructure
The valuation of the traffic infrastructure was based upon information of the State Road Construction
Office Kiel and the German Railways Corporation, network division, branch office Luebeck. The in-
formation comprised costs for road construction dependant on the type of road and construction costs
for railway lines (800,000 €/km as at 1996). Costs for road construction were averaged as they were
extremely differentiated. Consequently, an average construction price for a new development per km
was applied. One kilometre of motorway was assessed with 4.09 m €, federal (interstate) and countr-
side highways with 1.8 m €, county and other roads with around 1.28 m € (1996).

Gross value added
According to Klaus & Schmidtke (1990, p.76f) the gross value added is suited to describe the current
economic result and hence estimate the loss of production in case of flooding. The gross value added
is characterised as the economic activity during a specific period and defined by the value of all pro-
duced material goods and services minus the value of goods used during the production process. The
State Office of Statistics releases the gross value added only on the district level, why the rates of the
municipality had to be determined by means of a key value. This can be the amount of the Inland
Revenue, which is correlated with the gross value added (Klaus & Schmidtke, 1990, p.76f) and thus
can act as a proportioning parameter. With this ratio the dimension of the gross value added in eachof
the investigated municipalities could be estimated.

Tourism data
To get an overview about the tourism along the coast of Schleswig-Holstein, which is a significant
economic factor, the number of accommodations and overnight stays were taken and analysed from
the official tourism statistic. It has to be taken into account that the statistic only collects data from
commercial businesses which provide 9 and more beds. Details about the invested capital are not
available in the statistics. The tourism assets were consequently covered by the capital stock of the
service sector.

4.1.2 Results of the valuation analysis
The results of the valuation analysis yielded objective comprehensible information about the benefit of
coastal defence in Schleswig-Holstein for the first time. Table 3 displays the primary results of the
individual flood units and of the entire low-lying areas where coastal flood defence is needed. At the
North Sea Coast two regions were distinguished, the area between the first and the second dike line as
well as the area between the second dike line and the 5 m contour line. The latter areas are mostly pro-
tected against flooding by two dike lines in a row and have consequently a high level of safety.
Table 3  Damage potential at the North-Sea and the Baltic Sea Coast of Schleswig-Holstein (main categories; after Hofstede & Hamann, 2000):

<table>
<thead>
<tr>
<th>Coastal area in Schleswig-Holstein</th>
<th>North Sea coast between 1st and 2nd Dike line</th>
<th>North Sea coast between 2nd Dike line and 5.0 m asl</th>
<th>Baltic Sea coast 0.0 – 3.0 m asl</th>
<th>North Sea coast and Baltic Sea coast (total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (ha)</td>
<td>137,877</td>
<td>202,520</td>
<td>31,838</td>
<td>372,235</td>
</tr>
<tr>
<td>Inhabitants</td>
<td>126,574</td>
<td>126,044</td>
<td>91,606</td>
<td>344,224</td>
</tr>
<tr>
<td>Employees</td>
<td>43,572</td>
<td>41,517</td>
<td>87,091</td>
<td>172,180</td>
</tr>
<tr>
<td>Tourism capacity</td>
<td>29,752</td>
<td>2,234</td>
<td>19,533</td>
<td>51,519</td>
</tr>
<tr>
<td>Gross value added (in Bill. Euro)</td>
<td>2.38</td>
<td>1.99</td>
<td>4.06</td>
<td>8.43</td>
</tr>
<tr>
<td>Total values (in Bill. Euro)</td>
<td>15.59</td>
<td>16.03</td>
<td>15.44</td>
<td>47.06</td>
</tr>
</tbody>
</table>

In total, about 344,000 people or nearly 13% of the whole population of Schleswig-Holstein live in an area which would be frequently flooded during extreme storm surges without the existing coastal defence. This area comprises 3,722 km², material assets of 47 billion Euro and jobs for approximately 172,000 people. These figures illustrate the social value and the importance of an efficient coastal defence. The annual gross value added within the area at risk amounts to about 8.42 billion Euros.

The expenses of the coastal defence in a dimension of 40 to 46 million Euros per year (within the period 1990 until 1999) are thus applied effectively in terms of a cost-benefit analysis. Regarding the spatial distribution of the specific evaluated damage potential categories significant economic importance could be identified. A high proportion of the total damage potential is located in the biggest polder at the North Sea coast as well as in the urban settlements at the Baltic Sea coast.

In Table 4 the meso-scale results for the investigation area of St. Peter-Ording are displayed.

Table 4  Damage potential in St. Peter-Ording (meso-scale; after Hamann & Klug, 1998)

<table>
<thead>
<tr>
<th>Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area of St. Peter-Ording (ha)</td>
</tr>
<tr>
<td>Flood prone area in St. Peter-Ording (ha)</td>
</tr>
<tr>
<td>Total number of Inhabitants in St. Peter-Ording</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assets at risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhabitants</td>
</tr>
<tr>
<td>Employees</td>
</tr>
<tr>
<td>Tourism capacity</td>
</tr>
<tr>
<td>Private buildings</td>
</tr>
<tr>
<td>Private inventory</td>
</tr>
<tr>
<td>Gross value added</td>
</tr>
<tr>
<td>Capital assets of processing industries</td>
</tr>
<tr>
<td>Capital assets of building sector</td>
</tr>
<tr>
<td>Capital assets of trade</td>
</tr>
<tr>
<td>Capital assets of traffic and telecommunication</td>
</tr>
<tr>
<td>Capital assets of financial institutes and assurances</td>
</tr>
<tr>
<td>Capital assets of service industries</td>
</tr>
<tr>
<td>Capital assets of private organisations</td>
</tr>
<tr>
<td>Capital assets of regional and political corporations</td>
</tr>
</tbody>
</table>
4.2 Micro-scale VA in St. Peter-Ording

The meso-scale methodology is well suited e.g. as a basis for political decisions and strategy planning, but too imprecise to plan concrete measures. For this purpose a micro-scale vulnerability assessment is necessary. In the framework of the project MERK the authors developed a comprehensive method for this purpose (cp. Reese et al., 2003), which will be described below, taking St. Peter-Ording as an example. The explanation will concentrate on the illustration of the VA (valuation analysis and damage estimation) but will neglect the hazard determination and the flooding simulation even if it is one of the main basis for the VA.

4.2.1 Valuation methodology

After the specification of the potential flooding area the damage potential will be investigated by means of a valuation analysis. The damage potential comprises all monetary or non monetary elements which can suffer damage in case of flooding. Hence, these elements need to be identified, inventoried, and assessed.

The following elements at risk were considered in the context of the valuation analysis:

- Inhabitants
- Employees, jobs
- Guest beds, tourism capacity
- Buildings
- Private assets and values
- Motor vehicles
- Traffic areas
- Agricultural land
- Livestock assets
- Forest land
- Real estate values in residential areas
- Recreational land
- Gross value added
- Fixed assets
- Stock value
- Wind power stations

When going through a micro-scale object-related valuation analysis, serious problems may arise regarding uniform reference levels, reference data, and data sources. Moreover the data availability on the object level could be very restricted by data security. Consequently the valuation analysis had to be based on various sources, reference dates, and levels of aggregation (Table 5).

An important information base for the study at hand was the field work conducted in the investigation area. Besides the survey of land use, the specific structure of each building, as well as the number of storeys, age and use of the building was collected on the basis of the DGK5 (map scale 1:5000).

Table 5 Data sources for the micro-scale evaluation

<table>
<thead>
<tr>
<th>Damage category</th>
<th>Source</th>
<th>Reference date</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhabitants</td>
<td>Resident register St. Peter-Ording</td>
<td>4/2001</td>
<td>Number of people</td>
</tr>
<tr>
<td>Jobs</td>
<td>Business interviews, Field work</td>
<td>12/2001</td>
<td>Number of employees</td>
</tr>
<tr>
<td>Guest beds/</td>
<td>Tourism catalogue St. Peter-Ording, Field work</td>
<td>7/2001</td>
<td>Number of beds</td>
</tr>
<tr>
<td>capacity Tourism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buildings</td>
<td>DGK 5, Field work</td>
<td>different</td>
<td>Base of the building in m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12/2000</td>
<td>Number of storeys, age, condition</td>
</tr>
</tbody>
</table>
The time-consuming micro-scale data survey provides very detailed information about the elements at risk and enables accurate spatial mapping of all objects, such as the number of inhabitants. For the valuation of the inhabitants at risk the internal statistic of the municipality was used. While the economic data was derived from expert and company interviews, additional information was received through extensive internet inquiries.

Nevertheless, it should be made clear that the assessment of the damage potential is always a snapshot of the survey at a specific date. Short-term changes such as the variation of the land use within a season can be considered, but only with an enormous effort. In the future an iterative valuation analysis, at least for certain parts would be reasonable and eligible, especially in the scope of risk monitoring.

GIS plays an important role as a technical instrument within the valuation analysis. By overlaying the corresponding information layers an analysis regarding the spatial distribution of the values could be carried out.

Below the specific categories and the relevant assessment methodologies of the valuation are presented:

**Inhabitants**

The assessment of the inhabitants at risk was conducted on the base of the buildings shown in the DGK 5 and by means of the internal municipality residential register (Municipality St. Peter-Ording, 2001). The survey and an address register allowed an accurate assignment of the streets and street
numbers to each single house. Apart from short term variances the number and the spatial distribution of the inhabitants is extremely reliable and precise.

On the basis of the survey’s results and the mentioned register the number of inhabitants in the flood-prone area could be determined. Since secondary residences are of importance in tourist municipalities both the main and auxiliary abodes were surveyed. The recorded number of inhabitants at risk is consistent with the maximum population within the potential flooding area. No reliable information is available about variability of the population over time, e.g. absence of the people or seasonal concentration differences.

**Employees / Jobs**

Employees in this context are defined as the manpower resources within the study area. Thus this definition is different from the one given in the national statistical records i.e. such as persons employed liable to social security and economically active population. The number of employees is the key parameter for the evaluation of the gross value added and consequently requires a detailed assessment.

Information about the precise number of employees was collected for numerous companies previously selected. This was done by telephonic interviews. This information was updated and adjusted to the local conditions by additional interviews with executives selected from local firms in St. Peter-Ording. In connection with the knowledge about the effective area of each building, we could derive an average number of employees subject to their individual class of business.

Only for those companies, where no detailed information was available, mean values were assigned. On the basis of the interviews, square meter based mean values for various economic categories and subcategories could be derived. This information as well as the surveyed and mapped economic category and the companies’ surface area provided the base for the valuation of the employees/jobs parameter.

**Guest beds/ tourism capacity**

The official statistics on tourism are unsuitable for the determination of the number of guest beds at risk, since they include only companies with more than 8 beds. In many places private providers have a significant share in the total number of tourist accommodations. Because they often have less than 9 beds, statistical data alone will yield an underestimation of the total tourism capacity.

Hence, an analysis of the local accommodation catalogue and of the online pages of private providers was necessary (Tourism catalogue St. Peter-Ording, 2001). In connection with the information of the field mapping it was possible to allocate the beds spatially to the houses in the potential flooding area.

The surveying and mapping produced a much higher number of tourist buildings than the local accommodation catalogue. This can be attributed to the fact, that not all accommodations are registered in the catalogue. According to the size of the houses and the type of business an average number of 0.08 beds per m² were assigned to these non-registered accommodations.

**Buildings**

The building assets were computed according to the Valuation Guidelines and Manufacturing Costs 1995 (Kleiber, 2000). This allowed the calculation of the replacement value for different types of buildings by considering the height of each storey, base surface and age of the building. While the relevant building parameters were collected in the course of the field work, the surface area was taken from the DGK 5. As far as basements existed and were visible, they were considered in field surveying.
Different correction factors had to be included into the computation due to significant regional variations of the manufacturing costs. These factors consider the size of the city as well as the different regional construction costs within the federal territory.

Apart from the valuation of the main buildings the replacement costs of the annex structures such as garages or summer houses were also assessed. Official manufacturing costs don’t give much information about the value of these objects, so that additional data was extracted from an internet inquiry (Multi-Garagen, 2000; Heimwerker.de, 2000). Outside facilities have been assessed in consultation with the regional insurance company Provinzial Brandkasse Kiel in the amount of 3% of the total building value (Kaehler, 2000).

The value of the properties was determined separately in the scope of the real estate valuation.

**Private Inventory**

The determination of the inventory assets was conducted according to the rating of household insurances. The Provinzial Brandkasse (2000) estimated the private inventory of their clients by a flat-rate value of approx. 700 €/m² living area. This value has to be enhanced in case of high-quality houses and reduced for low-value buildings and annexes. The living area of each building could be computed from the gross base surface using the factor 0.66 for a “normal storey” and 0.44 for the first and 0.148 for the second top floor (Klagges & Aretz, 2000).

The inventory assets of business enterprises were determined separately in the framework of the valuation of the fixed assets.

**Motor vehicles**

The motor vehicle assets are estimated on the basis of a municipality based motor vehicle specification. Stock data of automobiles and number of powered two-wheelers, commercial cars and trailers were used. By the internet based analysis of the second-hand passenger car market in the context of the MERK project, mean values have been derived and applied for St. Peter-Ording (Annoncen Avis, 2000; Mobile.de, 2000). Besides regular cars commercial cars were also assessed. Their values were estimated through an internet based analysis. The transfer to the assets found in the study area took place via the business enterprises. The respective economic category and the size of each company were also considered.

**Traffic areas**

The traffic areas include both linear elements such as streets, railroads, cycle tracks and footpaths and spatial objects such as parking areas. The information about length and extent of the traffic structures were extracted from the Geographical Information System. Subsequently these objects were evaluated by average construction costs of different types of elements.

**Agricultural land**

The so-called “landscape plan” offers information about agricultural land use. This information was verified with the results of the survey and finally transferred into the GIS. The values of the agricultural areas could be evaluated on the basis of average prices, derived from sales of agricultural land by official soil consultants. Here, different land values classified by the type and quality of the soils were considered.

**Livestock assets**

In the context of this category all productive livestock is evaluated. The stock figures were taken from the Schleswig-Holstein State of Statistics (1995, 1999) and verified by field surveying. The assess-
ment of the assets is based on producer and wholesale prices of the ZMP (1999, 2001, 2001a). Farms with stock rearing have been attributed with municipality-based mean values. These farms were identified in the course of the surveying and mapping.

**Forest land**

Forest areas were identified via landscape plan of St. Peter-Ording and were updated by the field work. Information regarding the monetary valuation was provided by the official soil consultants. The monetary value of the forest land was then assessed on the basis of different hectare prices depending on the type of forest.

**Real estate values in residential areas**

For assessment of property values in residential areas all lots were summarized which show housing. This comprises the surface areas of buildings as well as real estate sites without buildings. These areas had not been included in course of the mapping of the building assets and thus had to be evaluated separately. As a valuation basis standard land values released by the Advisory Committee for Real Estate Values were used. The determination of these standard values was based upon a compilation of purchase prices. The main bases for these are the prices of undeveloped real estate areas, i.e. their values without unusual or special conditions on the real estate market. Standard land values are determined from the value which would result, if properties were undeveloped. They refer to building land regarding their development status. While the standard land values are usually classified either as construction sites, multiple storey construction sites or industrial building land, this study selected only a mean value, because a correct attribution to one of these areas was not feasible from the cartographic base at hand.

**Recreational land**

The surfaces of the tennis courts, sports fields, miniature golf, playgrounds and campgrounds are summarized under the term recreational areas. Due to the different infrastructure of these areas their valuation had to be made individually. For the campgrounds the standard land value was used for the monetary valuation. Information about the construction costs of the other recreational areas were received from expert interviews. Thereby both prices based on square meters and total values for the whole equipment were considered.

**Gross value added**

For the economic damage categories the limited micro-scale data availability allowed only a rough estimation of the potential values at risk in the study areas.

In national economic terms gross value added is defined as the manufactured goods and performed work given. In the national accounting the added value is taken as the difference between output value and intermediate inputs (Schreiber, 2000, p. 504). The gross value added can serve as a size for the possible losses of production in case of flooding accordingly. It is indicated for a full financial year. Since information about the gross value added was not available on municipality level, we had to revert to more aggregated data, in order to estimate the added value approximately. The Baden-Wuerttemberg State Office of Statistics publishes the average gross value added at manufacturing prices per employee for different economic sectors for the different states in Germany. Depending on the economic category an average gross value added can be assigned to the employees of each business of St. Peter-Ording.
Fixed assets

According to Schreiber (2000, p. 26) the fixed assets comprise all the assets designed for permanent or perennial use. Thereby material, immaterial and financial fixed assets are distinguished. It is assumed that financial assets and parts of the immaterial fixed assets are normally not vulnerable to flooding. Hence in the context of this study only the material fixed assets of the local businesses will be determined and can consequently be defined as the equipment assets. In the scope of the valuation analysis all non-private used buildings are considered. Expert interviews with different equipment-providing companies as well as factory insurance companies and potentially affected businesses provided information about the fixed assets, respectively the equipment assets. Square meter based prices were assigned to the individual companies according to the type of business. The surface area of each company was also included.

Stock value

The stock value is defined as part of the floating assets, which is in stock for production and sale. It includes raw, auxiliary, and operating materials, semi-finished and finished products (Schreiber, 2000, p. 490). During the valuation procedure we encountered the problem that statistical data is only available on regional level and is not differentiated according to economic sectors. The German Central Bank which publishes the annual financial statements of West German companies differentiates according to economic sectors (Deutsche Bundesbank, 1999). Furthermore, numerous firms submit their annual financial statements to the public, so that percentage ratios from fixed assets to stock value can be derived from these detailed listings of the tangible fixed assets and the stock value. Thus, on the basis of the determined equipment assets the stock value of each business could be assessed within St. Peter-Ording.

Wind power stations

The chamber of agriculture Schleswig-Holstein manages and updates the actual stock of all wind power stations on a municipality level (Landwirtschaftskammer Schleswig-Holstein, 2001). This register contains the classification and different technical details of all power stations. On the basis of this information and the manufacturing costs the monetary value of the wind power stations in St.Peter-Ording were assessed.

4.2.2 Results of the valuation analysis

In Table 6 and Figure 2 the results of the micro-scale valuation analysis for St. Peter-Ording are combined. According to this, 6,331 or 91% of a total of 6,934 inhabitants lived in the potential flooding area (< 5 m asl including foreland). As further intangible values in the investigation area 3,400 jobs and around 10,350 guest beds were identified.

The tangible damage potential of St. Peter-Ording has a total value of approx. 2,143 Billion Euro. The proportion of each category is displayed in Figure 2. Building values make up the highest portion with around 45%. Moreover, the real estate values (23%) and the private inventory (10%) are important categories as well.

These parameters were also the dominating categories in the other investigation areas of the MERK-project and yielded similar dimensions. The economic categories such as the gross value added and the fixed assets as well as the assets of the traffic areas complete the major part of the total damage potential. The rest of the elements is of comparatively little importance.
Table 6  Damage potential in St. Peter-Ording (micro-scale; Reese et al., 2003)

<table>
<thead>
<tr>
<th>Damage category</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intangible</strong></td>
<td></td>
</tr>
<tr>
<td>Inhabitants</td>
<td>6,311</td>
</tr>
<tr>
<td>Jobs</td>
<td>3,400</td>
</tr>
<tr>
<td>Guest beds/ Tourism capacity</td>
<td>10,354</td>
</tr>
<tr>
<td><strong>Tangible</strong></td>
<td></td>
</tr>
<tr>
<td>Buildings</td>
<td>962,058,500 €</td>
</tr>
<tr>
<td>Private Inventory</td>
<td>221,749,200 €</td>
</tr>
<tr>
<td>Real estate values</td>
<td>491,074,200 €</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>16,198,200 €</td>
</tr>
<tr>
<td>Traffic areas</td>
<td>116,349,900 €</td>
</tr>
<tr>
<td>Wind power stations</td>
<td>482,500 €</td>
</tr>
<tr>
<td>Agricultural land</td>
<td>16,215,500 €</td>
</tr>
<tr>
<td>Livestock assets</td>
<td>2,867,200 €</td>
</tr>
<tr>
<td>Forest land</td>
<td>379,600 €</td>
</tr>
<tr>
<td>Recreational land</td>
<td>22,253,300 €</td>
</tr>
<tr>
<td>Gross value added</td>
<td>109,443,500 €</td>
</tr>
<tr>
<td>Fixed assets</td>
<td>169,223,200 €</td>
</tr>
<tr>
<td>Stock value</td>
<td>15,027,000 €</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td>2,143,321,800 €</td>
</tr>
<tr>
<td><strong>%</strong></td>
<td>100.00</td>
</tr>
</tbody>
</table>

Figure 2  Tangible values in the flood prone area of St. Peter-Ording (Reese et al., 2003)

4.2.3 Damage estimation - methodology

On the basis of different flooding scenarios and the calculated damage potential the vulnerability can be subsequently assessed by means of an estimation of the possible damages. In the following two
possible scenarios will be singled out. The results represent only one of manifold consequences possible in case of an extreme storm surge. For a more comprehensive risk and vulnerability analysis numerous varying scenarios would be necessary.

The majority of the damage categories can be assessed via an empirical model. The calculation of the possible damages is mainly based upon so-called depth-damage-functions. Thereby it is assumed that standardized functions represent a dependency between the key parameter flood level at the individual objects and the expected damage. The functions are based on data of past flood events and describe either the monetary damage or the percentage of the total value of the object (cp. Murl, 2000: 40ff; Niekamp, 2001: 442).

An transfer of depth-damage functions, derived from fresh-water damages, to the coast is considered as problematic, because of the different hydrologic and hydraulic conditions as well as the different water ingredients (i.e. salt) the damages can be higher. Since damage data of past storm surge events is extremely rare, expert interviews were necessary to ensure the applicability to coastal storm surges or the development of new inundation depth–damage functions.

Figure 3 shows the depth-damage-functions used within the MERK-project (Markau, 2003):

![Depth-damage-functions](image)

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In addition there are categories (i.e. gross value added, forest land), whose damages are not defined by the flood depths. Here, specific other parameters such as the flood duration determine the damage expectation. From the expert survey an evaluation model was derived and transferred into a GIS. In consideration of the various damaging processes (flood depths, duration, mechanical damage within the high impact wave zone), the value of the individual objects and evacuation rates, the damages of the different categories and for the specific scenarios were evaluated.

4.2.4 Damage estimation - results

The results can now be analysed and visualised depending on the special demands and problems. Table 7 displays the total damages for two exemplary flooding scenarios (SPO I and II).

### Table 7  Tangible and intangible damages in the flood prone area of St. Peter-Ording (Monetary values in thousand Euro; after Reese et al., 2003)

<table>
<thead>
<tr>
<th>Damage categories</th>
<th>Total damages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SPO-I</td>
</tr>
<tr>
<td><strong>Intangible</strong></td>
<td></td>
</tr>
<tr>
<td>Affected Inhabitants</td>
<td>1,271</td>
</tr>
<tr>
<td>Inhabitants to evacuate</td>
<td>195</td>
</tr>
<tr>
<td>Affected employees</td>
<td>1,194</td>
</tr>
<tr>
<td>Affected tourism beds</td>
<td>3,454</td>
</tr>
<tr>
<td><strong>Tangible</strong></td>
<td></td>
</tr>
<tr>
<td>Costs for evacuation</td>
<td>190</td>
</tr>
<tr>
<td>Buildings</td>
<td>23,777</td>
</tr>
<tr>
<td>Private inventory</td>
<td>10,480</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>304</td>
</tr>
<tr>
<td>Traffic areas</td>
<td>4,105</td>
</tr>
<tr>
<td>Wind power stations</td>
<td>4</td>
</tr>
<tr>
<td>Livestock</td>
<td>547</td>
</tr>
<tr>
<td>Recreational land</td>
<td>299</td>
</tr>
<tr>
<td>Loss of gross value added</td>
<td>2,982</td>
</tr>
<tr>
<td>Fixed assets</td>
<td>11,504</td>
</tr>
<tr>
<td>Stock value</td>
<td>734</td>
</tr>
<tr>
<td>total</td>
<td>54,930</td>
</tr>
<tr>
<td><strong>Loss of acre profits</strong></td>
<td>81</td>
</tr>
<tr>
<td><strong>Loss of grassland profits</strong></td>
<td>504</td>
</tr>
<tr>
<td><strong>Loss of forest profits</strong></td>
<td>8</td>
</tr>
<tr>
<td>total</td>
<td>594</td>
</tr>
</tbody>
</table>

5. Comparison of the results of different assessment levels

With the completion of the micro-scale MERK-project results concerning the damage potential for the flood prone areas of Schleswig-Holstein are available for all three assessment levels. The vulnerability study of the IPCC worked on the macro-scale while the valuation analysis was concentrated on the meso-scale.

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2 Concerning the scenarios see Reese et al., 2003.
Especially the comparison of the micro and meso-scale results revealed significant differences. They mainly result from the different preciseness of the varied cartographic and data base. Of particular interest was the question if the differences show a uniform tendency. However, the absence of a uniform tendency of the differences did not allow the demination of a mathematical adaptation function nor the derivation of correction factors to update or adjust the meso-scale results.

Table 8 shows the differences between the results of the micro- and meso-scale study for exemplary damage categories. In the following the most important categories are explained.

Table 8  Comparison of the meso- and micro-scale results (after Reese, 2003)

<table>
<thead>
<tr>
<th>Damage category</th>
<th>Fehmarn</th>
<th>Kaiser-Wilhelm-Koog</th>
<th>St. Peter-Ording</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>meso</td>
<td>micro</td>
<td>meso</td>
</tr>
<tr>
<td>Inhabitants</td>
<td>851</td>
<td>920</td>
<td>332</td>
</tr>
<tr>
<td>Employees</td>
<td>421</td>
<td>894</td>
<td>117</td>
</tr>
<tr>
<td>Tourism capacity</td>
<td>607</td>
<td>925</td>
<td>120</td>
</tr>
<tr>
<td>Private inventory</td>
<td>19,359,448 €</td>
<td>44,584,000 €</td>
<td>6,433,959 €</td>
</tr>
<tr>
<td>Motor vehicle</td>
<td>2,530,786 €</td>
<td>4,773,700 €</td>
<td>1,001,672 €</td>
</tr>
<tr>
<td>Agricultural areas</td>
<td>17,320,972 €</td>
<td>62,054,300 €</td>
<td>10,894,581 €</td>
</tr>
<tr>
<td>Livestock assets</td>
<td>923,804 €</td>
<td>793,600 €</td>
<td>822,662 €</td>
</tr>
<tr>
<td>Gross value added</td>
<td>16,823,386 €</td>
<td>38,692,100 €</td>
<td>5,319,201 €</td>
</tr>
<tr>
<td>Stock value</td>
<td>4,127,048 €</td>
<td>1,531,900 €</td>
<td>644,422 €</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>€ 61,085,444 €</td>
<td>€ 152,429,600 €</td>
<td>€ 53,728,000 €</td>
</tr>
<tr>
<td></td>
<td>1 : 2.5</td>
<td>1 : 2.14</td>
<td>1 : 1.75</td>
</tr>
<tr>
<td>Total damage potential</td>
<td>€ 154,815,012 €</td>
<td>€ 434,967,100 €</td>
<td>€ 79,887,156 €</td>
</tr>
<tr>
<td></td>
<td>1 : 2.81</td>
<td>1 : 2.26</td>
<td>1 : 2.79</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Damage category</th>
<th>Scharbeutz</th>
<th>Timmendorfer Strand</th>
<th>Kiel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>meso</td>
<td>micro</td>
<td>meso</td>
</tr>
<tr>
<td>Inhabitants</td>
<td>1,666</td>
<td>1,151</td>
<td>6,174</td>
</tr>
<tr>
<td>Employees</td>
<td>344</td>
<td>641</td>
<td>2,523</td>
</tr>
<tr>
<td>Tourism capacity</td>
<td>722</td>
<td>2,295</td>
<td>4,854</td>
</tr>
<tr>
<td>Private inventory</td>
<td>35,440,976 €</td>
<td>69,416,100 €</td>
<td>143,410,759 €</td>
</tr>
<tr>
<td>Motor vehicle</td>
<td>4,950,292 €</td>
<td>4,234,500 €</td>
<td>18,346,395 €</td>
</tr>
<tr>
<td>Agricultural areas</td>
<td>802,870 €</td>
<td>952,400 €</td>
<td>1,162,927 €</td>
</tr>
<tr>
<td>Livestock assets</td>
<td>203,754 €</td>
<td>0 €</td>
<td>62,724 €</td>
</tr>
<tr>
<td>Gross value added</td>
<td>18,925,143 €</td>
<td>20,788,100 €</td>
<td>84,836,033 €</td>
</tr>
<tr>
<td>Stock value</td>
<td>2,883,410 €</td>
<td>2,516,500 €</td>
<td>25,224,912 €</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>63,206,447 €</td>
<td>97,907,600 €</td>
<td>273,043,751 €</td>
</tr>
<tr>
<td></td>
<td>1 : 1.55</td>
<td>1 : 1.23</td>
<td>1 : 0.29</td>
</tr>
<tr>
<td>Total damage potential</td>
<td>176,308,601 €</td>
<td>504,511,700 €</td>
<td>926,627,862 €</td>
</tr>
<tr>
<td></td>
<td>1 : 2.86</td>
<td>1 : 1.92</td>
<td>1 : 0.48</td>
</tr>
</tbody>
</table>

3 Concerning the problems of the comparisons of the data see Reese, 2003.
Looking at the differences of the number of inhabitants (at risk?) of the meso-scale study (1994) and the micro-scale study (2001) and considering the natural variation of the population between the two different census dates the following conclusions arises: The differences in Bannesdorf, Landkirchen and Westfelmarn as well as in Kaiser-Wilhelm-Koog are comparatively small, while in St. Peter-Ording and Scharbeutz the meso-scale method overestimates the real number of inhabitants in a range of 500. In Timmendorfer Strand the difference is approximately 3,500 and even reaches the value of 45,500 in Kiel.

Except of the pure rural areas, where the meso-scale study produced a lower number of inhabitants than in reality, this approach mostly produced exaggerated numbers. Especially in Kiel the methodical weakness of the meso-scale approach becomes apparent. While this wider approach reverts to aggregated data, the micro-scale study gathers the information directly from the residential register of the municipality. Additionally the small-scale cartographic base of the meso-scale study (topographical map 1:50,000) enabled only an insufficient identification of the residential housing. Because of the limited number of investigation areas there can only be a general tendency assumed concerning the determination and positioning of the inhabitants: the tendency of overestimation seems to increase with the urban character of the area.

The differences regarding the guest beds are quite easy to explain. Contrary to the micro-scale study the meso-scale approach uses the official statistic and hence only identifies accommodation with more than eight beds.

The comparison of the private inventory always shows higher values than the results of the micro-scale study except for Kiel. For the rural regions Kaiser-Wilhelm-Koog and Fehmarn differences are found of about 340% respectively 230%. With 135% to 205% they are only insignificant lower in Timmendorf, Scharbeutz and St. Peter-Ording. Kiel again reveals a contrary result. The meso-scale value is 1600% higher than the micro-scale one. Additionally it has to be considered that the meso-scale method doesn’t consider the replacement value but the current value in the range of 50%. Comparing the results under this aspect, the differences are even more significant.

Regarding the other categories for Kiel as well as the total sum, the dimension calculated by the meso-scale method is much higher than the results of the micro-scale study. This indicates that within the meso-scale valuation study key values were overrated. It can be assumed that, as a result of the small-scale cartographic base, the rate, and the size of residential, and industry areas in the flood prone region were assessed much too high.

The other investigation areas also reveal a much differentiated picture concerning the remaining categories. It is noticeable, that the discrepancy between the assessment levels is more distinctive in the rural areas than it is in the tourist resort municipalities. This is approved by the comparison of the total sums. The calculated damage potential of the rural study areas Fehmarn and Kaiser-Wilhelm-Koog is higher than the comparable meso-scale one by the factor 2.5 respectively 2.14. If not only the particular categories are considered but also the particular total damage potential the ratio increases to 1 : 2.81 and 1 : 2.26 (cp. Table 8).

The overall assets corroborate the mentioned tendency. Comparing the total damage potential of the rural investigation areas, the results of the meso-scale study are considerable lower than the micro-scale ones. Since only one urban area has been investigated, the significance of the comparison is limited. Nevertheless the ratio seems to reverse with an increasing urban character of the site. The meso-scale method obviously underestimates the total damage potential of the rural areas and overestimates it in case of the urban area; always assuming the micro-scale results are the more precise ones.

To adjust the results, the meso-scale overall damage potential should be reduced for urban areas and increased for tourist and rural areas. The classification into rural, tourist and urban sites was based on a representative “structure parameter\(^4\). From the statistical verification of the obvious correlation arose a value of \(r = 0.81\). Despite the noticeable correlation a generally valid statement can hardly be made due to the limited number of investigation areas. Hence, this tendency can be considered solely as a hypothesis.

\(^4\) Housing index = terrestrial proportion of the flood prone area / developed area)
Finally it can be stated that the comparison between the meso and micro-scale damage potential showed some significant differences. Basically there is a tendency of an underestimation of the tangible assets by the meso-scale methodology. Merely for the capital of Kiel a contradictory ratio could be determined. While a significant correlation between the differences and spatial structures could be identified for the individual categories, there was no obvious regularity concerning the difference of the overall damage potential. Nevertheless, the absence of a uniform tendency of the differences and the limited number of investigation areas did neither allow the determination of a mathematical adaptation function nor the derivation of a correction factor to adjust the meso-scale results. The differences revealed by the comparison underline the justified demand of micro-scale studies for concrete planning purposes.

6. References


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