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Future perspectives for the Lower Elbe Region 2005–2030: Climate Trends and Globalisation

(Vom Fachbereich Geowissenschaften der Universität Hamburg im Jahr 2005 als Dissertation angenommene Arbeit)

Authoress:
I. Grossmann

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Iris Grossmann

175 pages with 29 figures and 13 tables

Abstract

This thesis investigates development trajectories for the Lower Elbe region until 2030 in the context of present global change processes, both in the natural and in the human environment. Of particular significance are a) the transition of the region to a post-industrial service economy, b) climatic changes, c) environmental degradation and the protection of the region's ecosystems, d) the influences of globalization and the framework of the European Union, and e) increased international competition between city regions against the background of population aging and shrinking. Due to the strong interdependence of these fields, consistent results regarding the future of the region cannot be made through the isolated study of just one or two of those fields. The choice of methods reflects this need to study the dynamic behaviour of different human as well as natural fields, and great emphasis is placed on the study of the interplay between the different fields. Applicability of the results has been sought through a stakeholder workshop and interviews with more than 50 experts and stakeholders.

The study is in four parts. In part I, climate change in the region with respect to changes in temperature, precipitation and storm surge levels and expected impacts on agriculture, port businesses and the river ecosystems are investigated through a localization of the IPCC A2 SRES-scenario. Part II presents two scenarios for the future viability of the rural part of the region against the background of structural changes and new environmental regulations as well as a policy analysis for agri-environmental programs and the establishment of naturally flooded areas. In part III a cost-benefit analysis for the port of Hamburg is carried out given technological change and the declining position of the port in the regional economy. Part IV presents firstly an assessment of urban renewal processes in Hamburg on the basis of a comparative analysis of different metropolitan regions in Europe. This is then combined with the results of the previous three parts into three integrated scenarios for the greater Hamburg region.

Identifying and implementing suitable responses to climate change is a common concern for regions worldwide. Climate changes occur simultaneously with other major changes related to economic development and urban renewal, population patterns, changes in politics, governance and attitudes. Both impacts of climate change and the space for response depend decisively on developments in these other fields. Therefore it is essential to investigate these issues in conjunction. On the basis of such an integrated analysis, the scenarios in part IV of the thesis describe different possibilities of response for the study region. The long-term outcome of different strategies and the interrelatedness of the different fields within which decisions and changes occur are made visible. As a conclusion to the scenarios, likely threats and problems for the region and recommended strategies are extracted. It is hoped that the results will be of interest to planners or decision makers involved with the creation of a highly viable and attractive future for the region.

Zukunftsperspektiven für die Untere Elbe Region 2005-2030: Klimatische Trends und Globalisierung

Zusammenfassung

Diese Forschungsarbeit untersucht Entwicklungsperspektiven für die Untere Elbe Region vor dem Hintergrund von Prozessen des globalen Wandels in natürlichen und sozialen Systemen. Hierzu gehören insbesondere a) der Übergang der Region zu einer post-industriellen Dienstleistungsgesellschaft,

b) Klimawandel, c) Belastungen der Naturräume und der Schutz der Ökosysteme der Unteren Elbe, d) die Einflüsse von Globalisierung und der wachsenden Bedeutung des Rahmenwerks der EU sowie e) die zunehmende globale Konkurrenz zwischen Stadtregionen vor dem Hintergrund von Bevölkerungsrückgang und -alterung.

In sich konsistente Aussagen über die Zukunft der Region müssen die gegenseitigen Abhängigkeiten und Wechselwirkungen zwischen diesen Bereichen berücksichtigen. Die Wahl der Methoden für diese Forschungsarbeit spiegelt diese Notwendigkeit, das dynamische Verhalten von menschlichen und natürlichen Systemen gleichermaßen zu untersuchen, und dem Zusammenspiel der Bereiche Rechnung zu tragen. Die gesellschaftliche Relevanz der Ergebnisse wurde durch einen Workshop mit regionalen Interessenvertretern und durch mehr als 50 Interviews mit regionalen Experten und Interessenvertretern unterstützt.

Die Dissertation erfolgte in vier Teilen: In Teil I wird Klimawandel in der Region bezüglich Änderungen der Temperatur, des Niederschlags und Wasserstandshöhen durch die Lokalisierung eines IPCC A2 SRES-Szenarios untersucht. Dies wird ergänzt durch einen Überblick über mögliche Folgen für die Landwirtschaft, den Hafen und die Flussökosysteme. Teil II untersucht Zukunftsperspektiven für das ländliche Teilgebiet der Region auf der niedersächsischen Seite vor dem Hintergrund von strukturellem Wandel, der Reform der Agrarpolitik der EU und neuen Umweltrichtlinien. Es werden zwei Szenarien für die Zukunftsfähigkeit des ländlichen Raums präsentiert, sowie eine Analyse der verfügbaren Agrar-Umweltprogramme und von Aspekten der Wiederherstellung natürlicher Überflutungsgebiete. Teil III untersucht Zukunftsperspektiven für Hamburg als Hafenstadt im Rahmen einer Kostennutzenanalyse vor dem Hintergrund der gesunkenen regionalen Bedeutung des Hafens. Teil IV präsentiert zunächst eine Aufstellung kritischer und strategischer Erfolgsfaktoren für städtische Erneuerungsprozesse und wirtschaftliche Entwicklung in Hamburg auf der Basis einer vergleichenden Analyse verschiedener Metropolregionen in Europa. Diese Ergebnisse werden dann mit den Ergebnissen der vorangehenden drei Teile der Arbeit zu drei integrierten Szenarios für die Metropolregion Hamburg kombiniert.

Die Entwicklung und Umsetzung von Maßnahmen im Umgang mit Prozessen des globalen Wandels ist eine der zentralen Herausforderungen und Aufgaben weltweit. Hierbei erfolgen Veränderungsprozesse in natürlichen Systemen, wie etwa Klimawandel, gleichzeitig mit Veränderungsprozessen in menschlichen Systemen. Hierzu gehören wirtschaftliche Entwicklung, städtische Erneuerungsprozesse, demografische Entwicklungen, politische Entwicklungen und Änderungen von Werten und Einstellungen. Entwicklungen in diesen Bereichen haben entscheidenden Einfluss auf mögliche Klimafolgen, sowie auf die menschliche Kapazität, ökologisch nachhaltige Entwicklungen umzusetzen, und auf Klimawandel zu reagieren. Umgekehrt beeinflussen die Qualität der natürlichen Umwelt die internationale Attraktivität und Entwicklungskapazität von wirtschaftlichen Regionen. Für eine Untersuchung regionaler Entwicklungsperspektiven ist es daher von größter Bedeutung, diese Bereiche gemeinsam und in ihrer wechselseitigen Abhängigkeit zu untersuchen.

Die in der Arbeit vorgestellten alternativen Szenarien für die Metropolregion Hamburg beschreiben Entwicklungsperspektiven, die auf einer derartigen integrierten Analyse beruhen. Die Szenarien veranschaulichen die langfristigen Konsequenzen verschiedener Strategien und die wechselseitigen Abhängigkeiten und Einflüsse zwischen den verschiedenen Bereichen. Ein zentraler Bestandteil sind kritische und strategische Erfolgsfaktoren für die Entwicklung der Metropolregion. Eine wichtige Schlussfolgerung aus den Szenarien ist die Herausarbeitung von wahrscheinlichen Problemen und Risiken für die Region, sowie von empfohlenen Handlungsstrategien.

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CONTENTS

PART IV: THREE SCENARIOS FOR THE GREATER HAMBURG REGION

PART V: SUMMARY AND CONCLUSIONS

1 Introduction and research question

1.1 Research objectives

The aim of this thesis is to investigate development trajectories for the Lower Elbe region until 2030 in the context of present global change processes. These include both changes in the natural and in the human environment – i.e. climate change, globalisation, the transition to a post-industrial society, demographic patterns, changing attitudes and changing legal frameworks. Developments in these fields are not independent of each other but mutually influence and depend upon each other. The dynamics arising from this interplay are at the core of this study.

The study region consists of the city of Hamburg and the surrounding districts – Harburg, Stade and Cuxhaven in Lower Saxony, and Steinburg, Pinneberg, Segeberg, Stormarn and Lauenburg in Schleswig Holstein. The first question investigated in this thesis arises from global climate changes. Due to the proximity of the region to the North Sea and the changed hydrological characteristics of the river Elbe in consequence of extensive river construction measures[1] over the last 180 years, sea-level rise and storm surges may put the region at risk. In addition, the rural part of the region, which is still quite dependent on agriculture may be vulnerable to changes in temperature and in precipitation patterns.

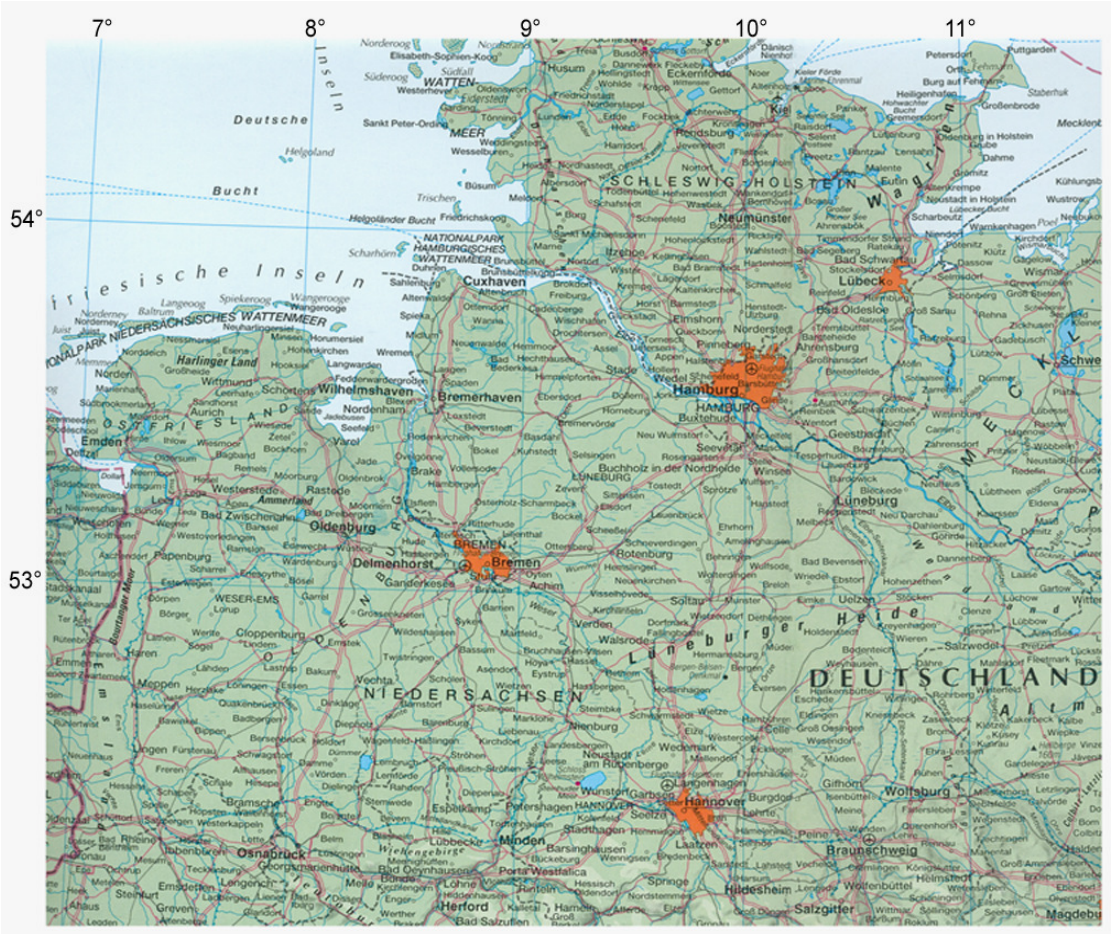

Figure 1-1: The region and its location in North Western Germany.

[1]These include river deepening, dike building, shoreline stabilisation and flood barrages at the river's sidearms (Siefert and Havnoe, 1988).

The region's vulnerability to both of these aspects of climate change is interlinked with choices towards different possibilities of socio-economic development and with political decisions. On the one hand, measures such as river construction that become necessary through port expansion alter the flow regime of the river, which in turn affects the region's susceptibility to flood risks. On the other hand, responses to climatic changes depend on people's *perception* of climatic risks, on policies – for instance to support the cultivation of hedgerows that improve soil moisture – or on negotiation processes as in the case of the establishment of natural retention areas that conflict with proprietary rights.

A major third aspect in addition to climate change and socio-economic dynamics concerns the ecosystems of the river basin. The river's freshwater mudflats, shallow water zones, islands, tidal creeks and other areas constitute highly valuable habitats to a large number of water birds, fish, plants and other species – some of them endangered or endemic to the region. These ecosystems are vulnerable both to climate change and to socio-economic developments. Therefore in our analysis, ecosystem concerns need to be connected with the socio-economic analysis and with climate change projections.

The second and third part of the thesis focus on specific aspects of socio-economic change. The fourth and final part combines this with the results of part I on climate change into three integrated scenarios for the region. The socio-economic, cultural and political changes that are expected to be of particular importance to the region's future can be summed up as follows:

- the transition of the region to a post-industrial economy and society,
- the influences of globalisation and the increased importance of the framework provided by the European Union, and
- the increased global competition between city regions, in particular against the background of population aging and shrinking in most developed countries outside the US.

The transition to a post-industrial economy and society throughout the industrialised world is marked by the shift to new economic sectors (Grossmann, 2000, Jorgensen, 2001, Jalava et al., 2002, Hutton 2004) – apparent in the clear decline of the share of Hamburg's manufacturing sector in jobs and value creation during the last two or three decades[2] (Gornig et al., 2003), a much more global orientation (Beriatos and Gospodini, 2004), a thinking in regions rather than in cities and nations, new criteria of attractiveness for these regions (Hubbard, 1995, Grossmann, 2000, Parkinson et al., 2004, Clark et al., 2002) and a closer integration of economic development with the improvement of the physical environment, the provision of urban amenities and the tackling of social problems (Carmon, 1999, Dekker and Kempen, 2000, Andersen and Kempen 2003). The challenge for metropolitan regions in the highly industrialised countries is to steer this transition process in such a way that the negative spin-offs are minimised and new opportunities are used. Negative spin-offs include high unemployment in established sectors – in particular goods manufacturing and established service industries –, increasing social polarisation and a rising crime rate, climatic impacts, the ongoing destruction of ecologically valuable areas within or close to densely populated areas, a decreased quality of life, and a weakened core city in conjunction with strong suburbanisation and population aging and shrinking. New opportunities arise from new information communication technology- (ICT-) based industries or other advanced service industries, and from a range of activities related to urban environmental renewal. Given the sharply increased worldwide competition between city regions it is absolutely crucial to invest

[2]In Hamburg, the share of this sector in the overall labour force[2] had dropped to 55.2 % of its 1970-level in 2003, while the service sector accounted for 83.2 % of the overall labour force (Statistisches Amt für Hamburg und Schleswig Holstein n.d and Statistisches Landesamt der Freien und Hansestadt Hamburg 2005).

in these fields at an early stage and to make efforts to establish the city's identity and competitiveness in the global or European context (Andersen and Kempen, 2003, Carmon 1999, Cochrane and Jonas, 1999, Beriatos and Gospodini, 2004). The challenge of locating and putting into action strategies of response that are informed by these developments, and that seek to minimize negative effects and to ensure the city's capacity to meet the requirements of a changing world are of core importance to this study.

For Hamburg these questions arise inter alia in the context of the traditionally highly port-centred nature of the city's economy and socio-cultural identity. Driven by the incisive increase in cargo especially since the late nineties, and by increasing competitive pressure through new requirements, the city continues to invest substantial sums into the port[3]. At the same time there has been a significant loss of jobs and value creation arising from port-dependent economic activities since the seventies and a further loss is expected. This is due to the effects of containerisation, rationalisation and automation, the integration of the transport chain and the shifting of port functions towards the shipper's and recipient's ends of the transport chain. Investigations commissioned by the city of Hamburg[4] establish a job-loss of between 16 % and 20 % between 1991 and 2001 in port-dependent sectors (compare section 16.1.3). At the same time overall turnover increased by 41 % (compare section 16.1). Arguably, job losses would have been much higher if the city had not registered such an enormous increase in turnover. However, one needs to ask whether continuing to put considerable financial resources as well as valuable inner city waterfront space into port development is the most efficient way for the city to preserve and create jobs, regional income and quality of life. This is the question motivating the analysis of port-development perspectives, port expenses and regional economic impacts in part III of the thesis. The observation that other, non-port related, sectors have grown much faster shows that such an analysis is highly needed.

It is crucial to note that Hamburg is not taking these decisions in isolation but rather within the context of sharply increased global competition between city regions. In particular in the advanced new sectors that are so indispensable to ensure a sustainable income for the region in the future, after an initial phase of rapid development certain regions emerge as strongholds of the respective new sectors while other regions are left behind (Porter, 1999 and 2000, Archibugi and Iammarino, 1999). Successful regions are characterized by a critical mass of companies in the respective fields, a large labour pool of highly skilled workers, suitable education and research facilities and generally a good reputation for the new field (Haug and Ness, 1992, Hall, 1997, Grossmann, 2000, Hutton, 2004, Läpple, 2004, Wolfe, 2005). This requires a range of costly measures – both economic measures and measures related to education, research or quality of life – as well as the clear communication of the city's interest in and support of new sectors. Hamburg is presently investing in the establishment of new economic sectors and in several large scale city development and urban renewal projects such as the Hafencity, the 'Wachsende Stadt' and the integration of the city's south. However, these projects are in sharp competition with the grand scale port development plans for the city's very limited financial resources – and possibly also on a less tangible level for people's mindsets. Our scenario analysis in part IV is motivated by the need to set the diverse development possibilities arising from different investment strategies and decisions in contrast to each other.

[3]The city plans to invest 746 million Euro between 2005 and 2009 to modernise existing terminals and to begin the construction of a new terminal, to improve transport connections and to pay its share of the Federally financed next Elbe deepening.

[4]A summary of the results from the study of 1991is given in Pool, 1993. To the author's knowledge there is no published material on the study from 2001.

Globalisation and structural change also have considerable impacts on the rural part of the region. The declining profitability of the agricultural sector, the EU extension to the East, and new EU-wide regulations through the reform of the Common Agricultural Policy and new environmental directives exert increasing pressure on the rural, highly agricultural structures. Again these changes do not evolve in isolation from other regional dynamics. Important interconnections include climate change, migration and commuting patterns, environmental impacts and – maybe most importantly – the growing need for spatial and economic planning for the region as a whole, taking into account global and regional changes. These questions motivate the investigations in part II of the study.

In terms of geographic scope, high importance is placed in this study on analysing both the city and the rural areas. Also, as outlined above, changes in the natural environment and changes in the social, economic, cultural and political spheres are both considered and seen in their interrelatedness. In doing so, the intention is twofold. Firstly, I intend to provide results on the meaning of global changes for an exemplary region, on risks, bottlenecks and opportunities and on *different* possibilities for an adequate response. Secondly, in depicting the development trajectories and the associated policies I aim to achieve a high degree of realism and usefulness to regional decision makers. This second aim in particular presupposes an interdisciplinary approach that is able to take into account and combine the dynamics of very different fields that mutually influence each other. It is hoped that the results will be relevant for regional planning and will offer a special view on global changes through investigating the impacts caused on the very different structures of a metropolis and of rural areas.

1.2 Structure of this study

The study consists of four parts. In the first part, climate changes in the region until 2030 are investigated (sections 4.1, 4.2, 5.1 and 5.2), together with expected impacts on the region's agriculture, the river ecosystems and the port of Hamburg (sections 4.3, 5.3 and 6.2). Possibilities for farmers and regional decision makers to respond to the projected impacts are also explored. This is complemented by an introduction to the Elbe ecosystems and the most significant environmental impacts in the last few decades (chapter 6). These results will inform the in-depth study on perspectives for the rural area in part II of the thesis and the scenarios in part IV. The conclusions of part I are summarised in chapter 7.

The second part investigates future perspectives for the Lower Saxon rural part of the region against the background of structural change, new environmental protection requirements and the reform of the Common Agricultural Policy of the European Union. This includes an introductory background section (chapters 8 and 9), a description of the methodology (chapter 10) and two scenarios for the rural area that were developed as possibilities of response to current challenges by the participants of a Focus Group (sections 11.2 and 11.3). In chapter 12, possibilities of response to climate change and approaches to dike relocation are presented. Chapter 13 presents the conclusions.

In part III, trade-offs between the costs of the port of Hamburg and its contribution to the regional economy and quality of life are assessed. A summary of the current situations and of relevant developments in the last few decades is given in chapters 14 and 15, together with a description of the methodology used. In section 16, benefits due to the port are assessed against the background of expected future developments. Direct, indirect and opportunity

costs due to the port are assessed in section 17. Chapter 18 presents the conclusions of this analysis.

In the final part, three scenarios for the greater Hamburg region will be developed based on the results of the preceding three parts as well as on new elements. In section 20.1, an overview of current approaches in urban renewal is given. The role of scenarios within science and the scenario methodology employed here will be introduced in section 20.2. The scenarios are based on our assessment of the current baseline situation in the region. Chapter 21 gives a summary of the baseline together with an extrapolation of critical and strategic success factors and recommended strategies for the region. The three scenarios are presented in chapter 22, followed by conclusions in chapter 23.

A final chapter presents the conclusions of the four parts of this study. Central points are risks, opportunities and in general the outcome of different development scenarios for the region, interdependencies between the different driving forces and a brief assessment of the suitability of the methodologies employed.

1.3 Overview of the methodology

This research topic is highly interdisciplinary and requires the usage of both qualitative and quantitative tools from the natural and social sciences. Also the four parts of the study differ in orientation and intention. Parts I and III are more quantitative while parts II and IV necessitate the in-depth treatment of "qualitative" elements such as people's concerns and attitudes or political motivations. Consequently very different methods have been used throughout the study. We will describe these in the following.

Methodology for Part I:

To obtain projections of possible water levels in St. Pauli, Hamburg in 2030 in a scenario of relatively strong climate change, results from a scenario of storm surge levels at the North Sea coast between 2070 and 2100 are projected onto St. Pauli and on the time horizon 2030. The scenario for the North Sea coast is provided by the regional climate model CLM (Woth et al., 2005) on the basis of the A2 IPCC SRES-scenario. The projection of the results for St. Pauli involves two steps:

1) The establishment of a statistical function to relate water levels at the coast to water levels in Hamburg, St. Pauli. We do this by minimising the difference between a linear-quadratic function of water levels at the coast in the interval 1980–1990[5] and water levels in St. Pauli.
2) The estimation of water levels in an A2-scenario in 2030 given water levels in the same scenario in the interval 2070–2100. Towards this end, we assume a development of storm surge heights parallel to the increase in temperature in the global A2-scenario.

This second approach is also employed to obtain scenarios of temperature and precipitation pattern changes for the time horizon 2030 from data provided by the PRUDENCE data archive for the time horizon 2070 to 2100. In a next step, structured interviews on expected climate change impacts were conducted:

1) interviews with shipping companies on possible risks through rising water levels in the port of Hamburg,

[5]This interval has been chosen as the high water level has been relatively constant during this time (compare chapter 4).

2) interviews with farmers and a dike reeve on their expectations of impacts on agricultural production given our projections for changes of temperature and precipitation in the A2-scenario, their perception of flood protection and possibilities of response to these changes, and
3) interviews with natural scientists, a nature conservation representative for the region[6] and an organic farmer with a background in environmental sciences on possible impacts of the projected scenario of climate change on the Elbe ecosystems.

Methodology for Part II:

The main methodologies for Part II were a Focus Group with farming representatives and farmers, environmental and flood protection, and local administration and a subsequent series of face to face interviews with selected participants. During the Focus Group meeting, two scenarios of response to changed requirements and new opportunities were developed. For each, bottlenecks and policy-requirements were identified. In addition, possible approaches to dike relocation were discussed. These results were supplemented with the results from the interviews conducted on climate change impacts for part I.

Methodology for Part III:

The analysis of costs and benefits due to the port employed an extensive literature and data analysis together with structured interviews with 20 port experts and semi-structured interviews with experts in city development. These included representatives of shipping companies and port businesses, port authorities and port researchers. The research in this part of the thesis had to deal with major knowledge gaps concerning in particular quantitative data on the port – e.g. direct expenses, indirect expenses, port-dependent jobs, regional income – as well as more qualitative data – e.g. the competitive situation of the Northern German ports, regional impacts of the port.

Methodology for Part IV:

For the scenarios, the results of the previous parts of the thesis were combined with new elements into an extensive analysis of the present situation in the region. This concerns in particular present and near future problems, risks and chances. Elements of the investigation carried out explicitly for this part of the thesis were a comparative analysis of the situation in the region and in other city-regions based on literature and data, and 24 semi-structured expert interviews[7] with leading experts from the relevant fields. This allowed the compilation of critical and strategic success factors that served as basis for the scenarios.

[6]German "Naturschutzbeauftragter", compare footnote 34 of chapter 3.
[7]Part IV also benefited from the interviews carried out for the other parts of the thesis. Altogether more than 50 structured or semi-structured interviews with regional experts and stakeholders were carried out.

2 Literature review

In this chapter we will provide a summary of existing results in literature on climate change and the Elbe ecosystems, perspectives for the rural part of the region, urban renewal and economic development in Hamburg, the regional context and port development. Each topic concludes with the identification of questions that require further investigation and indications where this will be carried out in this thesis.

2.1 Climate change and the Elbe ecosystems

To the author's knowledge, there is no investigation of climate change and its impacts in the region. Impacts of different river construction and deepening measures on the height of storm floods and on the sufficiency of existing flood protection have been investigated by various authors (Siefert and Havnoe, 1988, Lenkungsausschuss Sturmfluten Elbe, 1983, Freie und Hansestadt Hamburg and Wasser- und Schifffahrtsamt, 2002). Heinzelmann and Heyer, 2004 present a preliminary investigation of the expected impacts of the next Elbe deepening. The results are listed in Table 2-1.

	Siefert and Havnoe, 1988	**Lenkungs-ausschuss, 1983**	**Freie und Hansestadt Hamburg et al., 2002**	**Heinzelmann and Heyer, 2004**
River construction measures[8] 1950–1983	50–60cm			
Dike building[9]	20–55cm	10cm		
Elbe deepening 1950–1977[10]: NWL	20cm			
Elbe deepening 1950–1977: HHF	10–15cm			
Last Elbe deepening: NWL			4cm	
Last Elbe deepening: HHF			<1.5cm	
Planned next Elbe deepening: HHF				No change.

Table 2-1: The impact of river construction measures on the height of high floods (HHF) and on normal water levels (NWL) according to 4 different sources.

Several sources describe the present and historical ecological value and importance of specific Elbe ecosystems as habitats for a large number of species – including endangered and endemic species (Grimm, 1982 and 1983, Freie und Hansestadt Hamburg, 1993, Kausch, 2002, Mischke, 1997 and Mischke and Garthe, 1994). In Grimm 1982 and 1983, requirements for the functioning of the river ecosystems are also investigated. These include the existence of a large littoral, extended mudflats, tidelands and side-arms and the natural flooding of marsh land in winter. All of these have been severely diminished by river construction and dike building measures that took place mostly during or after the sixties (Grimm 1982 and

[8]This includes: the construction of the barrage in Geesthacht, the closing off of side-arms, dike building and river deepening (compare section 6.1).
[9]The list of dike construction measures considered in Siefert and Havnoe, 1988 is much more inclusive than that of Lenkungsausschuss Sturmfluten Elbe, 1983.
[10]Between 1950 and 1977 the Elbe was deepened three times, altogether from 10 to 13.5 m.

1983, Arge-Elbe 1984, Planungsinstitut Küstenregion, 1988). The latter two sources present more long-term overviews of river construction measures over the course of several centuries as well as the consequences for the river ecosystem. Arge-Elbe, 1984 also presents a detailed explanation of the river ecosystem functions.

Measures to improve the ecological and aquatic state of the river ecosystem are discussed in great detail in Arge-Elbe, 1991 and 1994. This analysis includes the suggestion of suitable sites for specific measures, the specification of the type of measure and detailed instructions on how to conduct the measures (see section 21.2.1 for details). Recent results on the implementation of the EU Water Framework Directive are presented in Arge-Elbe, 2004a. Several sources provide information on the present state of the river, the impacts of recent measures and expected ecological impacts of the planned next Elbe deepening: BUND, 2005a, Freie und Hansestadt Hamburg and Wasser- und Schifffahrtsamt Hamburg, 2002, Freie und Hansestadt Hamburg et al., 1998, Kausch, 2000 and 2002, Roberz, 2003, Thiel and Pezenburg, 2001. Results on toxic substances or nutrients in the river are regularly published by Arge-Elbe, see for instance Arge-Elbe, 2000a and Arge-Elbe, 2001. Changes in the concentration of dissolved oxygen in the river have been investigated in Arge-Elbe, 2004b. Surveys of the fish stock are found in Arge-Elbe, 1995 and Arge-Elbe, 2000b. A number of agri-environmental programmes to protect the river ecosystems have been set up in recent years. To the author's knowledge there is no published research on the more recent developments within the region in this respect. Results of different working groups between 1986 and 1996 on regional development who also discussed the protection of ecologically valuable areas in Kehdingen (compare Figure 8-1) are summarized in BUND, 1997.

This leaves the following main open questions:

1) What are the expectations for climate change in the region and what could be the environmental and economic impacts? This question will be investigated in part I of the thesis and in chapter 12 (part II). Climate change considerations also constitute an element of the scenario analysis in part IV.
2) Very little of the specified ecological and aquatic measures have been actually carried out – including compensation measures for river deepening, the carrying out of which is actually legally binding according to the Federal Law on Protection of the Natural Environment (Federal Republic of Germany, 2002). In addition, agri-environmental programmes are usually designed on the level of Federal states or on the national level so that region-specific environmental aspects cannot be included – which results in a lessened effectiveness of the measures.
   Thus we have the following three questions:
   i. What are the main obstacles for the carrying out of ecologically valuable measures?
   ii. How could agri-environmental programmes be improved in such a way that farmers' concerns, needs and traditional rights can be better taken into account and the acceptability of the programmes is raised?
   iii. Which improvements to existing programmes could be made in order to better address region-specific environmental characteristics and effectively protect the region's unique ecosystems?

   These questions will be investigated in part II of the thesis.

2.2 Urban renewal and economic development in Hamburg

2.2.1 City development, urban renewal and housing

Firstly, general literature on the major present projects of city development and on urban renewal in specific city quarters is of interest. Literature on the development of the Hafencity is mainly provided by the GHS Hamburg Port Area Development Corporation (e.g. the Masterplan: GHS, 2000 and GHS, 2002). Zukunftskonferenz Wilhelmsburg, 2002 and Breckner and Gonzalez, 2003 present an analysis of the weaknesses, qualifications and potential of the Elbe island city-quarters (Wilhelmsburg and Veddel) and of possible approaches to problems. A central measure suggested here is the development of a Masterplan for the Elbe Islands. A very brief overview of the development of Channel Harburg is given in Koch, 2001, a more elaborate overview in Bezirksamt Harburg, n.d. The latter also includes a brief summary of the development of Harburg in recent years and the interplay of developments in ICT, research and education – e.g. in the Technical University of Harburg and the MAZ (microelectronics applications centre), urban development and architecture, and living and recreation.

More specific is the presentation of the results of the International Design Workshop "Leap Across the Elbe" which took place in 2003 (Freie und Hansestadt Hamburg, 2003b). During the workshop, five projects contributing to the development and integration of Hamburg's South were designed. In addition, selected economic and historical aspects are discussed. The projects developed at the Design Workshop were

- the Brückenschlag (building bridges): the connecting of port-adjacent sites like the Grasbrook and Reiherstieg to the Hafencity in the North and Harburg in the South;
- the structural renewal of the area Reiherstieg through the establishment of commercial buildings, waterfront housing and recreation;
- the restructuring of the link between Wilhelmsburg and Harburg ("leap across the Süderelbe");
- an overall concept for the eastern edge of Wilhelmsburg (the "urban fringe") such that the abundant green spaces and fragile ecosystems are preserved and
- a development plan for the centre of Wilhelmsburg.

Additional projects that are already underway are also presented: the anticipated International Garden Show on the Elbe Islands in 2013, the initiative "Wachsende Stadt", city quarter development in Veddel and the results of the people's initiative "Zukunftskonferenz Wilhelmsburg".

A very good analysis of housing needs anticipated for approximately the next 2 decades is given in Empirica Institute, 2001. Despite the anticipated population shrinking, the number of households is expected to increase until 2010 or 2015 due to changing housing preferences. According to this study, the city's economic perspectives, attractive housing offers for people of an average income level, owner-occupied houses and flexibility with respect to changing preferences are of crucial importance to counteract population losses through suburbanisation and migration patterns.

2.2.2 Economic development and international attractiveness

A very comprehensive assessment of the labour market in Hamburg and trends of change during the last two decades (1980–1997) is presented in Läpple and Kempf, 2001. This study uses functional clusters[11] instead of the traditional classification of industrial sectors in order to make the present situation and shifts and trends in the labour market more visible. Particular emphasis is put on the examination of differences between the labour market in the city's core and in the periphery and on a comparison of the labour market in the metropolitan region with that of 12 other German metropolitan regions. Core results are:

- The high proportion of commuters in Hamburg (1/3 of all workers in 1997), which together with immigration and an increase in economically active women led to the decoupling of the unemployment rate and the number of employed people[12].
- Significant job losses between 1980 and 1997 occurred in all manufacturing or agricultural activities as well as in trade, storage and transport[13]. The most sustained increase occurred in the clusters consulting/ information, education/ training, medical care, research/ development/ design and advertisement/ entertainment/ media. In particular the latter is of high strategic importance for Hamburg.
- The overall number of jobs in the periphery has increased by 24.6 % from 1980 to 1997 while the overall jobs in the core city decreased by 4.6 %. In fact, the periphery showed higher increases or smaller losses than the core city in all clusters considered.
- While in other German metropolitan regions the periphery also shows a more positive development than the core city, this gap is particularly pronounced in the case of Hamburg.
- In nearly all of the clusters considered, Hamburg shows an average proportion of employment in comparison with the other metropolitan regions considered. In the clusters consulting/ information and research/ development/ design which are strategically very important due to their high significance for a region's know-how and innovative capacity, Hamburg takes place 11 (out of 13 city-regions). The only cluster where Hamburg has a leading place – ranking second with Munich being first – is advertisement/ entertainment/ media.

The strategically important new media sector in Hamburg is investigated in Läpple et al., 2004 against the background of Hamburg's particular affinity with this sector due to its historically strong qualifications in print-media and in international trade. Differences in organisation and requirements of this sector in comparison with traditional manufacturing sectors are investigated, for instance the need for more flexible, project-orientated organizational structures and a higher degree of academic qualification, the importance of networks and a critical core of companies and workers in this sector. These requirements will be included into our strategic success factors in section 20.5.

Menze and Ossenbrügge, 2000 analyse Hamburg's labour market in the context of changing global frameworks, in particular tertiarisation and the formation of Global Cities. Emphasis is put on the investigation of differences on the level of city quarters. Hamburg's city quarters are sorted into four different types of clusters that respectively consider: jobs offered on the labour market, urban qualities, and overall and sectoral demand on the labour market. The

[11]The actual *tasks performed* are considered and similar tasks as well as similar levels of requirements are grouped together into one cluster.
[12]This means that the unemployment rate has been rising despite an increase in the number of employed persons.
[13]The latter four showed an increase from 1987–1992 due to the German re-unification, but a clear overall loss from 1980–1997.

biggest structural problems are found in the traditional working-class neighbourhoods near the port (e.g. Wilhelmsburg, Veddel, St. Pauli and parts of Altona) as well as in some central city quarters (e.g. St. Georg, Horn, Hamm). For these city quarters only integrated concepts that tackle different types of problems are expected to be successful. Three basic orientation are recommended for labour market policies:

- The development of locally oriented policy complexes that take into account spatial differences in Hamburg's labour market and the living situation of the population of problem quarters and of specific target groups.
- Integrated policies: strategies to develop new job potentials should be combined with strategies that promote social integration and the strengthening of deprived groups and with strategies for the revitalisation of the city quarter as such.
- The policies should be empowering and as bottom-up as possible and represented in local offices. Cooperation and networking between businesses and specific agents on the labour market (e.g. trade-unions, trade associations or sectoral planning agencies) should be encouraged.

Handelskammer Hamburg, 2000 compares Hamburg's economic position and international attractiveness with that of seven other German metropolitan regions. Core results are:

- With respect to value creation and productivity, purchasing power and proportion of the service sector, Hamburg ranks in the middle part of the spectrum (Munich, Frankfurt and Berlin are at the upper end).
- In the important areas of patent applications, number of scientific and research institutions, education and qualification of the workforce[14], international courses of study and number of personnel in universities and research Hamburg takes place 7, 6, 6, 6 and 4 respectively (out of seven considered regions).
- Hamburg has a slightly above average travel-time to important German cities via rail and a relatively long combined road/air travel-time to major European cities: places 5 and 7, respectively, out of eight city regions. Hamburg's connection to large intercontinental airports is insufficient.
- Hamburg's position as city of exhibitions, trade shows and congresses is in the middle to lower part of the spectrum. However, Hamburg takes a leading position with respect to theatre and musical visits.
- The city has a substantial share among the principal offices of the 500 biggest German companies, even though particularly well-known German companies and Global Players are under-represented and none of the 30 companies covered by the DAX[15] has its headquarters in Hamburg. Hamburg takes place 7 and 5 respectively as domicile for insurance companies and banks.

Further important material on the comparative position of the Hamburg region is found in a variety of available city rankings. In international rankings Hamburg usual ranks in the third or fourth out of four categories (the first category lists Global Cities like London or New York, the second outstanding international cities such as Paris, Tokyo or Singapore and the third internationally highly attractive cities like Amsterdam, Brussels, Milan or Frankfurt). In two exemplary rankings for European cities – Parkinson et al., 2004 and Cushman & Wakefield, 2004[16] – one or more German cities rank above Hamburg in all categories. While

[14]The criteria used here is the percentage of the workforce with a completed apprenticeship or graduation, not the quality or modern orientation of people's qualification.
[15]the German stock index.
[16]Cushman & Wakefield, 2004 compares 30 European cities, among them 5 German cities (Berlin, Munich, Frankfurt, Hamburg and Düsseldorf). Parkinson et al., 2004 compare different sets of cities (61 European cities and 15 "core" European cities) as well as sets of regions – here Hamburg is among the 61 Europena cities but not

Hamburg does have a high percentage of employees in the service sector and a good presence in new media, medical technology and nanotechnologies, it is not a leader in these or in ICT-industries in general and is assigned a comparatively low score of "innovative strength"[17]. The city also receives an average to low score for its success in promoting itself as business location, for the business climate created by the city's government and for the city's external transport links – in particular via the airport. With respect to quality of life, different reports disagree on Hamburg's score; it seems that with new smaller German cities acquiring international popularity (for instance Düsseldorf) and other cities maintaining a clear leadership position (Munich, possibly Frankfurt) Hamburg needs to reassert its position.

A comparative investigation of the innovative position of Northern Germany that draws upon several other national and European studies and also recommends strategies to improve Hamburg's competitive position is presented in Keller et al., 2004. With respect to innovative power, Hamburg performs rather moderately – taking for instance place 27 out of the 148 regions that were assessed for the European Commission's "European Trend Chart on Innovation" (European Commission Directorate-General Enterprise, 2002). The number of personnel in research and development both in universities and in other research institutions has fallen by 9.4 % between 1991 and 1999. The recommendations made in this study are included into our list of recommended measures in section 21.5.1.

2.2.3 Integrated studies on urban renewal

The need for comprehensive planning for the region as a whole – encompassing economic development, environmental and flood protection, regional governance and urban management issues – has been recognized already in the eighties[18] when public officials and researchers from Hamburg, Schleswig Holstein and Lower Saxony formed the "Enquete Commission Lower Elbe". The work of the Commission was subsequently published in a report on possibilities to improve the economic and environmental situation of the region (Freie und Hansestadt Hamburg, 1986).

An up to date and very comprehensive investigation of urban renewal in Hamburg is the statement of the "Zukunftsrat Hamburg"[19] on the "Wachsende Stadt" (Zukunftsrat Hamburg 2002). The different components of the Wachsende Stadt are critically assessed on the basis of the principles of sustainability and the Aalborg Charter. Possibly the main point of criticism is the lack of treatment and valuing of the social and environmental dimensions of sustainability. The concept with which Hamburg had won the Federal competition "Regionen der Zukunft" (regions of the future) in 2000 had included all three dimensions of sustainability – economic, environmental and social aspects. At present, however, social sustainability seems to be considered solely a (desirable) side-effect of economic success, and the promotion of families, culture, education, science and environmental protection is regarded solely as necessary input for economic growth. A further point strongly emphasized

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among the 15 core cities. Both use a range of factors relevant for business and quality of life as well as selected environmental indicators.

[17]Defined in Parkinson et al., 2004 as the product of a number of factors such as employment in the high-tech sector, high-tech patents, public and business R&D expenditure and education.

[18]To the author's knowledge, earlier studies for the metropolitan region that date back to the sixties were much more monodisciplinary in nature, focusing for instance on settlement and planning questions (e.g. the "Entwicklungsmodell für Hamburg und sein Umland", 1969 – compare Mensing, 1997).

[19]The Zukunftsrat is a voluntary association of unions and organisations, businesses and citizen's initiatives that aim to play a part in Hamburg's politics in the spirit of the Aalborg Charter. Public participation and networking, innovative power and creativity and in general people's scientific, technical, cultural and social competences are encouraged and statements and reports on the city's politics, in particular in the context of social, environmental and economic sustainability are published on suitable occasions (www.zukunftsrat.de).

is the need to prioritize public participation. In particular there needs to be confidence that the ideas developed by the public will be taken into account by the respective decision makers.

Of great value for any investigation of urban renewal and for the international repositioning of Hamburg is Altrock and Schubert, 2004. This is a critical discussion of city renewal projects worldwide which devotes seven chapters to the case of Hamburg. A starting point for the editors is an elucidation of the ambitiousness and grand size of urban renewal plans in Hamburg against the background of population shrinking and nationwide economic depression. After a presentation of the vision statement and initiative "Wachsende Stadt" by Hamburg's present mayor, the following aspects of Hamburg's situation are investigated in a chapter each:

- A critical assessment of central aspects of the "Wachsende Stadt" (construction of housing, economic policy, the mixture of uses in the Hafencity, and governance structures) based on a comparison with other metropolitan areas,
- possibilities to improve the development, marketing and usage of industrial areas,
- regional cooperation and regional governance,
- aspects of the development and integration of Hamburg's south,
- the development of the new media sector in Hamburg and
- a critique of the city's realisation of "intelligent growth".

Suggestions made in this source on the improvement of present urban renewal approaches in Hamburg have been adapted where possible for section 21.5.

2.2.4 Open questions

Most aspects of urban renewal have been investigated in quite some detail. This concerns in particular the available material on practical measures to further city development and revitalisation. In our scenarios we aim to extend these results in particular in two respects:

1) Interdependencies between the different fields such as city development and economic development will be made more clearly visible. These interdependencies are crucial to the actual implementation of current projects and of measures suggested in literature. Success in either of these areas generally necessitates an improvement of the other areas, while at the same time each area competes with the others for the city's limited resources.
2) The long-term outcome of measures, decisions or projects due to large-scale global change is taken into account and made visible. This is important as regional decisions and developments do not evolve in isolation but against a changing global framework which may significantly alter the outcome of regional decisions.

In addition we offer a systematisation of the suggested strategies and of critical and strategic success factors in section 21.5.

2.3 The regional context and perspectives for the rural area

An overview of the "Regional development concept" (RDC) is given in Gemeinsame Landesplanung, 2000 and in Lenkungsausschuss, n.d. The RDC is an initiative for comprehensive planning and efficient projects for the region as a whole that came into existence in November 1991. The Lenkungsaussschuss also offers quarterly newsletters on current projects, initiatives and new decisions.

Attempts of cooperation between the Northern German Federal states date back to around 1900. Very good presentations of the historical development of cooperation processes in the region are given in Scharpf and Benz, 1991 and Mantell and Strauf, 1997. Scharpf and Benz, 1991 also include a discussion of different possibilities for more effective cooperation and

their respective advantages and bottlenecks. Both sources emphasize that changes through the RDC are occurring (and have to occur) on the level of informal networks, since the concept does not involve binding guidelines for the involved municipalities or governments, an institutional framework or actual changes in governmental competencies. Interestingly, present restructuring processes are giving the RDC a more binding quality (Lenkungsausschuss, 2005). Of interest are also the analyses of Mensing and Thaler, 1997, Walter-Roog, 2004 and Fürst, 2002. Mensing and Thaler, 1997 investigate processes that are crucial to the current regional situation – in particular suburbanisation and migration to the outskirts and the consequential population, tax and jobs losses. The analysis is carried out in particular detail for selected administrative districts. Walter-Roog, 2004 and Fürst, 2002 compare processes of regional cooperation and metropolitan governance in different German cities and elucidate some peculiarities of the case of Hamburg.

To the author's knowledge, there is no up to date investigation of development perspectives specifically for the rural area. An example of a very comprehensive study undertaken some 20 years ago that also investigated agricultural development perspectives is the report of the "Enquete Commission Lower Elbe" (Freie und Hansestadt Hamburg, 1986). A possible reason for the lack of up to date literature may be that the approach of improving the perspectives of rural spaces through diversification into tourism or agri-environmental programmes (Osterburg, 2001, Lütz et. al., 2002, Marggraf, 2003, Prager et al., 2004) is a relatively new idea. In part II of this study, aspects of this approach in the chosen study region will be discussed, together with two scenarios that aim to secure the region's viability.

2.4 Port development

2.4.1 Development perspectives for the Northern German ports

To date there is no real deep water port in Northern Germany. The construction of a new deep water port in Wilhelmshaven on the North Sea coast to the West of Hamburg is presently beginning. Cuxhaven has previously been considered as alternative location. In Berger et al., 2000, Wilhelmshaven is recommended as location for the new port on the basis of water depth and accessibility, the overall port concept, the available space for expansion, the modal split and hinterland connections, the costs of the terminal and hinterland infrastructure, the possibility to mobilise private capital, regional economic benefits and environmental impacts. The need for a German deep water port is investigated in Sichelschmidt, 2001. According to this study, a new deep water port may be necessary due to the restrictions of the tidal window in Hamburg and Bremerhaven combined with the expected increase of container turnover in North-Western Europe. Wilhelmshaven is concluded to be a slightly advantageous location for the new port. According to this study, the expected loss of market shares for the established German ports is not insignificant.

Planco, 2000 investigates the necessity of a Northern German deep water port. Expectations for an increase in ship-size are estimated based on cost calculations, an assessment of the draught permitted by ports worldwide and by the Suez and Panama canal, and interviews with respective shipping companies and port operators on their strategic plans[20]. Further inputs are expectations of economic growth and the development of trade, in particular container turnover for the different ports. It is concluded that ships between 10.000 and 12.000 TEU can be expected for the not too far future[21]. However, according to this study, ships of 12.000

[20]Thus, a technical analysis of feasible ship-sizes is not employed here (compare our analysis in section 15.2).
[21]Compare our analysis in section 16.1.2.2.

TEU will only be profitable with a high capacity utilisation rate. Multi-port strategies are concluded to be more profitable than Hub and Spoke strategies[22]. It is also shown that if ships are used that cannot call at a German port due to their size, inland transport via Rotterdam will become more profitable than transport via a Northern German port for areas in Europe of considerable size.

ISL, 2000 investigates development perspectives for the Northern German ports, both individually for each port and in the form of two overall scenarios for the group of ports until 2015, respectively with and without a new German deep water port[23]. The study draws upon economic data, interviews with port authorities, terminal operators, shipping companies and other experts and a workshop. Competition is expected to take place mainly between Hamburg, the Bremen ports, Rotterdam and Antwerp with the tendency of market shares to shift to Rotterdam if ship-sizes increase significantly. If a new deep water port is constructed, container turnover in the new port may reach 0.4 million TEU in 2010 and 1.8 million TEU until 2015. This increase is mainly due to a shift of market shares from the Dutch and Belgium ports; Hamburg and the Bremen ports are expected to lose small market shares of 200.000 and 100.000 TEU respectively[24].

2.4.2 Economic impacts of the port

An investigation of job- and value creation attributed to the port has been commissioned by the city of Hamburg in 1991, followed by a new study in 2001. Both studies are not publicly available, although selected results may be quoted (compare Pool, 1993). The methodology involves an extensive interview process with businesses in port-dependent or port-related industries. The study of 1991 registers 142.621 overall port-related jobs within the city-boundaries. In the study of 2001, between 112.321 and 124.707[25] port-related jobs are identified, of which 63.963 are classified as "port-economy"[26] and 16.963 as "port-

[22]A problematic assumption made is that in a Hub and Spoke system, transport from the main-port takes place exclusively on feederships that travel to the other bigger ports and from there to other destinations. However, there may be destinations that were formerly supplied with inland transport via one of the other big ports, but are now more efficiently supplied with inland transport from the main port. There may also be smaller ports (e.g. in the Baltic) that were formerly supplied with feederships via the nearest bigger port and can now be supplied directly from the main port.
A second critique is that in the Multi-port strategy the ship will likely not be fully loaded while travelling between the different European, respectively Asian ports. Travelling between the European ports considered in this study accounts for approximately 6–7 days and travelling time between the Asian ports for approximately 13–16 days (own calculations on the basis of Baird, 2002a and schedules of exemplary shipping companies – e.g. Hyundai: http://www.hmm21.com/hmm/ebiz/schedule/local_schedule/List.jsp?nation=EU or Cosco: http://www.cosco.de/en/services/far_east/. This includes travel time, time spent in the port and the tidal window of the Elbe). This would change the utilisation rate from, for instance 90 % to about 78.9 % (if we assume a travel time of 16–18 days between the last European and the first Asian port and a utilisation rate of 70 % between the European, respectively Asian, ports). This implies considerable additional costs that are not included in Planco's Multi-port strategy. It needs to be checked whether the Hub and Spoke strategy continues to be more profitable when these points are taken into account.

[23]When this report was written the construction of a German deep water terminal was being discussed for both Cuxhaven and Wilhelmshaven and no final decision had been taken yet.

[24]This contradicts the results of Sichelschmidt, 2001, according to whom the expected losses of market shares for the established German ports due to Wilhelmshaven are not insignificant.

[25]The study of 2001 employs a new methodology to estimate port dependent jobs, leading to quite different results. According to the new methodology, there were 124.707 port-dependent jobs in Hamburg in 2001. If the methodology used in the study of 1991 is employed, this number is reduced to 112.321 (Kerstan, 2005). This implies a job loss of 21.1 % instead of 16.1 %, thus the loss is actually higher if the older methodology is used (compare also section 16.2).

[26]This includes: stevedores, transport and storage functions, bank, insurance and accident assessors, public administration and customs as well as wholesale.

industries"[27]. The production of intermediate inputs and capital goods create 31.878 and 6.860 jobs respectively. The remaining 5.044 are due to consumer spending. A comparison of the results of the two studies[28] establishes significant job-losses in port-dependent sectors between 1991 and 2001. This will be further discussed in section 16.2.

The trends leading to these job-losses have been investigated by Läpple and Deeke in a number of studies (Läpple 1998, Läpple and Deeke, 1990 and 1996, Deeke, 2001). The main trends are containerisation and rationalisation, the integration of the transportation chain and maybe most importantly the economic shift to post-industrial industries. This means that transport and value creation have become decoupled. Sectors such as logistics have lost their strong port-dependency. The profitability of traditional port-functions has decreased significantly. Läpple, 1998 observes that ports are faced with the choice to either degenerate into a "container floodgate" with very little associated jobs or to develop into a "logistic service centre". However, even the activities associated to a "logistics service centre" are no longer necessarily port-dependent (compare paragraph e) above and Läpple, 1998). Thus the growth of turnover and transport functions since approximately 1990 has not led to a corresponding growth of jobs and added value. Ports are no longer the economic engines of port-cities or port-regions. Investments in ports are giving a much lower financial return than they used to give just two decades earlier.

A related point is the widening gap between costs, investments and the use of resources and space on the one hand, and the effects on employment and added value on the other hand. Läpple and Deeke, 1990 propose that a strategic re-orientation of Hamburg's port development can only occur in conjunction with an overall integrated city development concept. Such a concept would have to involve economic, traffic, housing and environmental considerations. Decisions would need to be informed by an investigation of competing job prospects, the competing usage of inner city space and competing financial requirements of different economic and city development projects. This is the topic of section 17.4.

Consequences of the high priority of port expansion for city development, in particular in the case of the Hafencity, are presented in a very precise and informative way in a brief article by Catherine Hoja, the former Head of Urban Planning in Hamburg (Hoja 1999). This includes in particular historic information on the Hafencity-project and a discussion of the cross-financing of the new container terminal in Altenwerder with property on the Hafencity site until mid 2005 and of the planning laws that made this possible.

2.4.3 Open questions

The four studies referred to above – Berger et al., 2000, Planco, 2000, ISL, 2000 and Sichelschmidt, 2001 provide a very good foundation for the analysis in this present study. However, in this study the intention is to develop scenarios that go more explicitly beyond the extrapolation of present trends. This will be explained briefly in the following on the basis of a few examples. The examples can be grouped into the two-dimensional categorization of scenarios established by Bruun et al., 2002. The authors of this study distinguish between "event-based conventional", "event-based unconventional", "trend-based conventional" and "trend-based unconventional" scenarios. Trend-based scenarios investigate foreseeable trends, either in domains known to have an influence on the topic in question (conventional scenario)

[27]This includes: mineral oil, chemical and metal industries, ship, vehicle and engine construction as well as comestible goods.

[28]Such a comparison is *not* part of the studies themselves and is explicitly not encouraged by the city of Hamburg due to the change to a new methodology in the study of 2001 (compare section 16.2).

or in domains that are not expected to have an influence on the topic in question (unconventional scenario). Event-based scenarios include the occurrence of surprising events, again either within domains that are known to be of influence on the topic in question or domains that are not expected to be of influence. Two examples for significant trends that were not sufficiently considered or misestimated in the four studies, and three examples for significant past *events* will be given in the following:

a) Already in 2005, container turnover in Hamburg was higher than the most optimistic scenario of the above four studies had considered possible for 2010[29]. This is an example of including but misestimating a trend in a domain known to influence port-development.
b) Containerisation, rationalisation and integration of the transport chain influence the contribution of the port of Hamburg to the region's economy. The global transition to a post-industrial service economy and society has led to a shift of value creation from goods-handling to data handling and advanced logistical tasks (Läpple, 1998, Läpple and Deeke, 1990 and 1996, Notteboom and Winkelmans, 2000) and thus to a change in trade-offs between the costs and benefits of the port. This large-scale trend is likely to have repercussions for the city's port development strategy sooner or later. Here we have a trend of importance for port development that is located within a domain not expected to be of influence on port development.
c) It is difficult to predict the emergence of new ideas for new port projects. In the above studies the expansion of existing terminals in Hamburg and the possible construction of a new terminal in Moorburg are unanimously taken to represent the bulk of the port's expansion potential. However, as of 2005, planning processes for a new terminal in an area that was previously not considered at all (Steinwerder) are well under way. Steinwerder has not been considered previously as it is partly rented to port-related companies, but as it turns out this does not constitute a real obstacle. This is an example for a "conventional event".
d) Another example for a conventional event of great importance to Hamburg is the recent exclusive decision of Maersk for Bremerhaven. ISL, 2000 notes that the impacts of this decision were of such importance that they had to be included in the results despite the very late occurrence of this decision. However, the scenarios do not include the possibility of other "surprises" of this kind, for instance in the form of significant corporate investment in the development of Wilhelmshaven[30].
e) In 1987 the Frankfurt region overtook the Hamburg region with respect to the number of jobs in logistics (Läpple, 1998). This was due to the increased importance of air-freight in combination with the fact that Hamburg decided to focus solely on its own airport and to drop the idea to build a new airport with much greater international, and in particular intercontinental, capacity in Kaltenkirchen north of Hamburg. This is an interesting example for an event in a domain not expected to influence the position of the port in the region's economy. This in turn may at some point have consequences for the city's investment into port expansion.

Possibilities of future developments that are not or not sufficiently considered in the study include: large-scale economic shifts, changes in the investment plans of shipping companies

[29]According to ISL, 2000, the growth potential for container turnover in Hamburg until 2010 is 64.9 mill tons. In reality, 64.2 million tons were reached in 2003 and 74 million tons were reached in 2004 (Port of Hamburg Marketing, n.d.).

[30]An example for the speed at which a new port can develop with the help of corporate investment is Thamesport, a new offshore port in the UK which began operation in 1990 (Peterlini, 2001). After the takeover by Hutchinson ports, it quickly became one of the leading ports in the UK. Thamesport is the UK's most efficient and only fully automated port and can handle some of the largest container vessels in the world.

(e.g. with respect to Wilhelmshaven, also in the form of an alliance of smaller shipping companies), the enactment of European port policies that limit the national subsidisation of ports and require the putting out to tender of virtually all European terminals, or the withdrawal of certain port-subsidies and of the support of the city's government for the port.

Regarding a trade-off analysis of regional impacts, the following elements are missing:

i) quite a number of cost and benefit assets have not been assessed at all. Important examples are:
   a. a compilation of direct costs,
   b. the investigation of port subsidies (including low rents for valuable central areas),
   c. indirect costs (e.g. relocation of companies situated on the area chosen for the new container terminal Steinwerder),
   d. externalities (e.g. environmental impacts, noise and container storage in areas adjacent to the port, traffic,
   e. opportunity costs (e.g. cross-financing port development with property sales in the Hafencity, restriction of budget available for the promotion of new economic sectors) – this is considered but not really analysed in Hoja, 1999 and Läpple and Deeke, 1990,
   f. the actual degree of port-dependency of the jobs that have been classified as such in the two studies on port-dependent jobs by the city of Hamburg: For instance jobs in trade and logistics are likely to stay in the region if market shares were to shift to Wilhelmshaven, since Wilhelmshaven does not offer even remotely comparable city amenities, infrastructure, and an insufficient labour pool for these industries (compare Notteboom and Rodrigue, 2004, p.10–11).

These points will be picked up in our analysis of part III.

ii) It would be highly interesting to explore possibilities of a strategic re-orientation of port development in conjunction with an overall integrated city development concept that takes into account competing resource and space requirements, as suggested by Läpple and Deeke, 1990. This requires the investigation of the following questions: What are the contributions of the port and of new economic sectors in terms of job creation and what are the costs of these industries for the city? Are there alternatives to the present port expansion course and what would be their costs and benefits in terms of jobs, regional income and quality of life, in the immediate future and in particular on the longer run? What are the contributions of the city's port and of new economic sectors to the city's international attractiveness? These questions will be investigated in part III and IV of this study.

PART I: CLIMATE CHANGE

AND ITS IMPACTS

IN THE LOWER ELBE REGION[31]

[31]Excerpts of this part of the thesis have been submitted to Die Küste with co-authors Katja Woth and Hans von Storch: Grossmann, I., Woth, K., Storch, H.v., 2005: Localization of global climate change: Storm surge scenarios for Hamburg in 2030 and 2085, Die Küste (in review).

3 Introduction

The topic of this part of the thesis is climate changes in the Lower Elbe region until 2030 and selected expected impacts. Especially in the case of long-term climatic changes, the impacts depend on people's response and the level of adaptation (Carter et al. 1994, p. 16). The capacity for skilful response and adaptation in turn depends on political, socio-economic, technological and cultural change processes (Bray, 2000, Bray and Krück, 2001, Berkhout et al, 2001). The importance of technological developments for adaptation to climate change may be apparent. An example for the probably less obvious role of cultural factors, attitudes and values is given by farmers' responses to the possibility of dike relocation, given their particular relationship to the river and its floods that has developed over many centuries. An example for the importance of economic change would be a structural decline or increase in industries that are particularly vulnerable to climate change leading to a decrease, respectively increase, of the expected economic losses in the case of climatic change events (Grossmann et al., 2003). These socio-economic, technological and cultural changes are only considered predictable, if at all, on much shorter time-scales than climate change. Consequently, a time-horizon of 25 years has been chosen for the scenarios presented here.

Three types of possible climate change impacts will be investigated. The first question concerns changes in the mean annual maximum water level of the Elbe in the city of Hamburg. Since both the disastrous flood of 1962 and the well-managed 1976 storm surge, flood protection in the city of Hamburg and the area downstream between Hamburg and the Elbe mouth has been constantly adapted to changes in the height of high water levels. Such changes may be due to river construction measures (Freie und Hansestadt Hamburg 2005, Arge-Elbe, 1984, Siefert et al., 1988) or to changes in the global and regional climate (Freie und Hansestadt Hamburg, 2005a). The influence of possible future climate change on water levels at high tide in Hamburg St. Pauli will be investigated in sections 4.1 and 4.2 in the form of a scenario of future climate change[32]. This is supplemented by a presentation of the results of interviews with shipping companies and port authorities on the issue of climate risks for the port (section 4.3).

The second aspect of interest concerns possible impacts of changes in precipitation patterns and temperature on agriculture, possible responses and farmers' perception of flood risks. The rural part of the region downstream of Hamburg is still quite dependent on agriculture[33]. We are particularly interested in farmers' perception of possible climate change impacts. Farmers may respond in a variety of ways to changing climatic conditions. This depends on their perception of the actual changes, on the vulnerability of the region's agricultural produce, and on possibilities of adaptation. The latter again depend on farmers' attitudes as well as on the availability of support for measures that may be taken in response. In addition, farmers' perception of flood risks under a scenario of climate change is of interest. Thus, the investigation will include:

- changes of temperature, precipitation and the mean annual maximum water level in a scenario of climate change (sections 5.1 and 5.2) and

[32]This investigation has been carried out in collaboration with Hans von Storch and Katja Woth from GKSS Research Centre.

[33]In 2003, wage-earners working in agriculture, forestry and fishery accounted for 7.82 % and 5.57 % of all wage-earners in the districts Cuxhaven and Stade respectively, compared to 3.48 % in all of Lower Saxony (Niedersächsisches Landesamt für Statistik, 2005).

- farmers' perception of the impacts that the envisaged changes might cause. This has been investigated through structured interviews with farmers. The results are presented in section 5.3.

In chapter 12 of the thesis this is supplemented by a presentation of possible strategies of response to climate change.

Thirdly, impacts of climate change on the Lower Elbe ecosystems are of interest. The investigation begins with an introduction to the river ecosystems, focusing in particular on the impact of river construction measures and resulting threats to species (section 6.1), which could be aggravated by climate change. Next, interviews on possible impacts of our projections of a scenario of temperature and precipitation changes on the river ecosystems were conducted. The interviewees included environmental scientists, a nature conservation representative for the region[34] and an organic farmer with a degree in environmental sciences. The results are presented in section 6.2.

[34]German "Naturschutzbeauftragter" – i.e. a representative of nature conservation associations who is consulted in matters of public law or specific environmental questions by the public authority for nature conservation. Frequently, the Naturschutzbeauftragte are also involved in local projects related to nature conservation.

4 Projection of water levels at Hamburg St. Pauli until 2030

4.1 Methodology

Results from the IPCC A2 SRES scenario (Houghton et al. 2001) of storm surge levels at the North Sea coast between 2070 and 2100 are projected onto Hamburg St. Pauli and the time horizons 2030 and 2085. The A2 scenario is one of a series of scenarios which have been considered in the EU project PRUDENCE (Christensen et al., 2002). They are all derived from a base climate change simulation with the global General Circulation Model HadAM3H of the Hadley Center processing the IPCC A2 SRES scenario. A2 is a relatively pessimistic scenario, assuming high population growth and slow, fragmented economic development and technological change. The envisaged increase of atmospheric greenhouse gas concentrations at the end of the 21st century corresponds roughly to a tripling of pre-industrial levels – according to the IPCC a high or medium-high increase (Nakicenovic et al., n.d.). Thus, through focusing on this scenario we are dealing with somewhat "noticeable" climatic changes, which is particularly suitable for the impact analysis.

The employed series of scenarios for North Sea storm surge levels (Woth et al., 2005) has been constructed in two steps. First, the HadAM3H global atmospheric scenarios given on a 300×400 km² grid were dynamically downscaled to a 50 km grid covering Northern Europe. Then the barotropic hydrodynamic model TRIMGEO of the North Sea was exposed to the downscaled wind and air pressure fields. TRIMGEO simulates water levels and currents on a grid of about 10 km (e.g., Aspelien und Weisse, 2005) for decades of years. When future conditions are simulated, the expected rise in mean sea level is not considered. Instead, following Kauker and Langenberg, 2000 and Lowe et al., 2001, we assume that surge heights are unaffected by the mean sea level, at least in the North Sea itself. Therefore, we consider changes in mean sea level height and surge heights as independent developments[35]. The expected sea level rise until the time of interest is added to the rise attributed to storm surges at a later stage.

The dynamical downscaling of the global scenarios is achieved with four different regional models (Woth et al., 2005). Figure 4-1 shows one of the resulting regional scenarios, which was obtained by running the TRIMGEO model with winds simulated with the regional climate model CLM. In comparison with results from the other models, the CLM-results have been found to provide an upper boundary for changes in water levels. Since this is useful for our analysis we use in the following only the CLM-downscaled results.

[35]This may not be true in the Elbe estuary, i.e., for the St. Pauli tide gauge, but is expected to provide an upper boundary for changes in water levels.

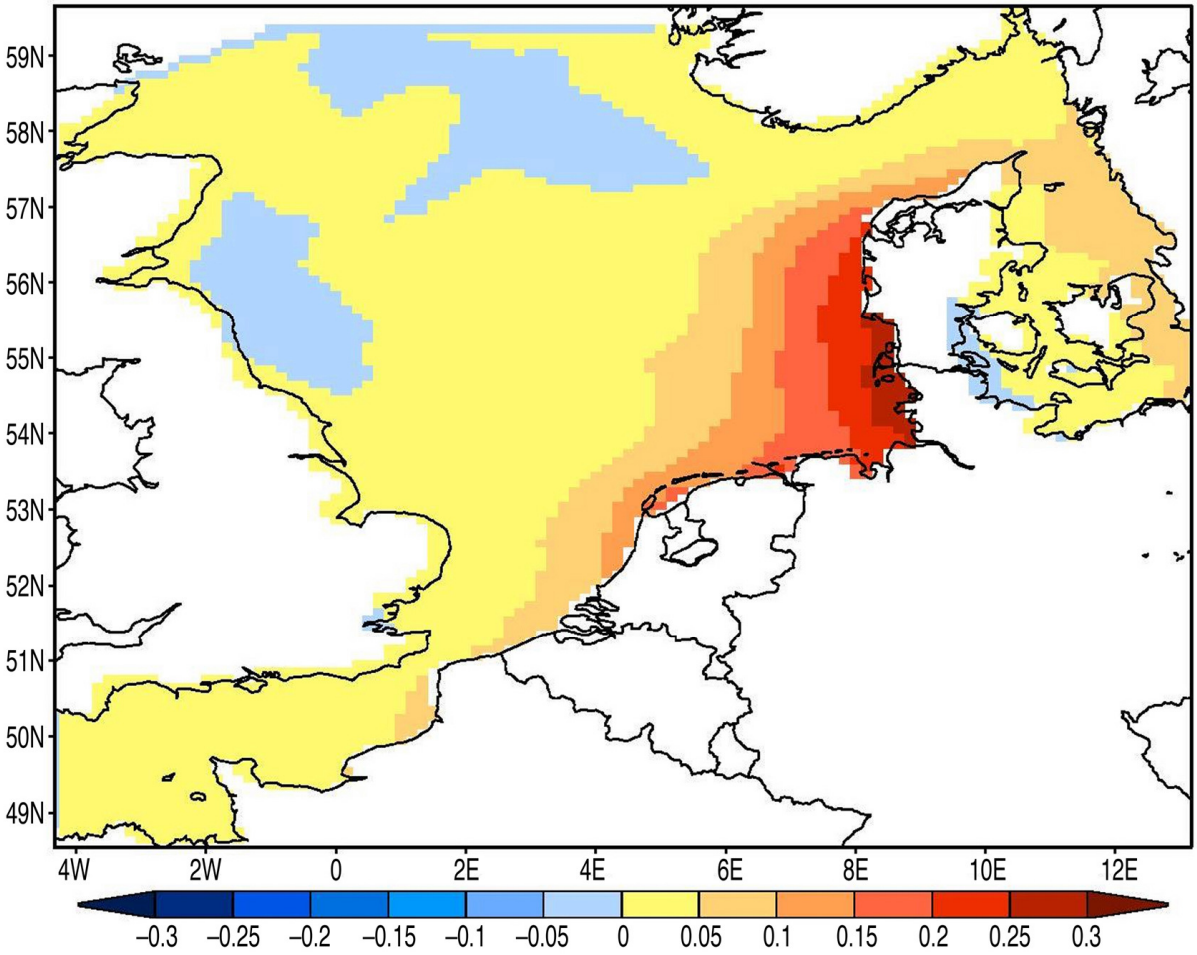

Figure 4-1: Changes of the inter-annual mean of the 99.5th percentile[36] of storm surge heights in metres, projected for 2070–2100 in the A2 scenario, as simulated by TRIMGEO as response to CLM winds. Courtesy of Katja Woth.

The downscaling cascade described above leads to an estimate of the expected changes from the interval 1960–1990 to the time horizon 2070–2100 given the emission scenario A2. It is not possible to use the simulation for the 2070–2100 directly as a possible future for this time. This is because of the systematic errors in the simulations – when simulating the 1960–90 time horizon in a "hindcast" run, high water levels are underestimated a bit, which originates mainly from the global climate change simulation. Therefore it is common in climate research to consider only the change from the hindcast to the projected scenario, assuming that the relatively small systematic errors will show up in both model runs equally and thus cancel out.

As a result of the downscaling cascade, scenarios of possible and plausible storm surge height changes in grid boxes covering the North Sea are available. Our geographic point of interest is Hamburg St. Pauli, which is located some 100 km upstream of the Elbe estuary. A methodology that links water levels in boxes in the mouth of the river Elbe to water levels in St. Pauli is explained in section 4.1.1. Having obtained a projection of water levels in Hamburg St. Pauli for the interval 2070–2100, we need to establish of the situation at the midterm 2030 from the two available time horizons 1960–90 and 2070–2100. A methodology to do this is explained in section 4.1.2.

[36]The 99.5th percentile is the threshold selected such that 99.5 % of the storm surge values are less than this threshold.

4.1.1 Linking North Sea surge levels and St. Pauli surge levels

To derive projections of water levels in Hamburg St. Pauli from water levels at coastal grid boxes, a statistical function describing the relationship between water levels in the two locations is needed. For this purpose, data on historical high tide water levels in Hamburg St. Pauli between 1980 and 1990 is used. This particular interval has been chosen because river deepening measures which might influence the water levels in St. Pauli – and would thus give a misestimate of the relationship between the water levels at the two locations – have not been carried out during this time (Figure 4-2). At a later stage, the statistical function was calculated for the interval 1990–2000 (which also shows only minor changes in the mean high water) to provide a verification of the accuracy of this method.

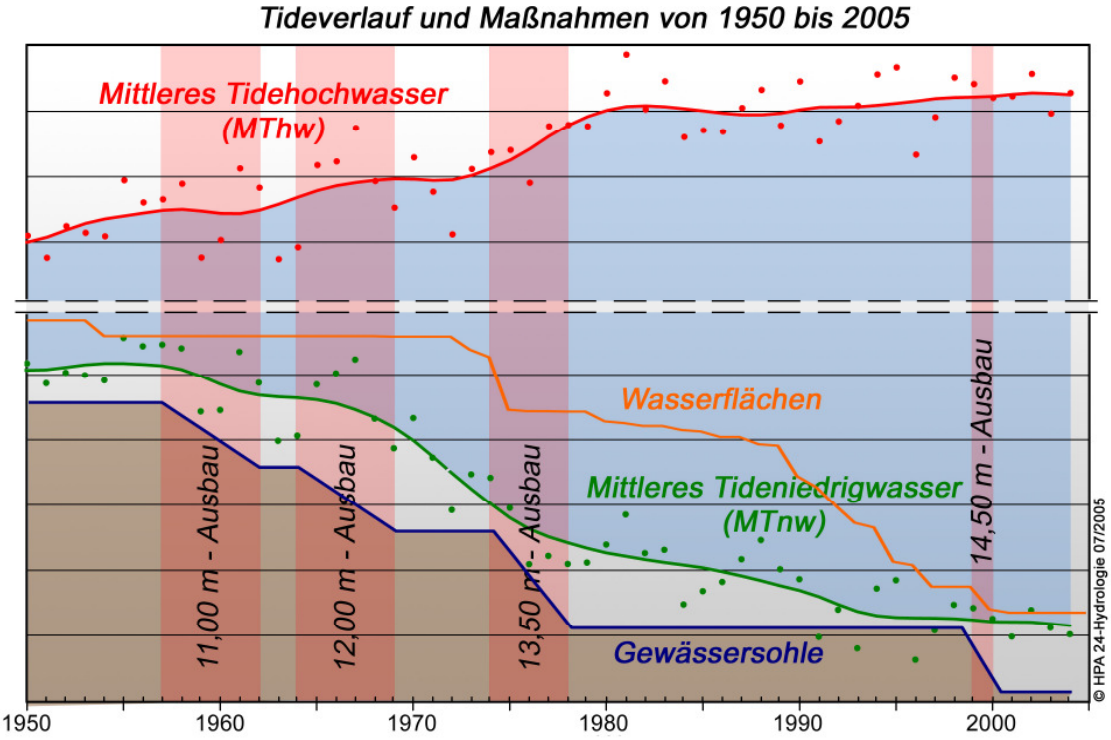

Figure 4-2: Mean low water (MTnw, green line), mean high water (MThw, red line) and mean depth of the shipping channel at Hamburg St. Pauli 1950–2004. The mean low water is not stable during the interval of interest (1980–1990), but the mean high water is stable. The horizontal lines delineate 1 m differences. Courtesy of Hamburg Port Authority.

For our approach, the St. Pauli data is related to the high tide water levels of a "hindcast" run during the same time period in five coastal grid boxes. This hindcast run was made with the TRIMGEO model, forced with high-resolution "analysed" wind and air pressure[37]. The grid boxes considered here are located at the coast close to the Elbe mouth and on the 10 m bathymetry-line close to the Elbe mouth. One of the boxes, which actually emerges later as the best suited box, contains the tide gauge of Cuxhaven.

A preliminary comparison of the two data sets on the basis of scatter diagrams suggested that a curve consisting of a linear component f_1 and a quadratic component f_2 would provide a good fit (compare Figure 4-3):

$$f(x) = \begin{cases} f_1(x) = ax + b, x < x_k \\ f_2(x) = cx^2 + dx + e, x \geq x_k \end{cases} \quad \text{with } f_1(x_k) = f_2(x_k) \text{ and } f_1'(x_k) = f_2'(x_k).$$

[37] "Analysed" means a best guess of the synoptic situation derived from observations (Feser et al., 2001).

As we intend to investigate changes in storm surge heights in terms of the multiyear mean of annual maxima we add the constraint $f_2(\mu_{C,s}) = \mu_{SP}$ to ensure that $\mu_{C,s}$, the multiyear annual maximum at the grid box s at the coast close to the Elbe mouth of the hindcast is mapped onto μ_{SP}, the multiyear annual maximum at St. Pauli.

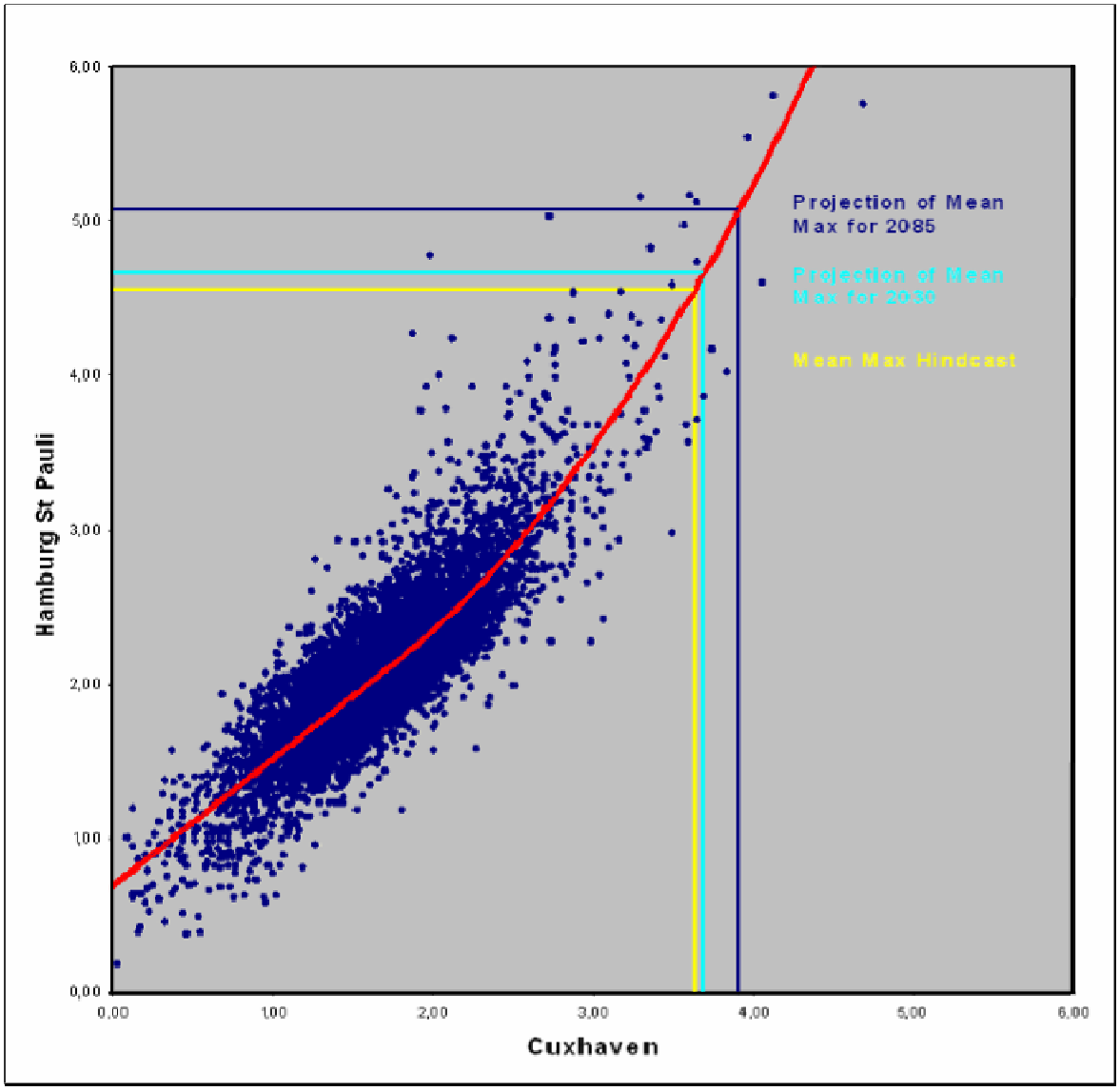

Figure 4-3: Linear-quadratic fit for water levels at Hamburg St. Pauli and at the coastal grid point 53.8°N / 8.8ºE (Cuxhaven) in metres. The yellow line indicates the multiyear means of annual maxima derived from the hindcast for the coastal grid point and derived from the observations at St. Pauli. The light blue line indicates the mean annual maximum in 2030 given changes in storm surge levels, and the projection for the St. Pauli tide gauge.

Starting with a sufficiently big interval $[x_1, x_2]$, the coefficients $a, b, c, d, e, \lambda_1, \lambda_2, \lambda_3$ are determined as those which minimize for

$$\varepsilon(s, x_k) = \sum_{i=1}^{k-1} (f_1(x_i) - y_i)^2 + \sum_{i=k}^{n} (f_2(x_i) - y_i)^2$$
$$+\lambda_1\gamma_1(f_1(x_k) - f_2(x_k)) + \lambda_2\gamma_2(f_1'(x_k) - f_2'(x_k)) + \lambda_3\gamma_3(f_2(\mu_C) - \mu_{SP}) = \min!$$

for each $x_k \in [x_1, x_2]$ at the site s. The numbers γ_i are weights given to the constraints. $\gamma_1 = 500, \gamma_2 = 1$ and $\gamma_3 = 1$ has proven useful for our purposes – that is, maximum weight is given to the continuity of the fit and minimum weight to the equivalence of the multiyear annual maximum heights at St. Pauli and at the gridboxes at the mouth of the Elbe, and to the continuity of the derivative of the fit.

This process is successively repeated for smaller intervals of which the determined x_k constitutes the middle. The algorithm terminates if no more improvements are achieved. The smallest value for ε is reached for the coastal grid box centred at 53.8°N 8.8°E. This grid box contains Cuxhaven. The optimal constants are a = 0.82, b = 0.69, c = 0.24, d = -0.01, e = 1.40 and x_k =1.71. Figure 4-3shows the linear-quadratic fit for this set of parameters and the scatter cloud of pairs of high tide values at St. Pauli and at the selected gridpoint near Cuxhaven. The constraints of continuity of the function and its derivative are satisfactorily fulfilled and the condition that the mean maximum $\mu_{C,s}$=3.63 m at s is mapped on the mean maximum of μ_{SP} = 4.56 m at St. Pauli is met. Figure 4-4 illustrates the close agreement of the two transfer functions calculated respectively for the intervals 1980–1990 and 1990–2000.

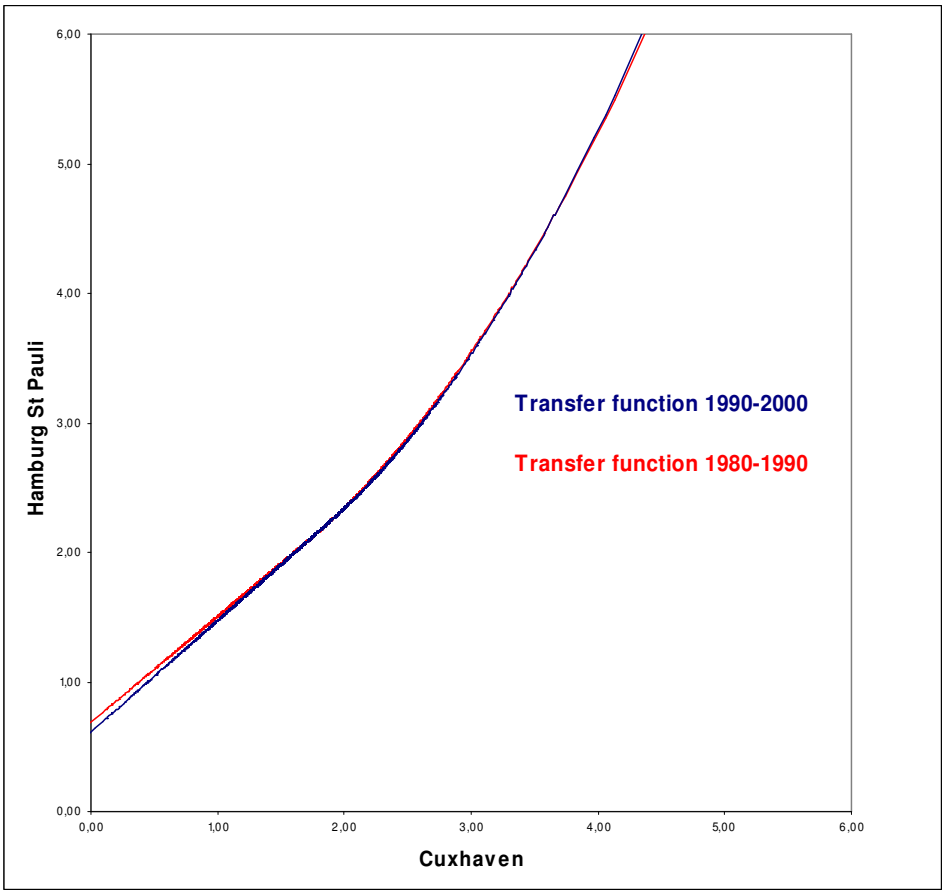

Figure 4-4: The transfer functions describing the relationship between water levels in Hamburg St. Pauli and in Cuxhaven for the two time periods 1980–1990 and 1990–2000.

For low high water levels, say 2 m, St Pauli is about 30 cm higher than Cuxhaven, for 3 m the difference is on average 50 cm, but for 4 m the difference is about 1.2 m, which corresponds about to the observed differences between the two tide gauges.

The root mean square error of the fit, i.e.,

$$\sqrt{\frac{1}{k-1}\sum_{i=1}^{k-1}(f_1(x_i)-y_i)^2+\frac{1}{n-k+1}\sum_{i=k}^{n}(f_2(x_i)-y_i)^2}\,,$$

amounts to 36.7 cm for the selected optimal set of parameters.

4.1.2 Temporal interpolation

As outlined in the introduction, the simulations provide only a projection of the expected change from the "control" period 1960–90 until 2070–2100, given scenario A2 and the global HadAM3H simulation. To establish a projection of the results onto our time horizon 2030, a development of storm surge heights parallel to the increase in temperature in the global IPCC-Scenario A2 (Houghton et al., 2001) is assumed. The expected increase from 1990 to 2030 is 0.7 K which is about $\varphi = 20$ % of the increase of 3.25 K from the interval 1960–1990 to the interval 2070–2100. Thus, we assume that the mean maximum surge height at the grid boxes at the mouth of the Elbe is increased by 20 % of the increase derived from the TRIMGEO scenario for the 2070–2100 time horizon.

For the mean sea level rise D the projections provided by the IPCC for the A2 scenario (Houghton et al., 2001) are employed. These are 10 cm for 2030 and 29 cm for 2085. It is assumed that mean sea level rise and changing storm surge height are independent and may simply be added. This assumption may not be fully fulfilled in the case of an estuary like the Elbe but is expected to provide upper bounds of plausible changes.

4.2 Results

Let M denote the multiyear mean of the annual maximum respectively of the hindcast simulation $H_{1960–90}$, the "control" simulation $C_{1960–90}$ and the A2-Scenario $S_{2070–2100}$. The indices are dropped in the following.

The projected mean annual maximum high tide water level P at St. Pauli in 2030 is estimated as

$$P = f(\mu_{C,s} + \varphi[M(S) - M(C)]) + D$$

The difference M(S)-M(C) of the mean annual maximum high tide at the Cuxhaven coastal point s = (53.8°N 8.8°E) in the Scenario S and Control-Run C amounts to 0.28 m. The present mean annual maximum is $\mu_{C,s}$ = 3.63 m. The expected global mean sea level rise is D = 0.1 m. Adding this all together, we have P = 4.76 m for the projected mean annual maximum high tide at St. Pauli in 2030, which represents an increase of 0.2 m. If the mean sea level would not add, the increase would be smaller. In Cuxhaven, the additive increase would be 10 cm plus 20 % of 20 cm, i.e., about 15 cm.

For the time horizon 2085 the expected increase in mean sea level is 0.33 m, and the effect of stronger surges amounts to an increase of 0.28 m in Cuxhaven, so that the total increase would be 61 cm. For St. Pauli, the mean annual maximum is expected to be P = 5.39 m, which is 0.84 m higher than presently.

4.3 Flood risks for the port of Hamburg – impressions of the corporate viewpoint

Interviews conducted with representatives of shipping companies, Port of Hamburg Marketing and the business association of the port of Hamburg indicated that an increase in the height of storm floods would pose slight disadvantages to port operations if the flood protection level were not improved. At present some quay walls are only 5 m high (compare Figure 4-5) so that the dock site is flooded if water levels surpass 5 m. Storm floods between 4.5 and 5.5 m are classified as "heavy storm floods", storm floods between 5.5 and 7 m as "very heavy storm floods". Further areas are flooded by water levels of 5.5 or 6.5 m. This does not occur very frequently, however. In the last 20 years, water levels exceeded 5 m twelve times and 6 m additional two times (Wasser- und Schifffahrtsamt Cuxhaven, n.d). In the projected scenario of climate change, higher water levels would occur more frequently.

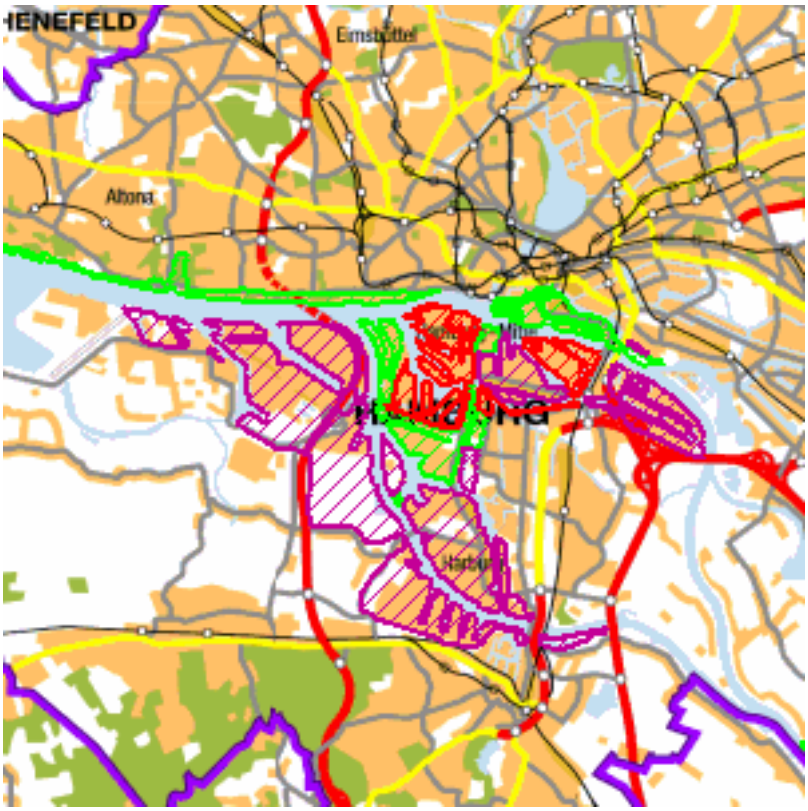

Figure 4-5: Level of flood protection in the port. Areas marked in green are presently flooded if water levels reach 5 m, areas marked in red by water levels of 5.5 m, and areas marked in purple by water levels of 6.5 m (Map courtesy of the Landesbetrieb für Geoinformation und Vermessung).

Water levels of 5 m or more result in business interruptions in these areas. This may be expensive for shipping companies since the port requires high speed and efficiency, on the other hand the interviewees indicated that they are well used to business interruptions due to floods. Containers on quay walls that are too low can be protected by placing empty containers under them that fill up with water once the flood reaches the quay wall. This requires a well functioning alarm system with precise warnings. The interviewees indicated that the presently established system is sufficient and was even rated as such by visiting representatives of an insurance business. At present, alarm is given if water levels are expected to exceed 4.5 m.

The city has planned to heighten all dock sites to 7.5 m during the next 5–10 years as part of the port expansion and modernisation programme (Freie und Hansestadt Hamburg, 2005a and 2005c). In addition an extension of the privately financed polders that receive support from the city is planned. There are also other areas near the port that are at present not adequately protected, namely the HHLA real estate and the "Speicherstadt" – which is only used for commercial purposes due to its insufficient flood protection. One interviewee related that the city is considering to build a barrage in order to protect the Speicherstadt. Our above results indicate that dock sites will be well protected from flooding until at least 2030, even under a scenario of relatively strong climate change, if this extension of flood protection is carried out.

Interviewees were also questioned about their trust in the city's assessment of the required heights of quay walls. It turned out that port businesses do not rely exclusively on the city's assessment of the flood situation and the consequences of deepening measures of the waterway but also consult other studies and invite independent experts for discussions. In this context it was stated that since there has been an increase both of the tidal hub and of the height of high floods due to the deepening of the waterway, dike building and other measures, dike relocation in the rural area downstream of Hamburg would be preferred in order to provide natural retention areas. Also flood barrages should be opened more frequently if possible.

5 Projection of temperature and precipitation changes until 2030

5.1 Methodology

Regional data provided by the PRUDENCE data archive[38] is used. The data is derived from a climate change simulation with the General Circulation Model HadAM3H of the Hadley Center processing the IPCC A2 SRES scenario. The resulting wind and pressure conditions have been used to drive the regional climate model CLM (Woth et al., 2005) for the time period 2070 to 2100.

Data from the PRUDENCE archive is available as monthly average for the years 2070 to 2100 for six grid points located within the study region (compare Figure 5-1). Since not all local variability can be traced back to the large-scale variability that is computed by the global model, the downscaling to these grid points would be problematic if we were interested in regional data of high accuracy (compare the analysis of Storch, 1995). However, our intention here is to provide approximate estimates of changes in temperature and precipitation in an A2-scenario that allow the investigation of farmers' expectations for climate change impacts through interviews. Towards this end we use only a rough rounding of our results for the interviews in section 5.3.

To establish a projection of the results onto our time horizon 2030, a development of temperature and precipitation parallel to the global increase in temperature in the IPCC A2-scenario (Houghton et al., 2001) is assumed. The expected increase from 1990 to 2030 is 0.7K, which is about $\varphi = 20$ % of the increase of 3.25K from the interval 1960–1990 to the interval 2070–2100 (compare section 4.1.2). We consider the difference

$$\Delta_t = mean_t(A2\_20702100) - mean_t(CTL\_19601990)$$

between the monthly mean temperature of the scenario and the control-run and the difference

$$\Delta_p = mean_p(A2\_20702100) - mean_p(CTL\_19601990)$$

between the monthly mean precipitation of the scenario and the control-run for for each grid point and each month. Then we take the change until 2030 to be 20 % of this difference, i.e. 20 % of the change until 2100.

This gives for the change until 2030 (here exemplary for January)

$$mean_t^{Jan} = mean_t^{Jan}(CTL\_19601990) + 0.2\Delta_t^{Jan} \text{ and}$$

$$mean_p^{Jan} = mean_p^{Jan}(CTL\_19601990) + 0.2\Delta_p^{Jan}.$$

The resulting projections for temperature and precipitation changes are listed in Table 5-1 and Table 5-2.

[38]The Prudence-project is funded by the EU through contract EVK2-CT2001-00132.

A t-test to compare the monthly means of the scenario and the control-run was then conducted for each grid-point. For the temperature-scenario the difference in means is significant at the 5 % level for all months and grid-points. For precipitation the difference in means between the scenario and the control-run is significant at the 5 % level only for the winter months December, January and February, for the summer months July and August, and for September and March (compare Table 5-2).

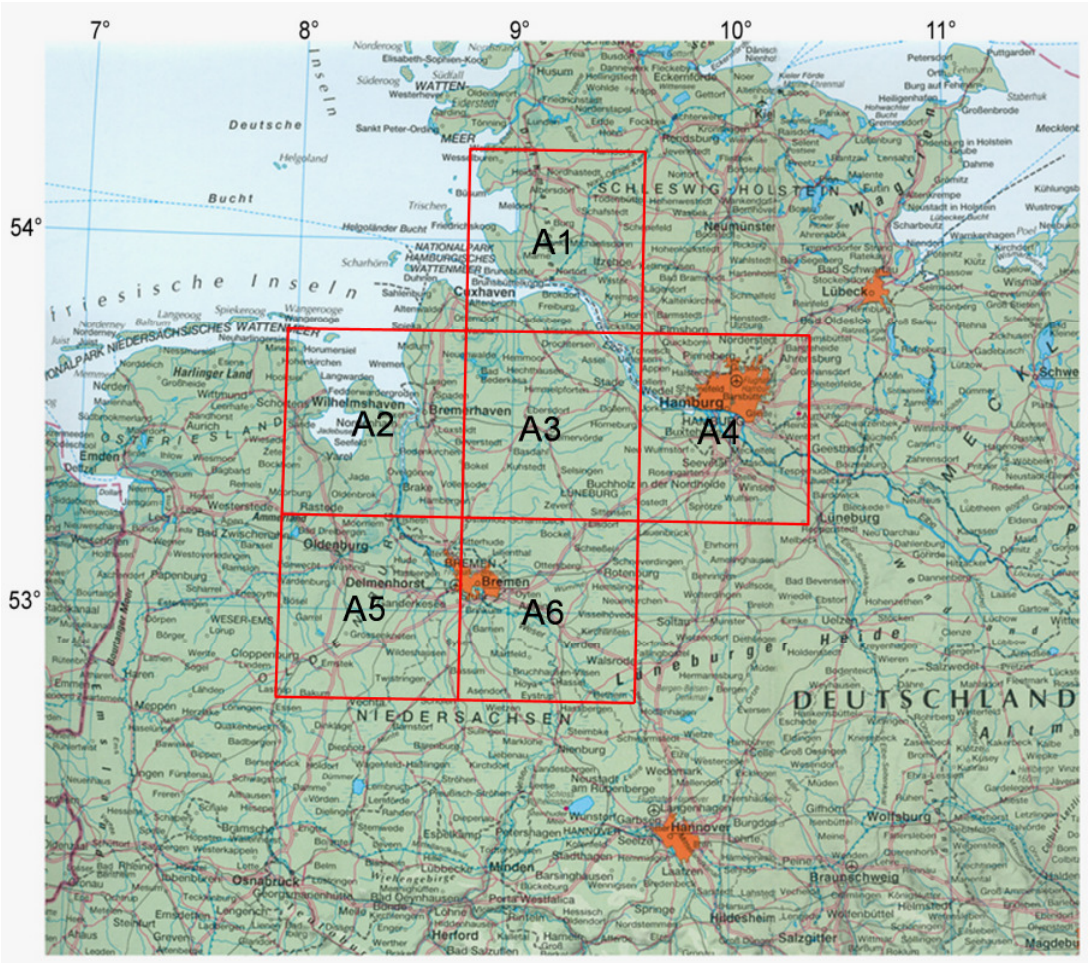

Figure 5-1: The region with the six grid-boxes.

5.2 Results

Table 5-1 and Table 5-2 list the projected changes of temperature and precipitation until 2030:

	A1	A2	A3	A4	A5	A6
January	+0.71	+0.73	+0.73	+0.72	+0.71	+0.73
February	+0.56	+0.55	+0.57	+0.57	+0.56	+0.57
March	+0.50	+0.52	+0.50	+0.50	+0.49	+0.50
April	+0.54	+0.53	+0.54	+0.54	+0.54	+0.53
May	+0.60	+0.60	+0.61	+0.61	+0.60	+0.59
June	+0.54	+0.54	+0.56	+0.56	+0.57	+0.57
July	+0.73	+0.70	+0.76	+0.77	+0.77	+0.77
August	+0.74	+0.70	+0.76	+0.78	+0.79	+0.79
September	+0.80	+0.78	+0.82	+0.81	+0.82	+0.82
October	+0.64	+0.62	+0.64	+0.65	+0.63	+0.66
November	+0.59	+0.56	+0.56	+0.56	+0.55	+0.56
December	+0.60	+0.59	+0.60	+0.60	+0.57	+0.60

Table 5-1: Projected temperature changes for the six grid boxes until 2030 in °C. According to the t-test conducted, the changes are significant at the 5 % level for all months.

	A1	A2	A3	A4	A5	A6
January	+0.24*	+0.22*	+0.19*	+0.15*	+0.14*	+0.13*
February	+0.16*	+0.19*	+0.16*	+0.13*	+0.12*	+0.12*
March	+0.09*	+0.12*	+0.09*	+0.05*	+0.09*	+0.08*
April	-0.03	-0.03	-0.04	-0.05	-0.02	-0.04
May	-0.04	-0.04	-0.07	-0.06	-0.06	-0.07*
June	-0.05	-0.06	-0.09	-0.08	-0.08	-0.09
July	-0.18*	-0.17*	-0.17*	-0.13*	-0.14*	-0.14*
August	-0.13*	-0.18*	-0.13*	-0.11*	-0.18*	-0.15*
September	-0.14*	-0.16*	-0.13*	-0.10*	-0.11*	-0.10*
October	+0.02	+0.04	+0.04	+0.04	+0.03	+0.05
November	+0.06	+0.06	+0.04	+0.02	+0.03	+0.02
December	+0.17*	+0.19*	+0.15*	+0.11*	+0.12*	+0.12*

Table 5-2: Projected changes of precipitation for the six grid boxes until 2030 in mm/day. The months and grid-boxes for which the changes are significant at the 5 % level are marked with an asterisk *.

5.3 Farmers' perception of the climate change scenario

For the investigation of farmers' expectations of climate change impacts, 7 farmers and one dike-reeve located in the areas corresponding to grid-boxes A1 and A3 were interviewed. For the interviews, projections of mean temperature changes in winter, spring and summer, and mean precipitation changes in winter and summer were employed (see Table 5-3).

	Winter temp.	Spring temp.	Summer temp.	Winter precipit.	Summer precipit.
A1	+0.62 °C	+0.67 °C	+0.55 °C	+0.19 mm	-0.12 mm
A3	+0.63 °C	+0.69 °C	+0.55 °C	+0.17 mm	-0.13 mm

Table 5-3: Projections of mean temperature changes in winter, spring and summer in °C and projected changes of winter and summer precipitation in mm/day for the selected two grid boxes A1 and A3. These were rounded for the purpose of interviews with farmers[39].

Farmers from both the Lower Saxonian and the Schleswig Holstein part of the Lower Elbe region were represented. This included farmers that had also been selected for the Focus Group on future perspectives for the rural area on the Lower Saxon side of the river (see part II of this thesis) and additional farmers that were identified through an internet search[40].

The interviews were conducted on the phone. The questions posed to interviewees are reproduced in the following:

1. Which impacts do you expect if temperature were to increase by up to 1 °C41 until 2030, with a tendency of a stronger increase in winter and spring than in summer?
2. Which impacts do you expect if precipitation decreases by up to 4 mm per month during summer until 2030, and increases by up to 6 mm during winter?
3. Are there other possible climate changes besides changes in temperature and precipitation that you would expect to negatively impact agricultural production?
4. Are there possible climate changes that would be beneficial for agricultural production in your region?
5. Do you feel that the level of flood protection is adequate
   i. now, as well as
   ii. under a scenario of an increase of mean maximum water levels in the Lower Elbe by up to 15cm until 2030?
6. Would you prefer to receive more information on flood protection from the responsible governmental agencies such as the 'Niedersächsische Landesbetrieb für Wasserwirtschaft und Küstenschutz'[42]?

[39]Compare our discussion of possible problematic aspects of downscaling in section 5.1.
[40]The internet search was useful in order to specifically identify farmers from both sides of the river and from both types of soil /landscape conditions, the Geest and the marshlands.
[41]This exceeds the projections made in 5.2, however, a change of 1 °C was considered much easier for the farmers to relate to.
[42]Farmers could name further agencies from which they wished to receive further information.

5.3.1 Temperature and precipitation changes

On both sides of the Elbe, two types of landscape and soil conditions can be distinguished, the marshland and the Geest. Farmers from both types of land were selected for the interviews. The results for the two land types will be presented separately here.

5.3.1.1 Expected impacts for the Geest

The Geest consists of sandy plains intermixed with extensive heaths and moors. It is situated on a higher elevation and lies further inland than the marshland. Soils are poor, scoring only 20–40 on a scale of 20–100[43] according to the region's chamber of agriculture[44], and have a very low water storing capacity. According to the interviewees, farmers are struggling with problems related to draught, water shortage and soil erosion already under present climate conditions. According to the farmers even temperature increases of less than 1 °C in spring and in particular in summer could pose serious problems for the farmers. Increased irrigation would not be a viable solution as this would result in too high production costs. This would grow more acute if summer precipitation were to decrease.

Since it is difficult to extract reliable results from a small number of qualitative interviews, we will reproduce some relevant quantitative data in the following, namely on the relation of profits and costs to turnover in farms located in the Geest. Since data is not available exclusively for farms in the Geest, data on farms located on comparable sites in Germany will be employed as reference value. Soils in the Geest have a quality of only 20–40 (compare footnote 43). This indicates that soils in the Geest have poor to very poor quality and can be classified within the lowest third or lowest quarter of German soils. Farming in the Geest focuses on crop production and animal husbandry, in particular dairy farming. Profits of farms situated on soils within the lowest third of German soils are often very low – in the case of crop production we have profits of approximately 22 €/ha agricultural area (1.3 % of overall turnover), for dairy farming 94€/ha (3.7 % of overall turnover) and for non-dairy animal husbandry losses between 28 and 273 €/ha (between 1.5 and 4 % of overall turnover) (Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft, 2005). These numbers may not completely coincide with the situation of farms in the Geest because of differences for instance in average farm size[45], but the differences are probably sufficiently small so that the relation between turnover and profits and costs in the Geest will be of a similar order of magnitude. If we assume that profits in the Geest do not exceed 4 or 5 % of overall turnover, farms would no longer be able to realize profit if an increase of costs or a decrease of yields by 4–5 % occurs.

The narrow profit margins are also reflected in the continuous decrease of the number of farms in the region, e.g. in the Stade district from 1352 farms in 1990 to 984 in 2001, the decrease of small farms (20–50 ha) from 839 in 1990 to 391 in 2001, and the increase of large farms from 335 to 593[46] farms in the same time period.

Another problem mentioned by farmers is that soils are expected to become karstic within a few years. One farmer explained that soils have become more sensitive due to the levelling of

[43]German 'Bodenpunkte'. Soils are classified on a scale from 20 to 100, with 100 indicating highest and 20 indicating lowest soil quality (compare Niedersächsisches Landesamt für Statistik, http://www.nls.niedersachsen.de/Tabellen/Landwirtschaft/bee_text/e_stat_t.htm).

[44]Source: Stade office of the Hannover chamber of agriculture, agricultural data: http://www.kreisstellen.lwk-hannover.de/index.cfm/startid/674/cfid/4477003/cftoken/95634720.html.

[45]The farm size in areas of poor soil quality in Germany's mountainous regions is usually much smaller.

[46]Source: Stade office of the Hannover chamber of agriculture, agricultural data: http://www.kreisstellen.lwk-hannover.de/index.cfm/startid/674/cfid/4477003/cftoken/95634720.html.

the ground and the disappearance of hedgerows and trees in the agricultural landscape during the last few decades. Consistently applied hedgerows and trees can increase the water storage capacity of the soil and help to prevent soil erosion. However, such a strategy not only requires additional work in order to plant the hedgerows, but is also in sharp contradiction to the need for larger farms and large fields without hedges or other obstacles that impede efficient tilling. Some farmers expressed the hope that promotion programmes would become available for the cultivation of hedgerows and trees and or that promotion for organic produce would be raised should climate conditions aggravate. However, in other German regions that presently experience problems with soil erosion and karstic dry soils – e.g. areas in Mecklemburg Vorpommern – there are no promotion programmes available yet. Thus, the following two options of response seem to be possible: Farmers could extensify production, in particular if promotion for this is received, maybe in combination with organic farming. For farmers who operate very economically the establishment of hedgerows might be an option.

An increase of winter temperatures of approximately 1 °C would shorten winter frosts. Interviewees from the Geest explained that winter frosts only improve the quality of their soils to a muss lesser degree than in the marshlands. It is possible, however, that pests would increase if winter temperatures would not fall below 0 °C. This would increase the farmers' workload and decrease expected yields.

Other possible climatic changes that the farmers expect to cause negative impacts are increased storms. Wind storms, in particular near the coast, would increase soil erosion and could impact the stability of buildings. Late winter and spring storms could necessitate a delay of letting animals out to pasture. In addition, fruit tree blossoms would be at risk if hail storms were to increase. Finally, increased unpredictability of weather conditions could hamper agricultural production.

5.3.1.2 Expected impacts for the marshlands

The marshlands are closer to the river. Soils here are usually very good. Farmers situated in the marshlands indicated that they are much less vulnerable to higher summer temperatures and in particular to a decrease of precipitation than farmers in the Geest. In fact, some agricultural areas are situated below sea level and are therefore inclined to be too humid rather than too dry. Since air humidity in these areas is already very high, a further increase of humidity might result in a decrease of photosynthesis that would impact yields.

In the parts of the marshlands that are higher in elevation, yields could decrease if summer temperatures were to rise. An increase of winter precipitation is definitely expected to have negative impacts. Several farmers stated that in recent years heavy rains seem to have become more frequent, resulting in problems with the draining of fields and pastures. Pastures were frequently flooded for more than 2 weeks and could not be used as usual. The pumps that are normally employed in such situations could not deal with the huge amounts of water. The sluices in the marshlands are often not controlled by farmers so that they cannot be used to accelerate the draining process. Some farmers also stated that heavy prolonged winter rains would necessitate a protection of their fields with winter coverage in order to prevent eluviation.

A decrease of winter frosts was consistently regarded as highly problematic. Soils in the marshlands considerably gain in quality if strong winter frosts occur[47]. In addition, pests and weeds on the fields and in greenhouses are kept in check by winter frosts. If the frost is too short or too light it is necessary to plough a second time. However, this cannot replace the beneficial effects of real winter frosts. An earlier spring, however, could be advantageous as it would imply a longer growth period and the possibility to let animals out to pasture at an earlier date.

Other climatic changes that would cause negative impacts according to farmers include storms and unpredictable periods of heavy rains. In recent years, unexpected heavy rains have led to the moulding of hay after mowing or to a delay of cultivation. Another possible consequence of heavy rains is eluviation.

5.3.2 Flood protection

Farmers' opinions on the level of flood protection were divided. About half of the farmers felt that flood protection was sufficient, the other half expressed mild to serious concerns. There did not seem to be a correlation of this with where the farmers were situated. A few interviewees suggested that dike relocation and the re-establishment of naturally flooded areas could become advisable in order to protect the marshlands and the parts of the Geest that are close to the coast. It was also stated that this option is usually not discussed due to a high degree of habituation to a high level of flood risks as well as the farmers' holding on to their traditional rights and the belief that the respective natural forces can and should be controlled through dikes.

The greatest danger according to interviewees are not so much *very* high floods as rather an increase in the frequency of high floods that would put the dikes at risk. Sea level rise was stated to add to this risk. Those interviewees who felt that floods pose an increasing risk wished to receive more information on the findings of the respective governmental authorities. In addition they felt that the respective governmental authorities should take flood protection issues more seriously and clearly take into account the long-term requirements. In addition to ensuring adequate flood protection for the short- to medium-term future (up to 20 years), flood protection planning should also involve the design of dikes in such a way that a successive fortification and heightening is possible. Such requests are frequently put forward by dike reeves.

It was also made clear that the possibility of dike relocation could only be acceptable under two conditions: Firstly, an opening of dikes is believed to lower water levels in Hamburg on a scale of a few centimetres only so that more effective possibilities should be sought for first. Secondly, dike relocation would destroy huge valuable agricultural areas. It would be indispensable to ensure that the farmers concerned can maintain their livelihood. Some interviewees stated that in fact, without the proper cultivation of the marshlands, the landscape is likely to become desolate and invasive plant species such as thistles, ash and poplars would spread.

[47]The clay soil of the marshlands consists of several layers with water-filled interspaces that have a high capacity to store nutrients, but also lead to the periodic compaction of the soil. In order to retain its fertility, the soil needs to be broken up by winter frosts (compare Scheffer and Schachtschabel, 2001).

6 Climate change and the Elbe ecosystems

The river basin of the tidal[48] Elbe is defined as the area between the weir in Geesthacht and the mouth of the Elbe near Cuxhaven. It is a very complex both terrestrial and aquatic ecosystem with limnic and marine components. Quite unique is the combination of strong tidal influences with a large area where the river divides into several branches. The river basin is home to several endemic species, and provides habitat of national or international importance to a number of species (Mischke and Garthe, 1994, Grimm, 1982 and 1983). Approximately 11 % of the river basin have been designated as EU birds reserves and 8 % as Flora and Fauna habitat reserves (see Figure 6-1 and Figure 6-2, Freie und Hansestadt Hamburg et al., 2004, European Commission Directorate-General for the Environment, 1979 and 1992 and Bundesamt für Naturschutz, 1998).

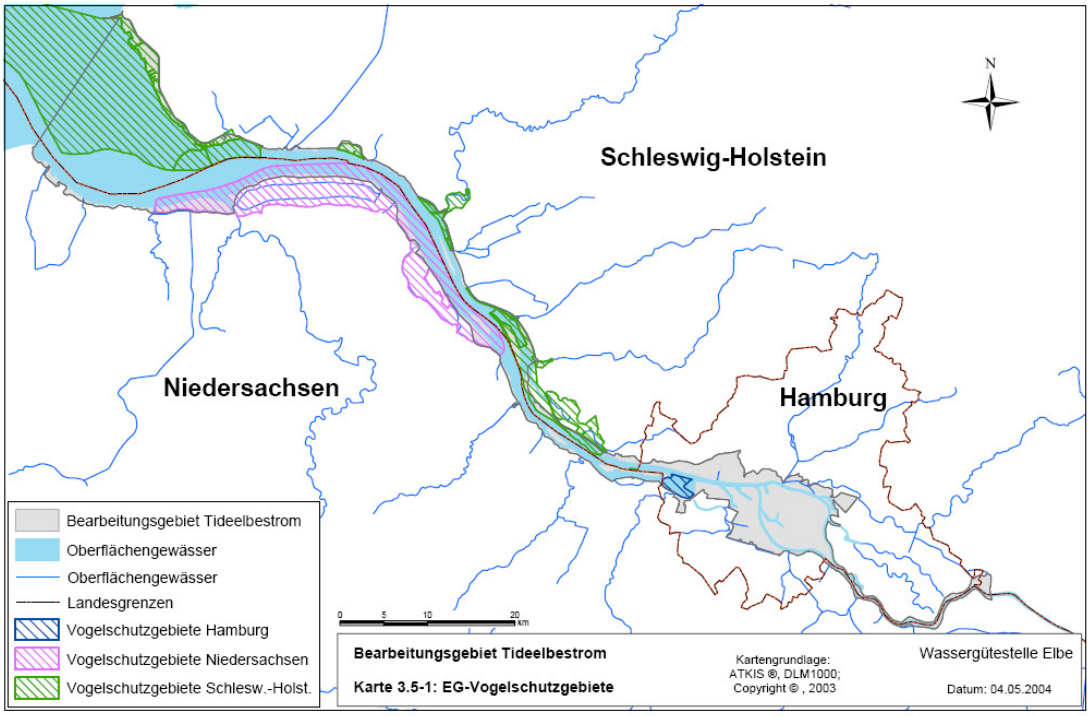

Figure 6-1: EU Birds reserves in the Lower Elbe region, courtesy of Arge-Elbe. The blue striped, green striped and purple striped areas are birds-reserves in Hamburg, Schleswig Holstein and Lower Saxony, respectively.

The river basin between Barnkrug and Otterndorf – an area of 11760 ha – has been a Ramsar-wetland since 1976. It includes salt marshes, tidal brackish and freshwater marshes and is of high importance as staging area for migratory waterfowl species, as breeding and wintering area for waterfowl. The Mühlenberger Loch at the edge of Hamburg – formerly the largest freshwater tideland in Europe – and the Wadden Sea next to the Elbe mouth are also Ramsar wetlands. All three provide important habitats to a large number of species, including endangered and endemic species (Grimm, 1982 and 1983). However the landscape and aquatic properties of these areas have been radically altered by the extensive dike building measures of the sixties and seventies, the partial filling up of the Mühlenberger Loch in 2002 and other river construction measures (ibid, Arge-Elbe, 1984, Freie und Hansestadt Hamburg, 1993, Mischke and Garthe, 1994, Thiel and Pezenburg, 2001). A summary of the most consequential measures will be given in the following together with a discussion of

[48]The term 'tidal Elbe' is usually taken to refer to the same area as the term 'Lower Elbe'.

consequences for the Elbe ecosystems. Possible measures that would be beneficial for the river ecosystems are listed in section 21.2.1.

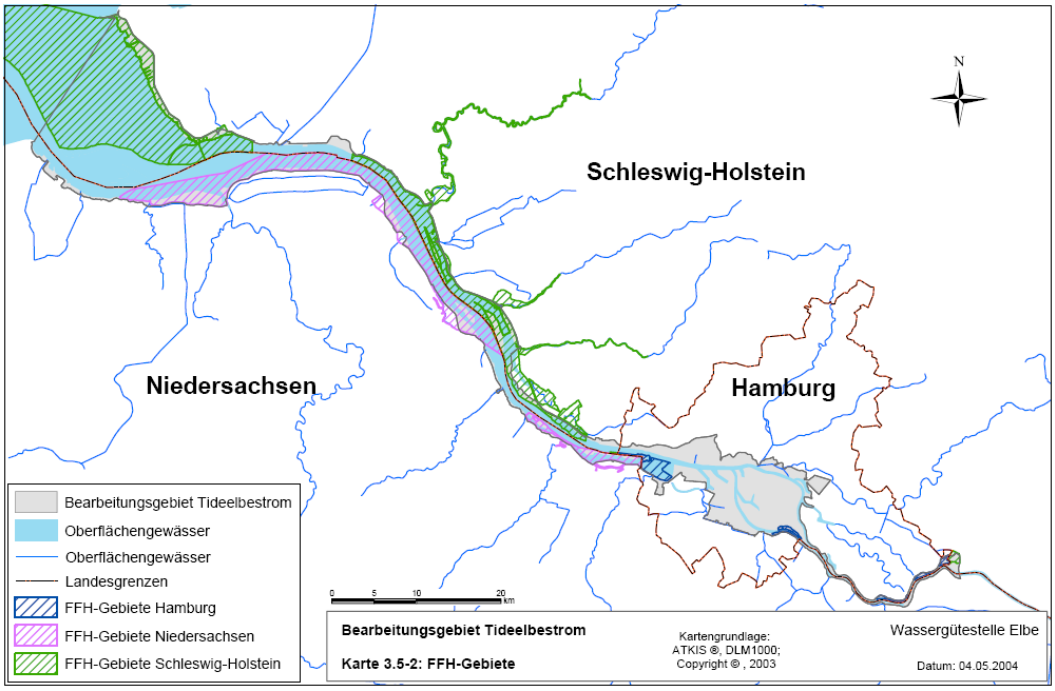

Figure 6-2: EU Flora and Fauna Habitat (FFH) reserves in the Lower Elbe region, courtesy of Arge-Elbe. The blue striped, green striped and purple striped areas are FFH-reserves in Hamburg, Schleswig Holstein and Lower Saxony, respectively.

6.1 Impacts on the Lower Elbe ecosystems

A preliminary classification of the tidal Elbe by the Länder Hamburg, Lower Saxony and Schleswig Holstein together with the Wassergütestelle Elbe[49] according to the classification system of the EU Water Framework Directive ascertains that the Elbe is a "significantly altered" water body (Arge-Elbe, 2004a). The most important alterations concern

- the depth and breadth of the river,
- the tidal hub,
- the artificial restriction of the tidal movement through the weir in Geesthacht,
- the flow velocity and
- the reduction of shallow water areas, mudflats and foreland areas (ibid).

Consequential river construction measures during the last 4 decades include dike building and fortification, river deepening, the barraging of tributaries or side-arms, shoreline fortification and the filling up of port basins and the Mühlenberger Loch. Over the last 180 years, the Lower Elbe has been gradually deepened from not more than 2.5 m in some parts to 15.3 m (Arge-Elbe, 1984). The waterway reached a depth of 5.3 m in 1859, 9 m in 1910, 11 m in 1961, and 12.5 m in 1969. Between 1974 and 1978, it was further deepened to 13.5 m and between 2000 and 2002 to 15.3 m (Freie und Hansestadt Hamburg, 1995, Roberz, 2003). A next deepening to 16.8 m[50] is currently planned. For the planned deepening, approximately 38 million m³ dredge material will have to be moved (BUND, 2005a). In addition to deepening measures the main waterway had to be straightened and narrowed in order to prevent siltation.

[49]This independent applied research institution could be translated as office of water quality for the Elbe.
[50]The indicated numbers describe the actual depth of the river rather than the maximum permissible draught.

River deepening together with other measures – dike building, the filling up of port basins, the construction of polders and of flood barrages in tributary streams and the straightening of the course of the river – have led to a decrease of the low tide and an increase of the height of floods (Sievert and Havnoe, 1988, Freie und Hansestadt Hamburg, 1995). According to Siefert and Havnoe, 1988, Elbe deepening measures account for approximately 20 % of the rise in higher high water, dike building for 66 % and flood barrages in the Lower Elbe's tributary streams for about 13 %. Following the flood of the century in 1962, existing dikes were heightened and fortified and further tributaries were separated from the Elbe through barrages.

The most important impacts were the loss of ecologically valuable areas and habitats, the discontinuation of the flooding of areas and the decrease of the concentration of dissolved oxygen. We will give more detail on these three types of impacts in sections 6.1.1–6.1.5. Other impacts that are generally regarded to be somewhat less significant include the upward shift of the brackwater zone (Bergemann, 1995), nitrate input leading to eutrophication in the river and at the North Sea coast, and shifts in land-use. The latter include road building, a sharp increase of visitors in ecologically valuable areas such as the Nordkehdinger Marsch, the earlier mowing of pastures, the increase of farm animals and the intensification of tillage operations. These are partly counterbalanced, however, through agri-environmental programmes. Such programmes and their acceptability by farmers will be discussed in part II of this thesis. Measures suggested in literature to improve the ecological properties of the river will be summarized in section 21.2.1.

6.1.1 The loss of ecologically valuable areas

The loss of ecologically valuable areas is due to dike building, the deepening of the waterway, the depositing of dredge material, the filling up of water bodies, the disconnecting or siltation of sidearms and tributaries, shoreline stabilization and the straightening of the course of the river. This concerns flood plains, shallow water areas, tidal inlets and ditches, mudflats, port basins and a significant part of the large freshwater tideland Mühlenberger Loch. These areas constitute important habitats to a large number of species. More than 70 % of the plant species that were originally native to the area have now disappeared or are threatened with extinction (Freie und Hansestadt Hamburg, 1993). Extensive populations of plants that find a habitat in the land-water interface usually require broad and somewhat plain shorelines. Due to extensive shoreline stabilization, these have become quite rare at the Lower Elbe[51].

During the last 30 years, 107 ha of port basins were lost through filling up (Freie und Hansestadt Hamburg, 1995). Other water bodies have been filled with dredge material (Arge-Elbe, 1991). Flood plains were lost mostly through dike building. Dike building after 1962 resulted in a loss of 47.9 % of the flood plains on the northern and 74 % on the southern river bank relative to 1900 (Arge-Elbe, 1984). These changes actually constituted the continuation of the decimation of the flood plains and water bodies since at least 1850 (Riedel-Lorje, 2005). Originally, the flood plains were home to extensive reeds, softwood floodplain forests as well as other types of wood further away from the river (ibid, Freie und Hansestadt Hamburg, 1993). The river was characterized by mosaic structures formed by side-arms, islands, tidal inlets and ditches. Parts of the city of Hamburg – e.g. Finkenwerder and Altenwerder – were actually created by sedimentary deposition through high storm floods (Riedel-Lorje, 2005). In addition to the loss of flood plains, shallow water areas were decreased. Arge-Elbe, 1984 notes a loss of 31.2 % on the northern and 8.5 % on the southern bank since 1900. In particular on the southern bank, shallow water zones near and in

[51]Important exceptions are the Haseldorfer Binnenelbe, Schwarztonnensand, Krautsand and Pagensand.

Hamburg have been lost almost completely while some new ones were gained further downstream. This implies a gain of brackwater shallow water zones at the expense of freshwater shallow water zones.

Different types of mudflats are found in the Lower Elbe river basin. Arge-Elbe, 1984 distinguishes between alluvial mudflats, sand mudflats and mixed mudflats. Due to their fine-grained sediment, the alluvial mudflats are characterized by a particularly high proportion of organic material and high species diversity. Freshwater mudflats are of particular importance as breeding area for waterfowl and as resting and feeding area for migratory birds (Freie und Hansestadt Hamburg, 1993). Saltwater and freshwater mudflats were decimated by 7 % and 25 % respectively since 1900 in addition to losses of unknown extent before 1990. The remaining freshwater mudflats aside from the Mühlenberger Loch are unfortified shorelines of the river and the shorelines of ditches or tidal inlets.

6.1.2 Impacts on the Mühlenberger Loch

The Mühlenberger Loch, a mudflat of 675 ha in Hamburg-Finkenwerder, formerly constituted the largest freshwater mudflat in Europe. Despite its status as nature reserve and Ramsar wetland, about 25 % of the Mühlenberger Loch have been filled up since 2001 in order to construct an extension of the Airbus plant[52]. It is expected that an additional part will be lost through siltation as a consequence of these measures (compare Figure 6-3). The Mühlenberger Loch is of extremely high ecological importance for the estuary ecosystem and for migratory birds. This is due to its location in the freshwater part of the tidal Elbe, its size, its low depth and ideal light conditions in the water, and the finely grained sediment with a high proportion of organic matter and processes stimulated by the tidal movement. In fact, the loss of large parts of the Mühlenberger Loch is not only environmentally extremely unfortunate, but is also questionable from a legal point of view. In addition to its protected status, the preservation (rather than destruction) of the shallow water zones in the Mühlenberger Loch had been intended as compensation[53] for the Elbe deepening measures of the late nineties (Kausch, 2002).

The Mühlenberger Loch has the highest biological production per area in the tidal Elbe (Kausch, 2002). Due to its well-functioning self-cleaning properties, the water in the Mühlenberger Loch is usually much cleaner than the water in the rest of the Elbe (ibid). It is of high importance for fish larva and as upbringing area for juvenile fish (e.g. Thiel, 2001, Kausch, 2002). Before it was partially filled, there were approximately 10–100 times as many larva and juvenile fish per area in the Mühlenberger Loch than in other areas of the tidal Elbe (ibid). Fish that particularly depend upon the Mühlenberger Loch include the stint (Osmerus eperlanus) and the highly endangered twaite shad (Alosa fallax). Fish used to find the by far largest remaining shallow water zones in the Mühlenberger Loch, they were able to find

[52]This was granted by the European Commission for reasons of "overriding public interest at the level of "Hamburg, the northern German region and the European aviation industry" (Ramsar Advisory Mission, 2001) which were specifically requested in a letter by German Federal Chancellor Gerhard Schroeder to the President of the European Commission Romano Prodi on March 15, 2000 (Westphal, 2001, Environment News Service, 2001). The extension of the Airbus-plant is not only questioned by various sources due to the overriding of international environmental directives, but also due to the associated dispossession of fruit farmers and other residents, noise exposure and the degradation and partial destruction of the cultural landscape that has been gradually established over the last 1000 years. In addition, despite public outcries, the city paid € 665 m for the preparation of the land for building (Buddensiek, 2002).

[53]Kausch, 2002, points out that the preservation of shallow water zones in the Mühlenberger Loch would only have served as *mitigation*, not *compensation* of the effects of the river deepening, since it only provides shallow water zones in a certain small part of the river while destroying shallow water zones or other ecologically highly valuable areas in many other parts.

nutrition there during high tide and could seek refuge during times of very low dissolved oxygen concentration in the Elbe[54]. Since the partial filling up, the new airbus area separates the deep water of the navigation channel from the fish-refuge areas of the Mühlenberger Loch (compare Figure 6-3).

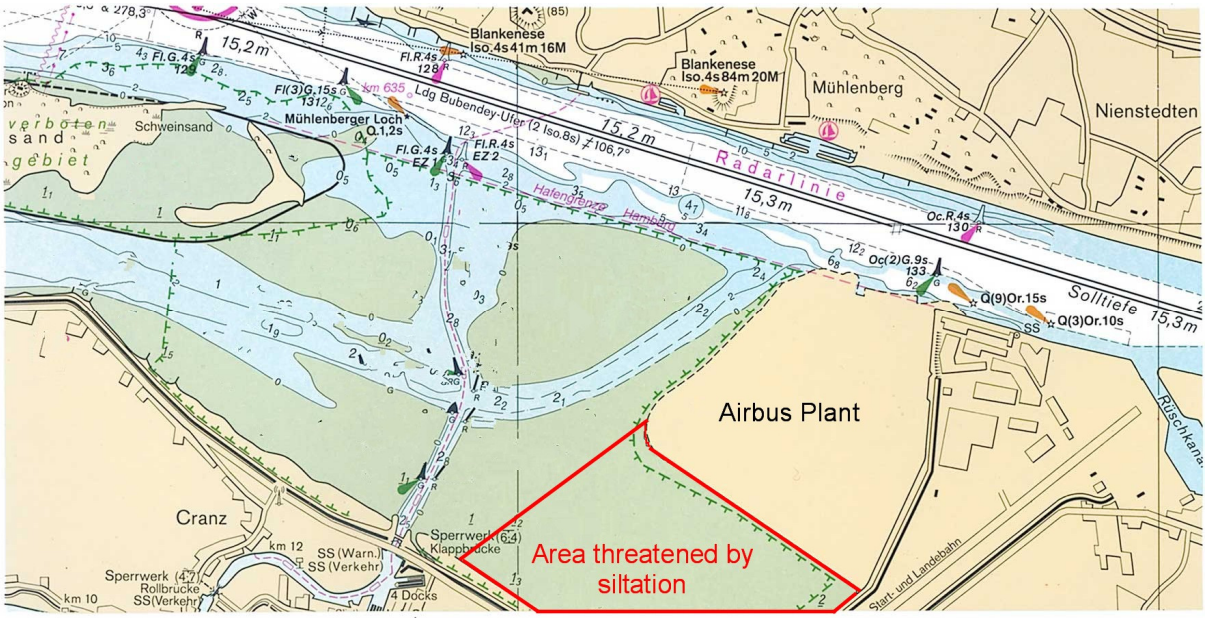

Figure 6-3: The Mühlenberger Loch. Courtesy of the Mühlenberger Segelclub e.V. The red lines indicating the area threatened by siltation have been added by the author on the basis of Kausch, 2002.

The mudflats of the Mühlenberger Loch also provide rich feeding grounds for waders and ducks. More than 10.000 water birds are regularly counted. Migrating ducks whose numbers frequently exceed 1 % of the North Sea-Baltic populations are the teal (Anas crecca), the Shoveler (A. clypeata), the Shelduck (Tadorna tadorna), the tufted duck (Aythya fuligula), the pochard (A. farina) and the goldeneye (Bucephala clangula) (Ramsar Convention on Wetlands, 1992). The population of the Shoveler in the Mühlenberger Loch before the filling up was more than three times the threshold which classifies a site as habitat of international importance (Mischke, 1997). The Mühlenberger Loch is also of international importance for the teal (Anas crecca) and the little gull (Larus minutus) and of national importance for the black-headed gull (L. ribibundus), the common gull (L. canus), the herring gull (L. argentatus), the great black-headed gull (L. marinus), the common tern (Sterna hirundo), the cormorant (Phalacrocorax carbo) and the pintail (Anas acuta) (Kausch, 2002, Mischke and Garthe, 1994, Mischke, 1997). In addition, the Mühlenberger Loch serves as habitat for various small water animals such as crabs or flatworms and for various insects. Four extremely rare plant species grow around the banks and in the Neßsand nature reserve: Deschampsia wibeliana, Denanthe conivides, Xanthium albinum and Rumex triangulivalis. These are restricted to the freshwater area of the Elbe's tidal reach (Ramsar Convention on Wetlands, 1992).

[54]According to Kausch, 2002, before the filling up of the Mühlenberger Loch, the concentration of dissolved oxygen was about 10–20 % higher than in the rest of the tidal Elbe.

6.1.3 The decrease of naturally flooded areas

Naturally flooded areas were reduced by 75 % between 1930 and 1980 (Arge-Elbe, 1984). This included areas flooded by the spring and autumn high floods and areas that are flooded by daily tidal movements – e.g. tide-dependent creeks, freshwater and brackwater mudflats, sidearms, ditches and tidal inlets. These areas are of crucial importance to the biological regeneration and self-cleaning capacities of the Elbe as well as for the fertilization of the flooded land. Flooded ditches and tidal inlets constitute highly productive habitats. The tidal flooding of these enabled the exchange of fauna and flora with the river and the functioning of these areas as part of a huge littoral – a kind of natural extension of the river's shoreline. This stopped with their disconnection from the Elbe. The biomass in the side-arms – which possess more shallow water zones – is now significantly higher than the biomass of the main river (Arge-Elbe, 1984).

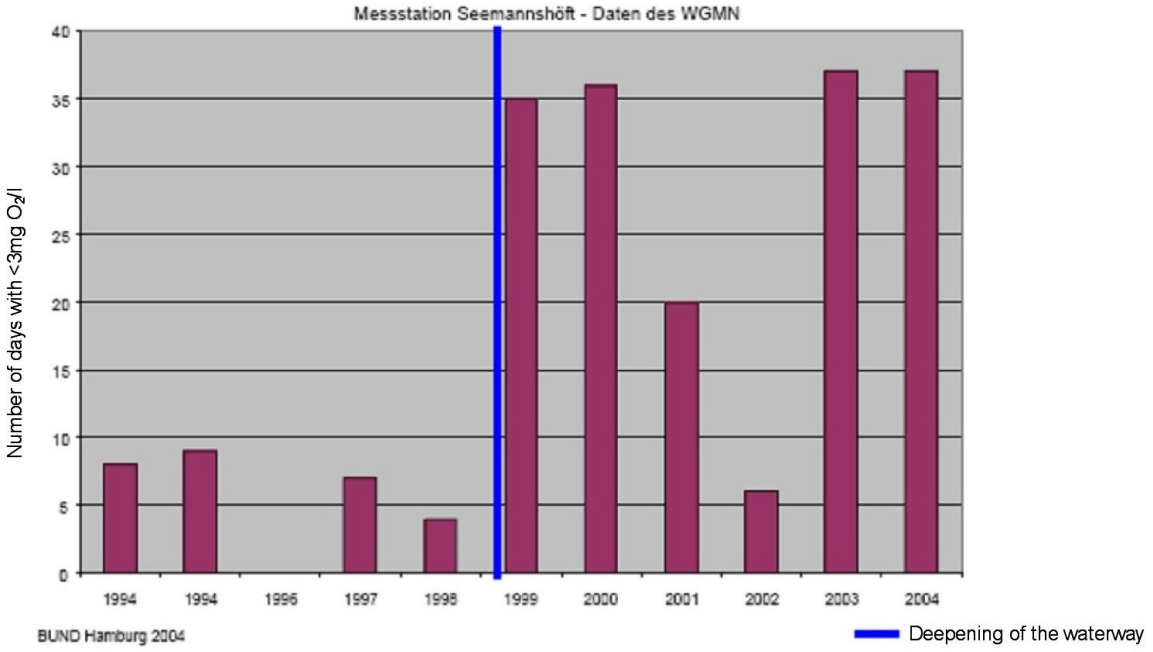

Figure 6-4: Number of days since 1994 with oxygen concentration below 3 mg in the Elbe river (based on data by the Wassergüte Meßnetz der Stadt Hamburg (WGMN), courtesy of BUND Hamburg). The dark blue line indicates the time of the deepening of the waterway in the late nineties.

6.1.4 The decrease of dissolved oxygen concentration in the river

Another problematic impact is the low concentration of dissolved oxygen at certain times of the year, especially during the summer months (Arge-Elbe, 2004b, BUND, 2005b). During the eighties, the concentration of dissolved oxygen repeatedly fell below the threshold that is necessary for the survival of fish in the Elbe (3 mg/l O_2, Arge-Elbe, 2004b). This was due to the discharge of large amounts of oxygen depleting substances (Arge-Elbe, 2004b). This led to frequent fish die-off. The first improvement occurred with the upgrading of the sewage treatment plant in Köhlbrandhöft /Dradenau, Hamburg. After the German reunion the discharge of oxygen depleting substances was cut by half through the closedown of industrial plants and the upgrading of wastewater treatment plants (ibid). This lead to a significant improvement of the oxygen concentration near Hamburg. However, the incisive loss of shallow water areas and increased overall depth of the river together with the still too high nutrient contents in the Middle and Lower Elbe have reversed this positive trend. The deepening of the waterway has decreased the specific water surface (the ratio of the surface to

the depth) so that the same surface has to supply a greater depth with dissolved oxygen. Figure 6-4 illustrates the sharp increase of days with low oxygen concentrations in 1999 that is most likely due to the deepening of the waterway that took place at that time. During times when no actual deepening of the waterway is taking place, regular dredging measures to maintain the required depth of the waterway have to be carried out. The carrying out of dredging measures during summer – the most critical time for the fish in terms of oxygen concentration – regularly leads to several days of oxygen concentration below the threshold of 3 mg/l O_2 (BUND, 2005b).

Other measures that affect a decrease of oxygen concentrations are the filling up of water bodies and the building of dams (BUND, 2005b). Due to the significantly higher depth of the water and the increased concentration of suspended sediment, oxygen producing algae often die downstream of the port of Hamburg. Their decomposition further reduces the concentration of dissolved oxygen. Also, due to the high concentration of suspended sediment, photosynthesis can only take place at a depth of at most 2 m, so that oxygen production is already outweighed by oxygen depleting processes from a depth of 1 m or even 0.5 m downwards (ibid). Fish, especially young fish, depend on shallow water areas for their survival. With the decimation of shallow water areas in the river itself, the filling up of parts of the Mühlenberger Loch and the disconnection of sidearms, high summer temperatures often lead to fish die-off.

Another anthropogenic influence that is regarded as main contributor to changes in the species-richness and quantity of fish in the Elbe compared to 1900 or earlier is overfishing (Arge-Elbe, 1995). Despite these influences and times of very low oxygen concentration the Lower Elbe is still quite species-rich – as are the Upper Elbe and Middle Elbe (Arge-Elbe, 1995 and 2000b). Arge-Elbe, 1995 counted 79 fish species in the entire Elbe during the research period 1991–1993 and 94 species during the extended period 1990–1999. This includes 37 limnic, 11 euryhalin and 31 marine species. There are two restrictions to this, however. Firstly, accounts of the fish stock of 1900, which are taken as best available historic accounts for a comparative stock taking of the present fish stock, also describe the situation of a fish stock exposed to heavy anthropogenic influences (Riedel-Lorje, 2005) through extensive fishing and river construction measures. The Elbe-salmon and sturgeon were already threatened around 1900 and considered extinct in the early twenties (ibid, Arge-Elbe, 1995 and 2000b). Secondly, a number of highly endangered or nearly extinct species that formerly found a habitat in the Lower Elbe (and not in the other parts of the Elbe) have now disappeared or are only present in small numbers (Arge-Elbe, 1995).

6.1.5 The deepening of the waterway

To conclude, possible ecological impacts of the planned next Elbe deepening will be looked at. Here, opinions are divided. According to Freie und Hansestadt Hamburg and Wasser- und Schifffahrtsamt Hamburg, 2002, if the changes of the river's water levels due to the deepening measures remain marginal, noteworthy environmental impacts are not expected to occur. Other sources[55] note and explain different types of impacts – some of which may only become apparent if observation of the state variables concerned occurs over a longer time period. This includes:

- increased siltation processes at the expense of valuable shallow water zones and other valuable areas (Kausch, 2000, Arge-Elbe, 1984, Eichweber, 2005, Arge-Elbe, 2004a),

[55]Sources quoted here will include scientists, the Wassergütestelle Elbe and environmental NGO's.

- the destruction of shallow water zones and mudflats with reeds (independent of siltation processes, e.g. through mechanical destruction (Arge-Elbe, 2004a, Riedel-Lorje, 2005),
- the loss of valuable ecological areas through the deposition of dredge material (Herbert, 2005),
- the amplification of oxygen depleting processes and decrease of oxygen producing processes through increased turbidity (Eichweber, 2005),
- the destruction of existing benthic bioceonosis and subsequent development of a new biocoenosis (Arge-Elbe, 2004a) and
- the upstream shift of the brackwater zone with the consequence that the limnic part of the river is shortened and freshwater mudflats, marshlands and reeds are lost (Herbert, 2005, compare also Bergemann, 1995).

With respect to the planned next Elbe deepening, BUND, 2005a notes that the dredge material that will have to be removed during the next deepening is three times the amount of the previous deepening. This is in parts due to the need to broaden the Elbe in several areas (river kilometres 680–644, 644–636, 636–632 and 632–626 – Herbert, 2005) Also, areas will be affected that were not affected by the previous deepening measures[56]. Further impacts that are particular to the planned next deepening are due to the construction of under water deposit areas for dredge material (ibid). 16 Natura 2000 sites may be impacted by the deepening, for one site this is regarded as "likely" according to the environmental risk analysis prepared by the Federal Agency for Hydrology (Bundesanstalt für Gewässerkunde) (ibid).

6.2 Consequences of climate change for the Elbe ecosystems

The opinions presented in the following have been collected during a series of interviews with environmental scientists, a nature conservation representative for the region[57] and an organic farmer with a background in environmental sciences. Some of these opinions may not be impartial. It was found, however, that the statements made by the different experts all pointed in the same direction – i.e. expected similar types of impacts – only the magnitude of the expected change differed to a minor degree.

The questions posed to interviewees are reproduced in the following:

1. Which impacts on the river ecosystems do you expect if temperatures were to increase by up to 1 °C[58] until 2030, with a tendency of a stronger increase in winter and spring than in summer?
2. Which impacts on the river ecosystems do you expect if precipitation decreases by up to 4 mm per month during summer until 2030, and increases by up to 6 mm during winter?
3. Do you think that some parts of the river ecosystems are more threatened by possible climatic changes than others? If so, which are these and what kind of changes would be particularly threatening?
4. Are there possible climatic changes that you would consider beneficial for the river ecosystems, and if so which?

According to the interviewees, a rise in temperature would be particularly consequential for both the river and the terrestrial ecosystems. Two types of impacts are possible. Firstly, for

[56] An example is St. Margarethen (ibid).
[57] German "Naturschutzbeauftragter", compare footnote 34 of chapter 3.
[58] This exceeds the projections made in 5.2, however, a change of 1 °C was considered much easier for the farmers to relate to.

both the river and the terrestrial ecosystems, migration of species that are used to a warmer climate may occur. Fish, bird, snail, crab and shell species that are not native to the region have been sighted in recent years. The reason for this phenomenon is not clear. Some of these animals are expected to reach the Elbe via ships. Since the newly sighted species are mostly native to a warmer climate, a rise in temperature is considered likely to contribute to their spread in the region's ecosystems.

Non-native fish species that have been sighted repeatedly in the last 10 years include the Flathead Mullet (Mugil cephalus), the Goldsinny (Ctenolabrus rupestris) and the Striped red Mullet (Mullus surmuletus). Birds that have been sighted repeatedly near the river or in the moors include the Great White Egret (Casmerodius albus), the Roller (Coracias garrulus), the Egyptian Goose (Alopochen aegyptiacus) and the Stonechat (Saxicola torquata). In certain cases, new species may compete with species that have been native to the region for the last few hundreds or thousands of years. This is the case with the native Whinchat (Saxicola rubetra) which shares its habitat with the Stonechat which is new to the region. If the primary aim is to protect native species, a rise in temperature could consequently be seen as disadvantageous, in particular if it should happen quickly. However, a certain change in species composition may also be seen as a process that tends to occur naturally over time. If necessary, native bird species may be protected against competition of new species through the cultivation of habitats such as areas of grassland, wetlands or extensively cultivated areas.

A rise in temperature may also impact native species directly. Rising surface temperatures in the North Sea may shift the reproduction time of fish or of plankton, so that feeding conditions are less than optimal when fish larva hatch in spring. In addition some species may migrate north. A native type of vegetation that is expected to benefit from a rise in temperature is the moor – in particular if both temperature and humidity rise.

The second and more significant likely impact of rising temperatures is a decrease of the river's oxygen content. As discussed in section 6.1.4, if the river's oxygen content falls below 3 mg per litre, fish have to seek out areas with a higher oxygen content in order to survive, such as shallow water zones. The interviewees expect that under a scenario of relatively strong climate change – such as the A2-scenario considered here – fish die-off will increase. More specifically, fish die-off can be expected to occur more frequently and for longer periods of time. Thus, under a scenario of relatively high climate change, the carrying out of measures to improve the river's concentration of dissolved oxygen or to provide fish refuge areas will gain in importance.

7 Conclusions

Increases of the mean annual maximum water level of up to 15 cm in Cuxhaven and up to 20 cm in St. Pauli due to the combined effect of storm surges and sea level rise appear possible and plausible for the time horizon of 2030, giving a total mean annual maximum water level of 4.76 in St. Pauli. In 2085, the expected increases for Cuxhaven are up to 61 cm and up to 84 cm for St. Pauli, with a total mean annual maximum water level of 5.39 in St. Pauli. These values are uncertain, not only because of the employed emission scenarios but also because of a series of downscaling steps, which describe the cascade of processes from increased emissions to local climate change impact. When using different scenarios and models we have a range of possible changes between 13–20cm in 2030 and 50–86cm in 2085. At present, water levels of 5 m or more result in business interruptions in the port of Hamburg. It is intended to heighten all quay walls to 7.5 m during the next few years. If this is consequently carried out, dock sites will be well protected from flooding until at least 2030, even under a scenario of relatively strong climate change.

An increase of the mean winter temperature in the region by up to 0.62 °C in some parts and 0.63 °C in other parts of the region is possible, as well as an increase of mean summer temperatures by up to 0.55, 0.65 °C or 0.71 °C for the region's different parts. Winter precipitation may increase by up to 0.13 mm in some parts and 0.19 mm in other parts, while summer precipitation may decrease by up to 0.1 mm, 0.12 mm or 0.13 mm. According to farmers, in the given scenario of climate change, a decrease of yields can be expected for the Geest-part of the region. Since profit margins are very narrow (up to 4–5 % of overall turnover), already decreases of yield, or increases of costs by less than 5 % are likely to result in the closing of farms unless additional Federal or EU support payments become available. In addition, soils are likely to become karstic, and soil erosion is expected to increase. It is difficult or impossible to compensate this impact.

In the marshland-part of the region, an increase of summer temperatures or decrease of summer precipitation would only have slight negative impacts. The increase of winter precipitation is expected to cause negative impacts in the marshlands, namely through prolonged flooding and soil eluviation. Warmer winters are expected to cause negative impacts in both parts of the region, in particular in the marshlands. Opinions on the level of flood protection were divided. A few interviewees suggested that dike relocation and the re-establishment of naturally flooded areas could become advisable in order to protect the marshlands and the parts of the Geest that are close to the coast.

With respect to the river's ecosystems, the main impact that experts expect in a scenario of relatively strong climate change concerns an amplification of oxygen depleting processes through the rise of temperature. This is likely to lead to fish-die off. It seems therefore advisable to carry out measures to improve the river's concentration of dissolved oxygen or to provide fish refuge areas.

PART II:

FUTURE PERSPECTIVES

FOR THE RURAL AREA[59]

[59]A paper based on this part of the thesis has been submitted to Agriculture, Ecosystems and Environment: Grossmann, I., 2005: Structural change and nature conservation in the agricultural landscape of the Lower Elbe region – a case study. Agriculture, Ecosystems and Environment (in review).

8 Introduction

This part of the thesis presents an investigation of future perspectives for a selected rural area that is part of the region. The study area consists of the two Lower Saxon districts Cuxhaven and Stade that are located on the southern side of the Elbe between Hamburg and the Elbe mouth (Figure 8-1). Both are primarily rural in character with agriculture playing an important role. The particular challenges faced by this region at this time are due structural changes and changes of the legal framework for agriculture that are common to rural areas throughout Western Europe (European Commission, 2003). The following chapters will explain these changes and explore possibilities for the study region to respond to new requirements and to access new opportunities. The core of the investigation is formed by results from a Focus Group held with the above question in mind and subsequent face-to-face interviews with selected participants. At a later stage, phone interviews were conducted to investigate farmers' expectations of impacts on agricultural production in a scenario of climate change.

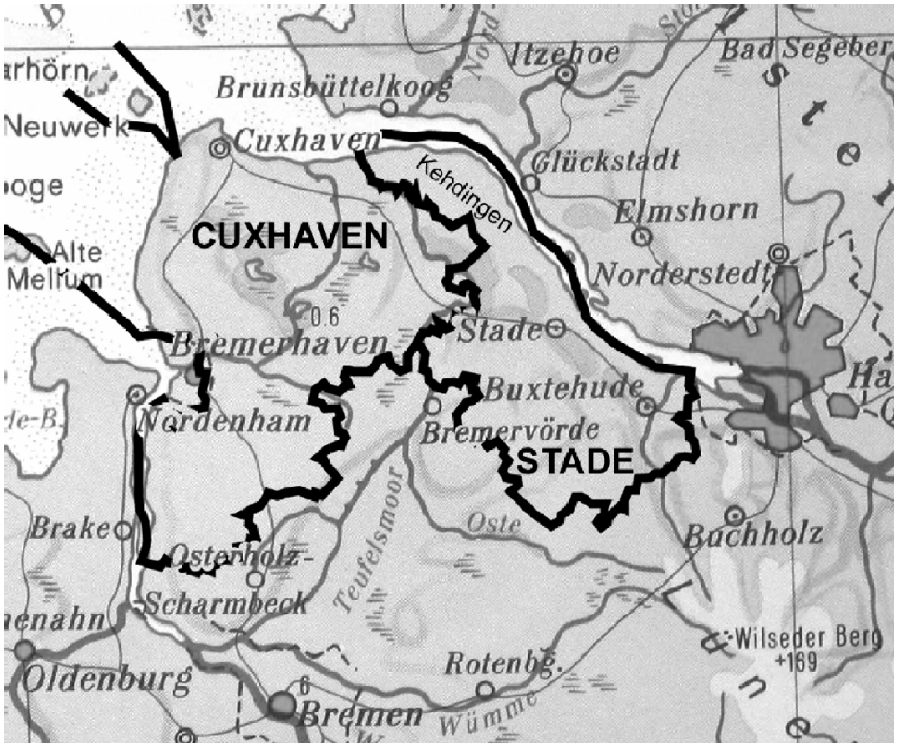

Figure 8-1: Map of the study region. Railroads are indicated by thin lines. © Hölzel Ltd., Vienna with friendly permission. Administrative borders added by the author.

An overview of current challenges and possible new income sources for rural areas in Western Europe is given in section 9.1. Section 9.2 gives a summary of the specific situation in the study region, followed by a summary of the questions and aims resulting for the Focus Group (section 9.3). Chapter 10 introduces the Focus Group methodology. In addition to gaining clarity on the regional situation, the primary aim of the Focus Group was to discuss viable future strategies. These were developed in the form of two scenarios. Particular emphasis was put on the practical details of each scenario. This includes strategies to maintain the region's viability, meet new requirements and access new opportunities, but also a discussion of shortcomings of present policies, agri-environmental programmes and approaches to dike relocation. We will give a summary of the main problems of the region according to Focus Group participants in section 11.1. The two scenarios will be presented in

sections 11.2 and 11.3, together with a discussion of bottlenecks and policy requirements for each. In chapter 12 this is complemented by a discussion of possible responses to a scenario of climate change. This includes a presentation of possible approaches to dike relocation projects in the region that would be more acceptable to the region's farmers (section 12.2), and agricultural adaptation strategies (section 12.1).

9 Research questions and aims

9.1 Current challenges for the rural areas of Western Europe

In the following, three groups of changes occurring in rural areas in Western Europe at present will be summarised.

Firstly, there is increasing pressure on the agricultural sector and the rural space as such. This is partly due to a further shift from a production-based economy to a service based economy and from rural to urban lifestyles, partly to the extension of the European Union. The competitive landscape for farmers in Western Europe changes as new EU member states with lower production costs enter the agricultural market and as payments to farmers in Western European countries are reduced (European Commission, 2003).

A second major change concerns the reform of the Common Agricultural Policy of June 2003 (European Commission Directorate-General for Agriculture, 2003). Payment entitlements for farmland will henceforth be decoupled from production and based on historic reference payments. For cropland, 25 % of the payments may remain coupled to production. With respect to farm animal premia, states may choose between different combinations of partial decoupling for cattle and slaughter premia. Cross-compliance with standards in the fields of environment, food safety and animal health and welfare is mandatory and payments will only be received for land that is kept in "good agricultural and environmental condition" (ibid).

A third type of change is due to several far-reaching new environmental regulations. This includes the establishment of Natura 2000 sites (European Commission Directorate-General for the Environment, 1999 and 2000) on the basis of the birds and habitat directives (European Commission Directorate-General for the Environment, 1979 and 1992). Sites of special importance for conservation of both species and habitats must be nominated to the European Commission by the member states. The member states are responsible for subsequent conservation strategies such as legal restrictions, conservation contracts or conservation by purchase (European Commission Directorate-General for the Environment, 2000). This implies restrictions to farmers' activities. On the other hand, for some regions positive economic impacts, in particular on tourism, are also possible (compare Getzner and Jungmeier, 2002).

Of importance for economic activity in rural areas is also the European Water Framework Directive (WFD) which came into force in December 2000 (European Parliament and Council, 2000). Member states are required to achieve a "good surface water status" with respect to ecological and chemical status and a "good groundwater status" with respect to chemical and quantitative status (European Parliament and Council, 2000). An important consequence for agriculture is the need to reduce nutrient input into ground- and surface water (Appel, 2001, Ruchay, 2001).

In some countries additional environmental laws have been or are presently being defined. For Germany this includes in particular the new version of the Federal Law of Environmental protection (Federal Republic of Germany, 2002). In this directive, new standards of "good professional practice" of agriculture are introduced that have to be framed into binding regulations by the Federal German States (Oerter and Hellenbroich, 2003). New requirements

include the avoiding of soil erosion, the establishment of nature-orientated shorelines and the establishment of a Germany-wide network of biotopes (ibid).

Rural areas in Europe are responding to these changes in different ways, depending on their set-up in terms of rural amenities and infrastructure, natural and cultural heritages and their economic base. With respect to the CAP, Germany has chosen a "combi-flex" approach in which a base rate for farm land and grassland is established that allows the maintenance of portions of the different cattle premia[60]. Nevertheless cattle rearing is probably the German agricultural sector that is most affected by the reduction of payments (Habermann, 2005, Isermeyer, 2003).

In comparison with new EU member states, many Western European regions – including the study area – are endowed with a high level of technical education and a highly developed infrastructure for marketing and consulting. This may enable them to access new income sources arising from a growing demand for high food quality and safety and organic food (Isermeyer, 2001). Another new income source is due to agri-environmental programmes (Osterburg, 2001, Lütz et. al., 2002, Marggraf, 2003). Diversification into tourism is another option. It is not the only source of rural employment growth, however (Terluin, 2003) – in the more successful rural European areas, economic growth is also due to employment in fields such as community services or wholesale and retail trade (ibid).

9.2 The situation in the region

The study area is quite rural and agricultural in character. In 2003, wage-earners working in agriculture, forestry and fishery accounted for 7.82 % and 5.57 % of wage-earners in the districts Cuxhaven and Stade respectively, compared to 3.48 % in all of Lower Saxony (Niedersächsisches Landesamt für Statistik, 2005). The number of farms has shown a strong decrease over at least the last 15 years[61]. Dairy farming is of high economic importance, implying considerable losses through the discontinuation or weakening of the cattle and slaughter premia. A substantial part of the region has very good soil that is suited for a large variety of produce. Nevertheless at present production is mostly limited to wheat, rapeseed, maize and apples. Parts of the region – e.g. Kehdingen – are not well accessible by train or road (compare the railroads indicated in Figure 8-1).

The region is part of the Lower Elbe river basin which is a Ramsar-wetland of international importance (compare section 6 of this thesis). Historically, the river basin had been characterized by periodic flooding, the presence of large stretches of marsh lands and wetlands, biologically highly productive tide-dependent ditches, and saltwater and freshwater mudflats. The extensive dike building measures of the sixties and seventies and other measures radically altered the landscape. Despite these measures the marshland of Nordkehdingen, which is located in the study region, has remained a very important breeding habitat for migratory birds, including the endangered species Brent geese (Branta leucopsis) and Bewick's swan (Cygnus bewickii) (Grimm, 1983).

Agri-environmental programmes aim to protect the marshland while providing an additional source of income to farmers. In Germany, 25 different agri-environmental programmes exist at the Federal states level (Osterburg 2001, Marggraf, 2003). These programmes account for nearly 40 % of the German government's expenditure for nature conservation (Stratmann and

[60]E.g. the slaughter premium and 50 % of the extensification premium for cattle.
[61]In Kehdingen for example, farms were reduced to 45.7 % from 3154 in 1991 to 1755 in 2000 and to 1140 in 2005 (BUND 1997b).

Marggraf, 2001) and have been co-financed by the European Commission since 1985. The national programmes mainly promote extensification measures and organic production methods (Marggraf, 2003), making use only of the first three issues out of six that are specified in the regulation 2078/92 of the European Commission (ibid, European Parliament and Council, 1992)[62]. Additional programmes have been established in some Federal states. In the study region, organic farming and the establishment or protection of grasslands as birds feeding area constitute the core part of the available agri-environmental programmes.

A possibility of high ecological benefit for the land close to the river is summer dike opening or dike relocation, for instance at the dikes of Belum, Hullen and Allwörden (Arge-Elbe, 1991 and 1994). Although public resistance is high, approaches of this kind are becoming more likely through the prospect of rising flood levels and the new Federal flood protection law which explicitly encourages the reclaiming of retention areas (Federal Republic of Germany, 2005).

9.3 Resulting questions

The changes faced by the region pose important questions. Firstly, the meaning of the changes for the farmers needs clarification. This involves identifying new requirements and ways to meet them as well as developing strategies to make use of new opportunities such as agri-environmental programmes. Secondly, the investigation of viable regional future possibilities needs to identify the possibly contradictory concerns of the different actors and interest groups involved and where possible, explore ways to synthesise these. Finally, new possibilities may need suitable support policies. In the case of the study region this concerns a clarification of the match or mismatch of agri-environmental programmes with farmers' needs, together with an investigation of possible adaptations of the programmes in order to increase their acceptability to farmers. For instance, depending on soil and climate conditions in a certain region, existing specialisation in certain agricultural produce or modes of production, different types of agri-environmental programmes may be most suited while specific bottlenecks may exist with respect to others (Prager and Nagel, 2004). Such differences may not be readily visible from the viewpoint of policy makers. In cases where conservation programmes are clearly profitable for landowners, obstacles towards the implementation of conservation programmes may arise due to attitudes, traditions and the farmers' particular relationship to the natural environment (Lütz et. al., 2002). Participatory methods are very well suited to gather knowledge about these concerns, to take into account underlying regional specifics (Polsky et al., 2003) and to discuss adequate strategies of response in a process that includes members of the different interest groups concerned (Kasemir et al., 2003, Shackley et al., 1998, Robertson and Hull, 2003, Prager and Nagel, 2004).

During a series of preparatory phone interviews with potential Focus Group participants, two core concerns became apparent. Firstly, it is necessary to further the understanding of the reform of the CAP (Common Agricultural Policy), the new regulations and the consequences of present structural changes and the EU extension. Secondly, it is necessary to discuss strategies for the future viability of the region, in particular strategies that integrate the viewpoints of different interest groups and access new income opportunities such as those provided by agri-environmental programmes. The Focus Group aimed to address these two needs.

[62]These are: substantial reduction of fertilisers and/or plant protection products as well as the introduction or maintenance of organic farming methods; change of farmland to extensive grassland and the introducing or keeping of more extensive forms of crops; and the reduction of sheep and cattle per forage area.

10 The Focus Group methodology

The core of the research into future perspectives for the rural area formed a Focus Group held with representatives of the study area. The results from the Focus Group were supplemented by in-depth face-to-face interviews with selected participants and by literature research.

In the following, a brief general explanation of the Focus Group methodology will be given, and the Focus Group process in the context of this study will be explained. For further details on the Focus Group methodology the reader is referred to Morgan, 1993 and 1995, Kasemir et al., 2003, Krueger and Casey, 2000, and Glicken, 2000.

Focus Groups are a specific form of guided discussions, usually involving between 2 and 15 people. They are a combination of two methods of the social sciences: a) interviews in which information is gathered in a focused way and b) a moderated group discussion in which a small number of persons, discuss a topic which is of concern to all of them (compare Kasemir et al., 2003). Frequently, information on the chosen topic is given at the beginning[63]. Different aims may be pursued. This may include a normative aim such as the raising of awareness on certain issues or social learning. Aims may also be substantive, meaning that the contribution of the public to a research issue is sought out. Finally, there may be an instrumental aim, for instance to improve the effectiveness or acceptability of policies or products through involving the public in their design and implementation (ibid).

When employing the Focus Group methodology, it is common to conduct several meetings. Kasemir et al., 2003 recommend about 15 hours of group discussion. In the present case, approximately 6 hours of discussions were held, in addition to approximately 3 hours of introduction and expert presentations. Thus, the usage of the Focus Group method in this study had a somewhat exploratory character. It would be desirable to conduct further Focus Group sessions in order to further validate and extend the results.

The aim of the Focus Group in the case of this study was mostly substantive and to a lesser degree normative and instrumental. The Focus Group methodology has been selected as particularly useful to serve the following aims:

- the elicitation of region-specific information
- the development of realistic future possibilities that take into account local concerns and frame these into policy suggestions and
- to bring together the viewpoints of the most relevant interest groups, and explore possibilities for solutions that are of mutual benefit.

Focus groups facilitate the inclusion of region-specific aspects. In the present case these include the presence of the river and of extensive, highly valuable ecosystems, the good soil quality, the farmers' high level of education and the positioning of the region in a relatively badly accessible place near the city-states Hamburg and Bremen. Within the Focus Group process, participants are encouraged to identify these and the key analytical terms and frames of reference for themselves rather than having these imposed by researchers or policy makers (Kasemir et al., 2003, Pini, 2002). Finally, Focus Groups answer the need to synthesize the concerns of different interest groups and information from different fields. They help each interest group to learn about the concerns of other groups (Kasemir et al., 2003). Through the

[63]This is an important difference between Focus Groups and ordinary group discussions (compare Kasemir et al., 2003).

group interaction, possibilities to synthesize the different interests may be found. In the present case this was of central importance as agriculture, environmental and flood protection and administrative issues had to be taken into account equally.

For the Focus Group, a heterogeneous group consisting of nine participants from agriculture, environmental and flood protection and local administration was chosen. The selection process involved preparatory phone conversations with potential participants. In addition, information on regional politics provided by suitable representatives was taken into account (compare Pini, 2002). The selected "active" participants were complemented by the two organizers, three invited experts and four agricultural and environmental scientists who served as "passive" contributors[64]. During the first half of the day, three talks were given by the experts to provide input to the discussion. New requirements and opportunities resulting from the CAP-reform and from relevant new environmental regulations were explained. Environmental measures in the region, such as the establishment of Natura 2000 sites, were put into a larger context through an illustration of the particular value of the region's ecosystems and an explanation of their history. Finally, perspectives for the region's agricultural sector in view of the region's strengths and weaknesses and the EU-expansion to the East were presented.

Following the presentations, discussions were held. The moderator's role involved the suggesting of questions in order to address the necessary aspects of each scenario or to pick up earlier statements and clarify or investigate these in more depths. In discussions that involved only certain parts of the group, participants from other areas were invited to contribute in order to avoid silencing of margin opinions (Pini, 2002).

Questions that seemed useful for discussion had been prepared by the organizers based on the phone interviews conducted beforehand with potential participants. The questions were adapted during the Focus Group. Interestingly, participants turned out to be far better informed than expected and in many cases more aware of connections to fields seemingly outside their range of direct interests or responsibility. There was a substantial political awareness and concern beyond what the organizers perceived to be the direct interests or needs of the respective group. A highly interesting outcome in the view of the organizers was that without exception, the farming representatives were well informed on environmental matters while the representatives of environmental and flood protection stated that the in-depth learning about farming concerns that occurred during the Focus Group was a new and welcome experience to them. Agricultural topics that had been of particular interest to environmental and flood protection representatives included the different types of agriculture present in different parts of the region, the CAP and its reform, and the changed perspectives through the EU extension. Several participants expressed the wish to participate in further Focus Groups, in particular if future meetings were to include participants from a wider choice of municipalities and from further fields of relevance, such as tourism and industry.

Single face to face interviews were used during the weeks following the Focus Group to systematically fill in details, in particular about the practical aspects of the scenarios and about policy requirements. Interviewees were selected from each represented interest group. A common interview guide was used irrespective of the interviewee's background.

[64]The passive contributors were given the opportunity to contribute to the discussion when appropriate; the participants were then asked whether the information provided should be recorded within the workshop results.

11 Results

11.1 Participants' perception of the situation in the region

At the beginning of the discussion session in the Focus Group, participants were asked to report the main problems that the region is facing at present or is expected to face in the next few years. This question also formed the starting point for the interviews. Four core topics emerged: agricultural restructuring, the area of conflict between different interest groups, structural weaknesses, and problems of governance.

Problematic aspects of agricultural restructuring include the closing of farms and the increase of farm-size through increased pressure on farmers, and shortcomings of agri-environmental programmes and policies. A particularly significant shortcoming is the short running time of such programmes. A running time of at most 5 years means there is low reliability, and long-term planning is not possible for the farmers. Another problematic point is the discontinuation of an important market niche through the lowering of standards for organic produce as defined in the "Bio"-certificate. Finally, the weakening or discontinuation of the cattle and slaughter premia is highly problematic in the study region as pasture farming constitutes an important part of regional income, while at the same time making it possible to maintain the ecologically highly valuable grasslands.

A number of contributions referred to conflicting interests between agriculture, environmental protection, industry and flood protection. Most participants did not see a problem per se between agriculture and environmental protection. They maintained that the coexistence of farming with birds and their habitats has settled down into a form of balance over the centuries. Present conflicts between these two are due to the radical intensification of agricultural production since the last few decades, the increase of non-pasture farming, and on the other hand the increased number of birds through deliberate cultivation of bird habitats. Some farmers now try to scare away birds through noise-making devices in order to avoid feeding damage.

Structural weaknesses are due to the weak economic base, population shrinking and the low accessibility of parts of the region. Kehdingen, which forms the central part of the region, is located at too much distance from the railroad (see Figure 8-1). This results in the closing of shops, social problems and migration to the cities. Some of the participants expect that the dynamics in remote areas will be revived once the planned crossing of the Elbe is built towards the end of the decade.

Problems of governance include the lack of coordination and agreement between the Federal states Lower Saxony and Schleswig Holstein and the city-states Hamburg and Bremen. Participants put high importance on the need to coordinate land use designation and major projects such as a possible agreement on a Northern German main-port, or the construction of a new airport within the larger region. Also, compensation measures for the Elbe deepening and harbour expansion in Hamburg or Bremen are almost exclusively carried out in the rural areas. This is experienced as a shifting of the problems of the city-states onto the rural areas. Another critical aspect concerns the lack of open dialogue between governments or other decision makers and the public. People are not included into major projects and often decisions are taken in an intransparent way.

11.2 A specialisation scenario

In this scenario the region seeks to ensure its future viability through fully specialising in produce for which the region is internationally competitive up to now, in particular in those parts that are characterized by soils of high quality. These products include animal husbandry – in particular pigs and chicken –, wheat, fruit and cabbage.

Participants noted that grain cultivation prevails in Eastern Europe. This is expected to support the region's competitiveness in animal husbandry in the future. In particular if rents for farmland continue to rise, animal husbandry may be the only way for farmers to continue to make a living. The specialisation will involve an increase in size of existing big farms (100–150 ha) and a closing of virtually all small farms (15–30 ha). Expansion is most pronounced in the marshlands where good soil conditions prevail. Relative success factors in addition to the specialisation and the good soils are the farmers' high level of technical education, the availability of infrastructure for marketing, and of advisory services to the farmers. Another possible success factor is the growing world-wide demand for food. The latter trend was suggested by some participants on the basis of the growing world-population, and in particular changes in consumer patterns such as a drastic increase in meat consumption in Asia. In this context, one participant noted that recent events such as the drought of summer 2003 and the growing worldwide demand for food have led to an incisive and rapid rise in corn prices (40 % in 8 weeks and at the same time a reduction of the agricultural area required to lie idle by 50 %[65]). Future developments of a similar kind would favour the developments outlined in this scenario.

Participants in the Focus Group and the interviews agreed that the compliance with environmental regulations such as the WFD would not pose significant problems as long as the same standards would apply throughout Europe. It seems likely, however, that German environmental regulations will surpass the European minimum standards in particular with respect to revitalisation of the river landscape. The new draft law for flood protection points in this direction (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 2003) as does the new version of the Federal Law of Environmental Protection (Federal Republic of Germany, 2002, Oerter and Hellenbroich, 2003). Dike relocation or a reduction of drainage would increase the percentage of soils with marginal land. In fact, while the marshlands tend to have very good soils, the region also includes a relatively high percentage of marginal land, namely the Geest and moor areas further away from the river. Up to now, production in these areas has focused on dairy products in small farms of 15–30 ha. With the discontinuation or weakening of the cattle premia, these farms will be forced to close. The falling behind of such disadvantaged parts of the region constitutes one of the major bottlenecks of this scenario[66].

The risk that the region will not be able to compete with the low price level offered by new member states is another critical bottleneck. The third bottleneck named by participants is the expected thinning out of the rural space. Due to the lack of economic alternatives to agriculture and the low accessibility, increased migration to the cities is expected. The local economic structures, in particular in the service sector, will thin out and pool in the parts of the region where the larger farms are located. Participants named tourism in the form of local recreation as the best suited means both to prevent the thinning out of the rural space, and to provide perspectives for the agriculturally disadvantaged parts of the region.

[65]Franz Stolte, personal communications 2004.
[66]This would be aggravated in a scenario of relatively strong climatic changes – such as the one projected in part I of the study.

11.3 A scenario of diversification

In this scenario the chosen strategy to ensure the future viability of the region is diversification. The three main elements of this strategy are agri-environmental programmes, tourism and regional marketing of a variety of high quality and organic produce.

At present, three types of protection programmes for ecologically valuable areas can be distinguished in the region: protection of private areas under contract, inclusion of private areas into nature reserves against compensation, and purchase of private areas with subsequent rent-free lease of the land to the original owner. A large share of the protected sites consists of grassland. In the third variant, farmers have to follow guidelines about the usage of the land. The long-term nature of this programme and the cooperative, flexible handling of the contract through the local office of the environmental ministry results in high willingness from the side of farmers to actively contribute to the success of this protection programme. Protection under contracts has also been found to have a particularly positive impact on biotic resources when compared with other German agri-environmental programmes (Wilhelm, 1999). In this scenario, such programmes are made available to further parts of the region. This is made possible through extended EU or Federal funds or an extension of the Lower Saxon budget allocated to agri-environmental programmes.

Organic agriculture is another useful building block of a diversification scenario. A major requirement is the existence of clear and high quality product standards, and clear and reliable promotion programmes. It would be ideal if farming representatives could be included already at the development stage of new programmes and standards.

Different types of shortcomings of present agri-environmental programmes were named. A summary of shortcomings and suggestions for improvement is provided in Table 11-1. General points of criticism concerned budget restrictions for the programmes and their short-term and unreliable nature, and in some cases complicated application and accounting procedures. Farming representatives complained for instance that programmes may be retracted in the course of a new election or due to changes in the household situation. The discontinuation of premia required for dairy farming is regretted by representatives of both farming and environmental protection.

Even in the case of programmes that are generally profitable, considerable conflicts may exist between the program's requirements and individual farmers' needs. An example is the prohibition to graze horses on privately owned protected areas. Horses that are out to pasture are an important source of income to farmers in the region. Another example is damage through birds' feeding which amounts to the substantial annual loss of approximately 50–300.000 Euro in Nordkehdingen[67]. Discussions about insurance against such losses have been dismissed, as landowners feel that the government as initiator of bird protection programmes should be held responsible. These issues require further discussion between the government and the farmers if acceptability is to be raised.

[67]Georg Ramm, personal communications 2004.

Shortcomings of schemes	Suggested improvements
General aspects a) Short running time and unreliability. b) Complicated application and accounting procedures of some schemes.	a) Guaranteed running time of at least 5 years; schemes not to be retracted due to new election or changes in household situation. b) Simplify application and accounting procedures.
Economic aspects a) Problem through weakening of cattle premia. b) Issue of damage through birds feeding.	a) Schemes to compensate losses incurred through weakening of cattle premia. b) No improvements suggested[68].
Cultural issues a) Peer pressure on farmers who are interested in schemes. b) Perception of schemes sabotaging farmers' traditional rights. Conflicts with farmers' sense of identity as food producers. c) Lack of information on profitability of schemes. d) Need to address region-specific characteristics and farmers' needs.	a) More regional round-tables and other forms of transparent, sensitive, long-term communication processes. b) Communicate achievements of schemes and value of birds for regional identity to farmers and society. c) Address prevailing lack of belief in economic profitability of schemes. d) Contact person with whom contract conditions can be adapted.
Lack of certain types of schemes/ schemes for certain areas a) Lack of schemes for areas that are not suitable for grasslands. b) Lack of schemes to prevent soil erosion and keep in soil moisture.	a) and b) Create schemes to support hedgerows and/or trees on fields in dry and sandy Geest areas, possibly in combination with organic agriculture.
Requirements for specific schemes: a) Protected sites (including Natura 2000) b) Organic agriculture.	a) Adequate negotiation with and compensation of landowners before protection status is established. b) Quality standard for organic produce needs to be clear and relatively high-level. Possibility of regional standard that is developed in collaboration with farming representatives.

Table 11-1. Shortcomings of present agri-environmental schemes from the viewpoint of farmers and improvements suggested by Focus Group participants.

Participants also stated that it will most likely not be possible or interesting to farmers in all parts of the region to benefit from agri-environmental programmes. In parts of the regions programmes are not available. In areas where programmes are available, more effort needs to be put into passing information to the farmers in order to address the prevailing lack of belief in the economic profitability of the programmes. In some cases there is high peer pressure on farmers who are interested in cooperating with environmental authorities to refrain from doing so as this is perceived to sabotage farmers' traditional rights and their sense of

[68]Suggestions on the basis of recommendations made in literature have been included into the research paper 'Structural change and nature conservation in the agricultural landscape of the Lower Elbe region – a case study' (submitted to Agriculture, Ecosystems and Environment).

themselves as producers of food products (compare the results of Lütz et al., 2002). A particularly high potential for conflicts lies in cases where protection status is established on a private area without adequate negotiation with and compensation of the landowner. This is even more fatal if the ecological value of the site is due to previous voluntary efforts from the owner. According to participants, possibly the most important step towards the addressing of these obstacles is the establishment of an effective and transparent communication process between farmers and environmental authorities.

Also, other traditional elements of the region's landscape, such as reed, various water bodies and small woods should be included into the protection programmes. An important deficiency of current agri-environmental programmes concerns the lack of programmes to improve the region's water balance. Heavy drainage in parts of the region leads to the sinking of moors and a drying up of the marsh areas adjacent to the river. Programmes for the consolidation of existing protected sites should be set up, as well as programmes for the establishment of nature-orientated ditches or the reengineering of existing ditches. Ideally this would be combined with dike relocation or summer-dike opening to re-establish the connection of the ditch-system to the river and thus the exchange of fauna and flora with the river (compare Grimm, 1983).

Both farmers and environmental protectors underlined the importance of acknowledging and actively promoting the region's cultural landscape and the regional identity. This could encourage a cooperative attitude of farmers towards the protection of the region's highly valuable ecosystems and would be a crucial contribution to the healthy development of the tourist sector (compare the results of Getzner and Jungmeier, 2002 for four regions in Austria). Participants named traditional charming farmhouses, regional specialties, but also birds and the marshlands as important components of the region's identity. Initiatives like the annual welcoming of birds in the spring together with visitors begin to make use of this, although on the whole farmers tend to be cautious about regarding the birds as asset of the region. The region also possesses large untilled natural areas, including a 8000 ha EU birds reserve. These should be more clearly promoted to attract visitors.

Measures to promote tourism include more decisive marketing strategies, also for the region as one entity. This is tried for instance through the recently initiated "Maritime Landscape Lower Elbe". The initiative aims to create a shared identity for the area adjacent to the river on both sides of the Elbe, focusing on historic villages, harbours and the region's maritime and rural flair. Participants also discussed the establishment of a Lower Elbe biosphere reserve. This could be beneficial both for environmental protection and for tourism. Action would have to be taken to ensure the acceptability of the biosphere reserve. Ideally, farmers' representatives would be included at an early stage of development so that their concerns can inform the design of the zoning concept.

There was disagreement on whether direct marketing could be established on a larger scale in the region. On the one hand, a regional label with effective advertisement and political support for the commercialisation of regional specialties could create niches also for small farms, in particular if a greater variety of agricultural products is produced. On the other hand, due to the lack of a convenient connection to the other side of the Elbe, the outlet area for regional products will most likely be too small. Fruit production in the Stade district and the *Altes Land* is sufficient for 11 million people[69]. Dairy products and cattle are produced in

[69]Franz Stolte, personal communications 2004.

similarly high numbers. An important contribution could be made if local restaurants and butchers were to use regional produce as competitive strategy.

12 Possible responses to a scenario of climate change

12.1 Strategies based on changes in cultivation patterns

In chapter 5 of this thesis, an A2-scenario of climate change was projected for the region for 2030 and farmers' expectations of possible impacts on agricultural production were investigated through interviews. In the following we will discuss changes in cultivation patterns that farmers suggested as strategies to deal with the projected climate changes.

One problem concerns water shortage and soil erosion through a possible increase of summer temperatures and a decrease of summer precipitation in the dry and sandy Geest-part of the region. A possibility of response is the extensification of production, in particular in combination with programmes for the promotion of extensive cultivation or organic production. A possibly more interesting suggestion concerns the cultivation of hedgerows and trees and the usage of a winter ground cover in the fields. Hedgerows are known to be of great benefit to maintain soil moisture and to prevent erosion by providing a windbreak. Thus, this strategy would not only help farmers but prevent the soil from becoming karstic and barren. In fact, according to farmers soils will also become karstic if the fields are being left idle. However, this strategy requires additional work and will impede tilling. It would only be feasible if farmers either invest a lot of work[70] and operate very economically, or receive financial support for the cultivation of hedgerows and trees and thus the maintenance of fertile soils.

Impacts are also expected due to a possible rise in winter temperatures by up to 1 °C. Winter frosts are necessary in order to keep pests on the fields but also in greenhouses in check. In addition winter frosts improve the soil quality, in particular in the marshlands[71]. A strategy that was suggested by some farmers is a second round of ploughing. However, in addition to increasing the farmers' workload, this will not be a substitute for winter frosts and in greenhouses this option is not available.

[70]One farmer with 80ha of fields and pastures explained that he has established or maintained 12km of hedgerows in order to raise the water storage capacity in his fields.
[71]Compare footnote 47.

12.2 A revisal of dike relocation approaches

A particularly problematic environmental measure is dike relocation or the opening of summer-dikes. Dike relocation and summer-dike opening in the rural Lower Elbe region in order to restore large stretches of ecologically valuable naturally flooded areas constituted central elements of the first blueprint of compensation measures for the last Elbe deepening. The intention had to be dismissed, however, as it became apparent that the respective land could not be bought from the landowners. After this, dike opening or relocation in the Lower Elbe region was no longer seriously considered even in cases where the respective land was owned by the Federal Republic72. In the following we will discuss particularly problematic aspects of the local government's approach to dike relocation and possibilities to avoid the encountered difficulties. Most of the ideas presented here have been suggested in single interviews. A summary of the most problematic aspects and suggested improvements is given in Table 12-1.

To enforce dike relocation as compensation measure for projects carried out by one of the two city-states – Bremen and Hamburg – is highly problematic, in particular as the benefits due to the respective projects are usually reaped almost entirely by the city-states, thereby strengthening their dominant position in the region.

Aspects of preparation: • No dike relocation as compensation measure for projects of city-states. • Planning and design by regional authorities rather than city-states and Federal government. Incorporate residents' concerns into specification of measures in long-term, transparent communication process. • Communicate priority of people's security. • Communicate advantages of dike relocation. • Water management to take stance on dike relocation in particular regarding flood risks and shoreline protection.
Organizational aspects: • Landowners to remain owners of land against compensation. • Contract with guidelines that take into account farmers' needs. • Possibility to adapt guidelines each year according to weather conditions and specific needs of individual land-owners with local authority.

Table 12-1: Elements of an improved approach to dike relocation or summer-dike opening.

Dike relocation as compensation measure constitutes a particularly awkward case, as the measures are designed by the city-state and carried out by the Federal Republic in areas that lie outside the borders of the city-state. This usually means that there is no adequate preparation of and communication with the affected landowners, and their wishes and needs are not incorporated into the specification of the measures. If summer-dikes are opened or dikes shifted, landowners prefer to remain owners of the land and receive compensation for the incurred losses rather than to be required to sell the land. A contract with guidelines that take into account the farmers' needs should be established. In earlier times, the nutrient-rich naturally flooded areas were cultivated with produce that were suitable for the given length of time in which the land would be dry. Present-day flooding concepts and guidelines for the management of periodically flooded areas would have to pay respect to this. In addition, a

[72] An example for the latter would be the area between the Elbe and the former dikeline east of the Oste-mouth.

local public authority should be commissioned to adapt the given guidelines each year as necessary according to weather conditions and according to the specific needs of individual farmers. A similar approach is carried out already with respect to protection of land under a contract. The local authority understands the regional conditions, knows people in the region and invests in trusting relations with landowners. The adaptations to the contract allowed for each farmer every year are recorded in a database that is managed by the local authority.

A point repeatedly stated by participants is the crucial place of long-term preparation and sensitive communication. It needs to be made clear that people's security still has first priority and is not pushed back behind the interests of nature conservation or the interests of the city-states. At present, this is far from obvious, given that a next Elbe deepening is planned by the city of Hamburg while there is still no publicly available data on the effects of past Elbe deepening measures on flood risks. In addition, advantages of dike relocation need to be communicated clearly. Dike relocation plans need to be made transparent at an early stage. Particularly disastrous for farmers' openness towards dike relocation are cases where an election-pledge that the dikes will not be touched is given and later broken for the sake of cooperation with the city-states. Finally, water management needs to take a stance on dike relocation, in particular with respect to risks and to the importance of dike relocation for the protection of the shoreline.

13 Conclusions

In this part of the thesis, future perspectives for a rural part of the study region have been investigated. This includes possibilities of response to structural and legal changes currently faced by most rural regions in Western Europe, but also agricultural adaptation strategies to a scenario of climate change, and approaches to dike relocation.

In response to structural and legal changes, the Focus Group participants developed two scenarios based respectively on diversification and specialisation. The results in particular from the diversification scenario and with respect to improved approaches to dike relocation confirm earlier results on the importance of accommodating landowners' concerns if conservation programmes are to be accepted by a sufficient percentage of landowners (Lütz et al., 2002, Prager and Nagel, 2004). They also confirm the usefulness of participatory methods towards this aim (ibid, Shackley et al., 1998, Cortner, 2000, Robertson and Hull, 2003).

An important bottleneck of the specialisation scenario is the possibility of lower prices being offered by new member states that the regions' farmers have to compete with. The possible decline of the rural space is another bottleneck. In addition, problems may arise if German environmental regulations surpass the European minimum standards. This seems likely in particular with respect to the revitalisation of the river landscape.

Bottlenecks in the diversification scenario are due to the limitations of the governmental budget for agri-environmental programmes, the often short-term and unreliable nature of the programmes and in some cases complicated application and accounting procedures. In some cases there are conflicts between the requirements of programmes and the farmers' needs. These may, however, be remedied if conservation happens on a contract basis with the possibility that contract details be adapted by the responsible local authority. The programmes are also not always well designed to protect the region's unique ecosystems. There is a clear need for programmes that improve the region's water balance, for instance through the consolidation of existing protected sites, reengineering of ditches and a restriction of drainage. Also, further traditional elements of the region's landscape, such as reed, various water bodies and small woods should be included into the protection programmes in addition to grassland.

Rising summer temperatures and a decrease of summer precipitation would pose a problem for the Geest part of the region which is already experiencing water shortage and to some degree soil erosion at present. The soil's water storage capacity could be improved through the cultivation of hedgerows and trees at frequent intervals in the fields. In addition hedges and trees would provide a windshield and thus help to prevent erosion. The bottleneck of this strategy is the additional work-load required. Most likely, the strategy would only be feasible in combination with promotion programmes for the cultivation of hedges. An increase of winter temperatures by up to 1 °C would lead to a shortening of winter frosts. Winter frosts are important in particular in the marshland-part of the region to improve the soil quality[73]. In both the Geest and the marshlands, insect pests are kept in check through winter frosts. At present there is no real substitute for winter frosts.

With respect to the possibility of dike relocation, long-term preparation and sensitive communication through local rather than Federal authorities is seen as indispensable. Farmers also indicated a clear preference to remain in ownership of the flooded land and manage the

[73]Compare footnote 47.

land against compensation according to contract-guidelines that take into account the farmers' needs.

PART III:

FUTURE PERSPECTIVES

FOR THE CITY AS A PORT CITY[74]

[74]A research paper based on this part of the thesis has been submitted to Geoforum: Grossmann, I., 2006: Perspectives for Hamburg as a port-city – a critical assessment on the basis of a cost-benefit analysis. Geoforum (in review).

14 Introduction and methodology

This part of the thesis investigates decisions by the city of Hamburg regarding port development within the context of present large-scale global socio-economic and technological changes. This concerns firstly changes directly affecting the port in the form of changing competitive requirements that lead to rising costs and a favouring of (coastal) deepwater ports. Secondly, the role of ports within the economy of advanced, post-industrial metropolitan regions is significantly different from the former role of ports as 'growth engines' of a regional economy. This concerns both job losses in port-dependent sectors, and a growing need to invest in other fields in order to establish highly competitive new economic sectors, to maintain a high quality of life and to address challenges such as population shrinking and aging or social polarisation. These new needs may imply demands on the city's resources that compete with the demands of port development. The need to calculate benefits and costs of port expansion in connection with these changes is especially relevant for those European ports – including Hamburg –which are still largely financed by a city.

Large parts of the required data, e.g. on value- and job-creation through the port are not publicly available, insufficient or ambiguous. This concerns cases where two versions of the same "fact" exist, e.g. two quite different results for the number of port-dependent jobs in 2001 (compare section 16.2), cases where different recording methods for the container turnover of different ports[75] are used in the *same* table without mention of this, or cases where the costs of a particular investment programme are only indicated until a certain date, withholding the required information to assess the overall financial requirement.

To address these methodological problems, the approach of this study combined extensive literature research and data analysis with structured face to face interviews with 20 port experts, semi-structured interviews with researchers and authorities in city development and new economic sectors, and a number of additional discussions with port representatives or experts. The expert interviews were indispensable in filling data gaps and discussing different interpretations of data. The interviews also pointed to possible future developments or decisions that are not being considered within literature. Great care was taken to select interviewees from a wide variety of backgrounds and business interests. This included representatives of the relevant shipping companies, several members of Hamburg Port Authority and of the Department of Trade and Economics, Port of Hamburg Marketing, researchers dealing with development perspectives for the Northern German ports, with regional economic impacts, economic trends or developments within logistics, a politician leading the economics and port department of his party and two port-related NGOs.

The questions posed in the interviews covered the following aspects:

1. Expectations for the growth of turnover in Hamburg relative to the growth of world trade.
2. The port's competitive position given changing competitive requirements – including changing transport patterns, and the increasing horizontal and vertical integration.
3. Port development perspectives: possible bottlenecks for port expansion, possible changes in Federal port subsidies or EU port politics, possible alternatives to Hamburg's present port development strategy, possibilities for coordination with the port of Wilhelmshaven and expectations for the development of Wilhelmshaven, consequences of the establishment of the Hamburg Port Authority, and privatisation possibilities.

[75]E.g. with or without empty containers, or counting cargo destined for transhipment once or twice (that is, once for incoming and once for outgoing ships).

4. Regional impacts: port-dependent value- and job-creation, port expenses, impacts on quality of life and city development, and aspects of area usage policies.

Chapter 15 establishes the basis for our analysis. Section 15.1 summarizes the results from chapter 4 on climate change risks for the port. Section 15.2 offers a summary of relevant changes in competitive factors for ports. Section 15.3 offers a discussion of the socio-economic change processes affecting the port-city interrelationship and thus the port's regional benefits and costs. Regional benefits and costs are investigated in chapters 16 and 17. This concerns, firstly, turnover expectations for the port: General expectations for turnover development (section 16.1), expectations with respect to world trade development (section 16.1.1), expectations with respect to Hamburg's main trading partners (section 16.1.2), and expectations with respect to the competitive situation of Hamburg and the other Northern German ports (sections 16.1.3 and 16.1.4). The next question of interest concerns the actual benefits derived from turnover. Direct income and the creation of value and jobs through the port are investigated in section 16.2, followed by a discussion of future expectations for the development of value creation and jobs (section 16.3). Costs due to the port are discussed in section 17. This includes an overview of direct costs (section 17.1) and expectations for the future (17.2), followed by an overview of indirect costs (section 17.2). Opportunity costs with respect to area usage and city development are discussed in section 17.4.1 and with respect to economic development in section 17.4.2. Chapter 18 presents our conclusions for this part of the thesis.

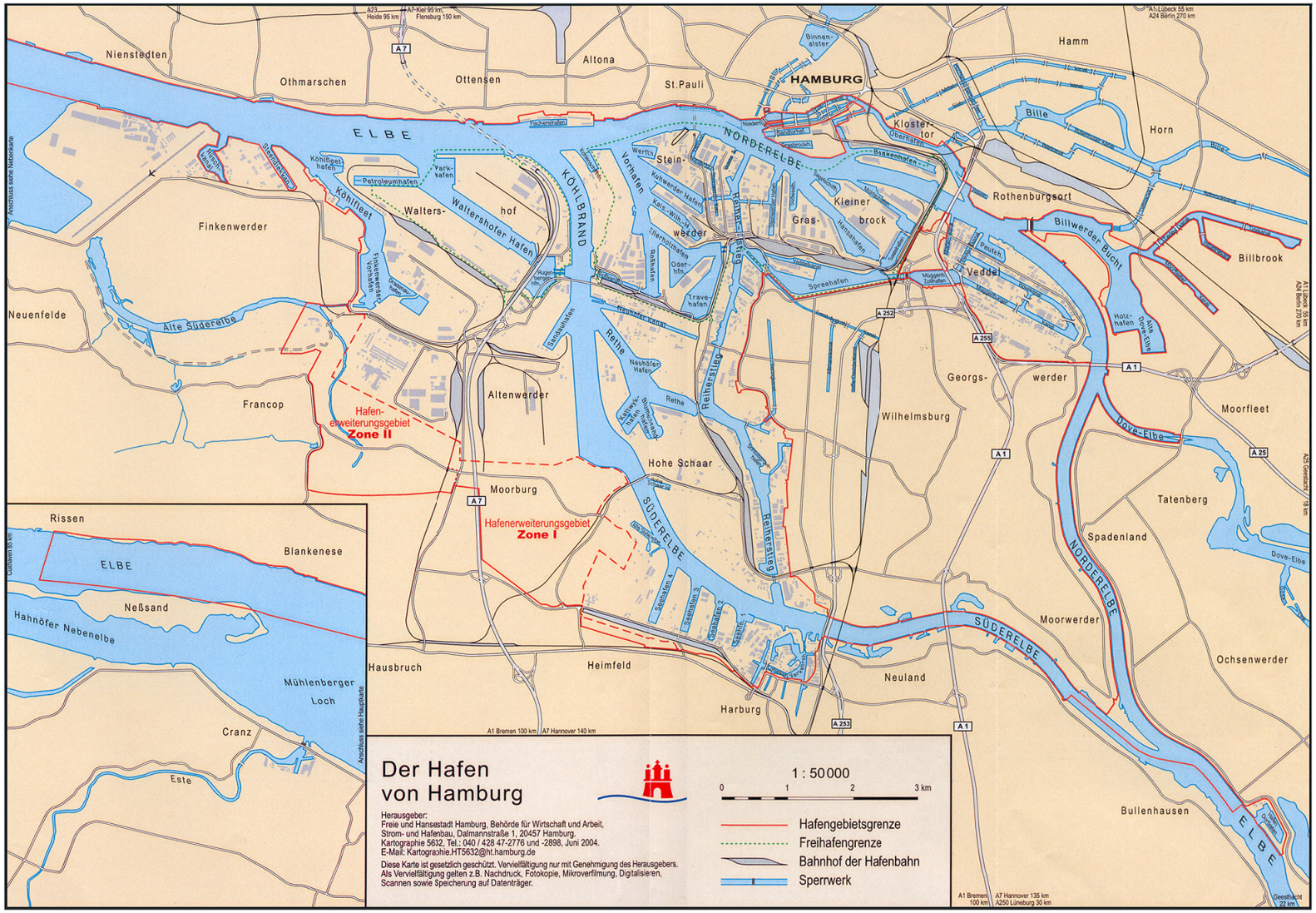

Figure 14-1: The port of Hamburg (courtesy of Hamburg Port Authority). The red line indicates the border of the port, the blue dotted line the border of the free port trade zone. In addition, the port extension areas zone I and zone II to the west are delineated in red.

15 Hamburg and its port: Brief assessment of the current situation

15.1 Climate change risks for the port

As presented in section 4.3, storm floods that exceed 5 m in height result in business interruptions in parts of the port (compare Figure 4-5). The city intends to raise the height of all quay walls to 7.5 m during the next 5–10 years (Freie und Hansestadt Hamburg, 2005a). If this is consequently carried out, flood protection should be sufficient also in the scenario of relatively strong climate change that we discussed in section 5.1. In this scenario, an increase of water levels of up to 20cm in Hamburg St. Pauli until 2030 would be likely.

15.2 Changes in the port and shipping sector

Ports worldwide are facing new requirements. In the Hamburg-LeHavre-range with its low prices and huge public port-investments relative to Asia (Deeke, 2001), competition is particularly fierce and failure to keep up with new requirements poses the risk of losses in market shares (Notteboom and Winkelmans, 2000, Robinson, 2002). Another important factor is the increasing power held by shipping companies (Heseler, 2000). Shipping companies take over ports' traditional areas of authority through offering integrated logistics packages that include supply chain management services, local transport and customs clearance (Martin and Brian, 2001, Notteboom and Winkelmans, 2000, Heaver, 2002). Control over port operations is increased through mergers with terminal operators and through dedicated terminals (e.g. Baird, 2002b). Also, shipping lines are investing in inland transportation and inland depots (Notteboom, 2002) and are thus able to offer point-to-point freight rates. Due to the high degree of efficiency of maritime transport the potential for cost-saving through an improvement of inland transport is very high. Notteboom and Rodrigue, 2004 report that the portion of inland costs in the total costs of container shipping is in the range of 40–80 %.

This shift of power frequently places shipping companies in a position to drop ports that do not fulfil their requirements. Examples in the Hamburg-Le Havre range are CP Ships' decision in 1999 to leave Zeebrugge, where it had generated some 17 % of container traffic in favour of Antwerp (Notteboom and Winkelmans, 2000), or Maersk Sealand's recent decision to leave Hamburg in favour of Bremerhaven. Important factors for ports to remain competitive concern firstly efficiency requirements as given by ship-sizes, port accessibility, automation and the modernization and speeding up of operations within the port. Secondly, dedicated terminals and the flexibility of ports towards preferences of shipping companies are becoming more important. The offered 50 % share in a new terminal in Bremerhaven was one contributing factor in the decision of Maersk Sealand to concentrate its business there and drop Hamburg[76].

Interestingly, during interviews, representatives of shipping companies tended to attribute higher priority to these factors than port authorities. The latter tended to give high priority to traditional factors such as the presence of port-related industries in the port city, the hinterland *as such* (without looking at transhipment in the respective port). It is possible that with the recent establishment of the Port Authority in Hamburg there will be more openness towards

[76]Hamburg is now supplied with feederships from Bremerhaven where necessary. This concerns only a share of 2.6 % of the overall turnover at the respective terminal (compare http://www.ntb-bremerhaven.de/).

the establishment of dedicated terminals. This would be quite timely, as Asian shipping companies have a high interest in the operation of terminals in Europe and generally have a significantly greater financial scope than European – let alone German – shipping companies[77]. For instance, if Hutchinson were to invest in the new terminal in Wilhelmshaven, it would have a deep water monopoly in Europe[78]. This could significantly change the financial perspectives of the new terminal and thus the time-horizon of its construction.

A port's accessibility is determined by the maximum permissible draught for incoming and outgoing ships and within the port, additional travel and waiting times in the estuary or river with a possible tidal window, and security aspects related to waterway conditions. The latter concern for instance shoals caused by specific flow conditions. These may make it necessary to quickly carry out dredging measures in order to re-establish the required depth – which is possible for instance in the Weser – the waterway leading to the port of Bremerhaven – but not in the Elbe. In the Elbe, the ship would also not be able to reverse in order to clear the waterway for other ships.

While there is currently no agreement on the limit to ship-sizes, economies of scale and technical aspects appear to afford ships between 16.000 and 18.000 TEU (Gilman, 2000, Ircha, 2001[79]). Up to 12.500 TEU, ships may be powered by a single engine (Ircha, 2001). With sufficiently increased carrying capacity, two-engine ships of at least 16.000 TEU should still afford economies of scale (Gilman, 2000). These ships would have draughts of 15–21 m (Ircha, 2001). As of 2000, at least 17 terminals world-wide are equipped for ships with a draught of 15 m or more, by 2008 this will increase to 28 on the basis of committed investments (ibid). A more serious challenge to ship-sizes could be the need to travel with high capacity utilization rate while maintaining the same frequency of travel. The present trend of large mergers and alliances between shipping lines (e.g., Slack et al., 2002) such as the recent giant merger of Maersk Sealand and P&O Nedlloyd will likely enable solutions to this.

The speed of operations in the port depends on the technical equipment of the port, the efficiency of transhipment to other means of transport (e.g. Klink and Berg, 1998, Kumar, 2002), the organization of port operations, but also on the degree of control given to shipping companies. For instance, in the Eurogate terminal of Hamburg, 1100 containers per m quay wall can be handled, in Altenwerder – which has a considerably more modern equipment – this is raised to 1350 per m quay wall, and in the terminal of Maersk Sealand in Bremerhaven – which has a similar level of equipment but is under the control of the shipping company – to 1700[80]. At present transhipment to freight vehicles in Hamburg is delayed by permanent long traffic jams near the highway entry. Improvements are planned by the city. However, these will have to account not just for present bottlenecks but also for the planned increase of container turnover by a factor of 2.6 until 2015 (Port of Hamburg Marketing, 2005a). Of great advantage in this context is also the collaboration with shipping companies. In Bremerhaven, Maersk Sealand has established a terminal-hub that is designed to minimize waiting times and costs of the transfer to truck and rail. In fact, Maersk Sealand claims that transport from

[77]Hutchinson's buying into Rotterdam and PSA's buying into Antwerp were, in fact, results of an outbidding of European shipping companies (personal communications, 2005 with representative of Eurogate, Hamburg).
[78]Hutchinson already has a dedicated terminal in Rotterdam, which is the only other European port next to Wilhelmshaven (and Thamesport – the highly modern English offshore port) that has a draught exceeding 16 m.
[79]Ircha, 2001 also quotes additional sources that anticipate ships of 16.000 TEU or more.
[80]Personal communications with a representative of Eurogate Hamburg, 2005.

Bremerhaven to the German hinterland is not more expensive than from Hamburg[81] and that relative costs will fall further with growing amounts of cargo.

Regarding Hamburg's competitive position with respect to these factors, the insufficient depth of the port is often quoted as the port's main (or only) disadvantage. While it is true that the larger ships are often not fully loaded when travelling up the Elbe, shipping companies explained that it is not always possible to calculate the utilization rate in advance, especially for cargo from the Far East that is meant to reach Hamburg without delays. Currently, the Lower Elbe can accommodate ships of a maximum draught of 15.1 m for incoming and 13.8 m for outgoing vessels, both using the high tide (Port of Hamburg Marketing, 2002). The planned deepening of approximately 1.5 m ships should allow ships of up to 12.500 TEU (or possibly less, depending on construction) to call at Hamburg (compare Ircha, 2001, Planco, 2000). The tidal window will be at most 4.5 hours for incoming and 89 minutes for outgoing ships, with waiting times of up to 8 hours. The journey through the estuary takes additional 6 hours. Hamburg's new competitor, the deepwater port in Wilhelmshaven that is presently being built does not have these restrictions. Using a coastal port instead of Hamburg also saves an average travel time up the river of 6 hours. During that time 500 containers could be handled[82].

15.3 Changes in the port-city relationship

Port regional impacts have changed with the present transition of highly industrialised countries to service- and information based economies (Hall, 1997, Porter, 1999 and 2000, Grossmann, 2000, Hutton 2004). This transition implies that powerful new industries emerge while others lose in importance and undergo pronounced rationalisation and job-losses. Ports and port-dependent industries are prime examples for industries that have undergone such losses in value and job creation (Läpple 1998, Deeke, 2001, Vigarie', 1991, Benacchio et al., 2000). Value and job creation have become largely decoupled from traffic flows. Commodities frequently pass through the port without stopping or inducing economic activities (Läpple and Deeke, 1990 and 1996). Strongly port-dependent jobs have been significantly reduced and many categories of port-dependent jobs (e.g. in trade, insurance and banking, logistics) are much less dependent on the port now.

For most European river ports this has led to the relocation of the port or of parts of goods handling to the coast (Hoyle, 1996, Deeke, 2001), also in the form of cooperation with a coastal port (Notteboom, 1997). Often former port cities offer an economically sophisticated metropolitan environment so that highly value-adding advanced service functions related to port activities remain in the city, while the low value-adding, largely automated and resource-intensive goods handling disappears. As demonstrated by successful former port cities like London, Amsterdam or Stockholm, such a transition offers the opportunity of profound economic, structural and cultural renewal (Breen and Rigby, 1994, Hoyle, 1996) and a redefinition of the city's international status from a "port city" to an actual "world city" (Friedmann, 1986).

For port cities having chosen instead a port expansion course, however, the post-industrial transition results in the need to reassess the port's costs and benefits. The ratio between these two will be changed not just directly through losses in port-dependent job and value creation

[81]This seems credible given that the 50.000 containers transported from Bremerhaven to Hamburg on feederships equal just 2.6 % of the overall turnover at the North-Sea-Terminal that is jointly operated by Maersk Sealand and Eurogate (compare http://www.ntb-bremerhaven.de/).
[82]Personal communications with representative of Maerks Sealand, 2005.

and through rising expenses, but maybe most importantly through the impact that port development has on other aspects of the city's economic welfare and quality of life. This has three aspects. Firstly, the port's high financial requirements compete with projects in other fields that are often characterized by much higher job and value creation or that are indispensable for the city's international attractivity. This concerns most of all the establishment of new economic sectors and processes of urban renewal. Secondly, the ongoing port expansion consumes huge areas of city-space (Notteboom, 1997), e.g. approximately 11.5 % of the city area in the case of Hamburg (own calculations based on Port of Hamburg Marketing, 2002), mostly in a highly valuable central waterfront location (Hoja, 1999, Läpple and Deeke, 1990). The third aspect concerns externalities such as environmental impacts, and impacts on quality of life through traffic and congestion, pollution and noise.

The competition of advanced service and ICT-industries with the port for the city's financial and other resources gains particular relevance due to the fact that these industries usually have locational factors that are very different from those of the port and port-dependent industries (Hall, 1997, Grossmann, 2000, Clark et al., 2002, Hutton, 2004, Parkinson et al., 2004). This may include modern education and research facilities, a high-capacity intercontinental airport (which Hamburg does not have) and very good inland travel connections. Very important is also the marketing of the city region as modern business and high-technology region, a top-performing professional business environment and a business climate characterized by a lack of bureaucratic barriers to innovation and company formation, and by the clear communication of support for new economic sectors. Another important component is high quality of life in order to be able to attract and maintain highly qualified people for new sectors. This factor has gained in importance in the last two decades in Europe due to population decline and aging and the associated sharp increase in competition between city-regions across Europe.

Thus, a crucial question for port-cities concerns the trade-offs of the port's costs and benefits and the integration of port planning with an overall integrated city development concept (Läpple and Deeke, 1990, Verbeke and Debisschop, 1996, Klink, 1997, Hoja, 1999, Deeke, 2001). Towards this end, in a first step costs need to be assessed as far as possible. This is carried out in sections 17.1 and 17.2. Next, the costs of different port, economic and city development projects need to be weighed against the ensuing job prospects, contributions to regional income, to the city's international attractiveness and to quality of life. This is the topic of sections 16.2 (value and job creation through the port) and 17.4 (comparison with benefits of other projects). Expectations for the future development of costs are presented in 17.2. Finally, alternatives to the present port development course can be considered and their meaning for regional income, job creation and the overall development of the city can be investigated. Two such alternatives together with a more or less business as usual scenario will be presented in part IV of this thesis.

16 Benefits and the related trends and changes

16.1 Container turnover in the port of Hamburg

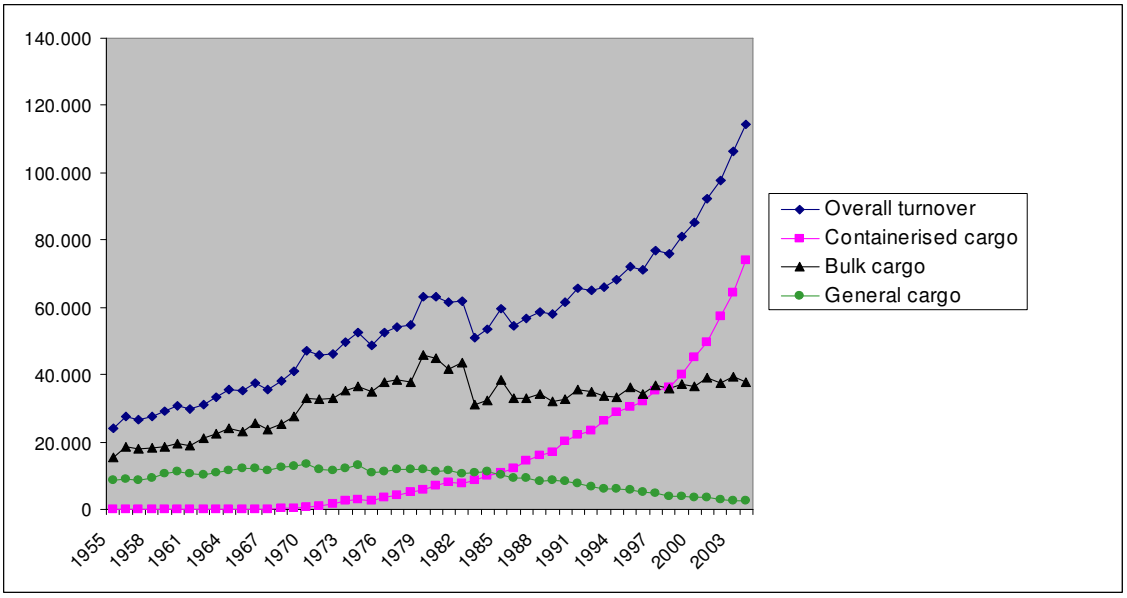

Figure 16-1: Turnover in the port of Hamburg 1955–2003 in 1000t (Source: data provided by Hamburg Port Authority, 2005).

Figure 16-1 shows the development of turnover in the port of Hamburg since 1955. Uncontainerised general cargo has decreased sharply in the last 2 decades. Bulk cargo is still relatively important, in particular liquid bulk cargo. Interesting is the recession in the seventies and eighties. The resume of growth in the early eighties is most likely due to the German reunification and the expansion of Hamburg's hinterland into Eastern Europe (Läpple and Deeke, 1996). The present high growth rates (from 65.5 m tons in 1991 to 92.4 in 2001, compare Figure 16-2) are usually attributed to the rapid development of the Baltic, Russia and China. In fact, feedership transport (almost entirely for the Baltic, Russia and Eastern Europe) constitutes 58.2 % of the overall turnover in Hamburg. It is therefore possible that turnover in Hamburg will more or less stabilise again on a higher level once the growth in these countries has slowed down.

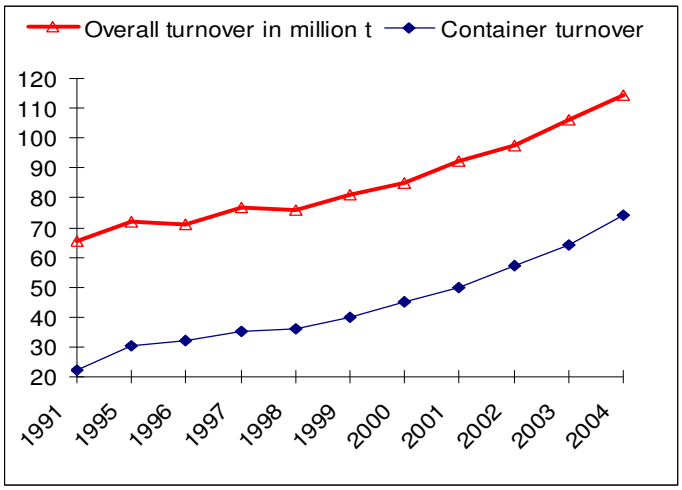

Figure 16-2: Turnover in the port of Hamburg 1991–2004, Port of Hamburg Marketing, n.d.

16.1.1 General turnover expectations

More than half of the interviewed experts guessed that the growth of turnover in Hamburg will be faster than the growth of world trade. This was mainly based on the present rapid economic growth in China – which is expected to continue for the next 10 or perhaps 15 years. The Institut für Seehafenverkehrswirtschaft und Logistik (ISL) expects that container export from China will grow by 7.5 % until 2022 (ISL, 2004 on the basis of projections by Global Insight). Those interviewed experts who were willing to quantify their expectations for the growth of turnover in Hamburg named a ratio of 1.3–1.5 times the growth rate of world trade. World container turnover has been projected to rise from 576 million tons in 2004 to approximately 1 billion by 2015 and almost 1.3 billion in 2022 (ISL, 2004 on the basis of Global Insight). This is a growth by approximately 126 % until 2015. If container turnover in Hamburg would increase with a comparable rate it would reach 15.8 million TEU in 2015. This is clearly more than all projections in Figure 16-3 indicate. A growth by 1.3 times the growth of world container trade would imply that Hamburg would reach 18.4 million TEU in 2015. Interestingly, this is in alignment with the official expectations of the city (Port of Hamburg Marketing, 2005a) on which current port expansion plans (see section 17.1) are based.

Figure 16-3: Container turnover projections for the port of Hamburg until 2015. As the diagram shows, the actual turnover has topped the projections in the last few years. Courtesy of Port of Hamburg Marketing.

However, all interviewed experts agreed that there are significant uncertainties which could lead to a much lower growth rate, namely:

1. uncertainties in the development of Hamburg's major trade partner China as well as other Asian countries,
2. uncertainties in the development of the Northwest European ports, given current technological and economic developments of unforeseeable outcome.

The first issue will be discussed in section 16.1.2, the second in sections 16.1.3 and 16.1.4.

16.1.2 Expectations with respect to trading partners

The 10 most important trading partners of the port of Hamburg in 2004 were: China (together with Hong Kong) with a 22.1 % share of the overall container turnover, Singapore with a 7.9 % share, Finland with a 7.1 % share, Sweden with 5 %, Japan with 4.8 %, Russia with 4.2 %, the US with 3.3 %, Taiwan with 3.3 %, Korea with 3.1 % and Brazil with 2.8 % (Port of Hamburg Marketing, 2005b).

The interviewed experts agreed on the importance of China and the Baltic countries for the port of Hamburg and expressed the expectation that the present rapid economic growth in both will continue for several years, probably 8–15 years. In the following we will give some data to show what this qualitative expectation could actually mean. The importance of countries as trading partners for the port of Hamburg is often assessed in terms of imported and exported TEU. However, often the actual value traded with a certain country differs significantly from the number of containers traded. Thus, containers imported from Russia in 2004 constituted 9.9 % of all containers imported in 2004, while the value of the goods imported constituted just 2.5 % of the overall imports to Hamburg in that year. Similarly for the Baltic countries we have a 2.1 % share in container import versus a 0.38 % share in imported goods and for China a 29.4 % share in container import versus a 10.1 % share of imported goods[83]. (Statistical Office of Hamburg and Schleswig Holstein, 2004, 2005b and 2005c). In addition one needs to distinguish between actual import or export at present, and growth expectations.

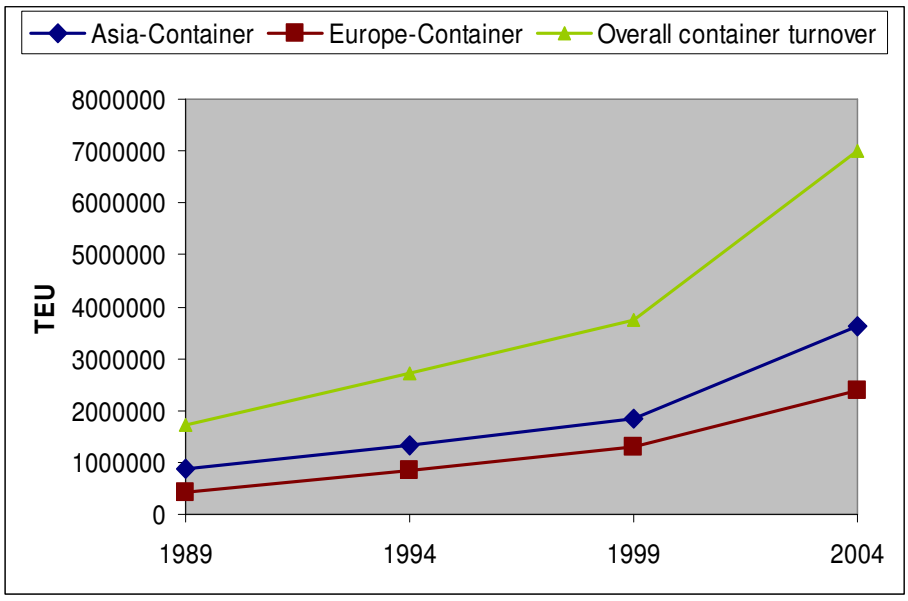

Figure 16-4: Container turnover from/to Asia, Europe and total in the port of Hamburg 1989–2004.

China – together with Hong Kong – has been the most important trading partner of the port of Hamburg in terms of container turnover since at least 1990 (Port of Hamburg Marketing, 2005b). Since 1990, container turnover has increased by 30.7 %. In million €, trade with China constituted 7.8 % of the city's foreign trade in 2004, while import from China to the Federal Republic constituted 9.5 % of the overall import.

[83]For China the data is for 2003.

Figure 16-4 and Figure 16-5 depict the differences between the development of container turnover and the actual value of the imported or exported goods from Asia, Europe and total. The proportion of container turnover with China has grown much faster and reached a much higher percentage than the value of the imported goods from China. This implies that either, imported goods from Asia tend to be low-value goods, or else that a large percentage of the cargo arriving from China does not remain in Hamburg but is transhipped to other destinations. In fact, according to Statistical Office of Hamburg and Schleswig Holstein, 2005a, through traffic constitutes 33 % of the cargo arriving from China. Of course, through traffic is of very little economic benefit for Hamburg. The high share of containers from China in overall turnover (22.1 %) implies, however, that a Chinese economic crisis would be disastrous for the port. This was also asserted repeatedly by the interviewed experts.

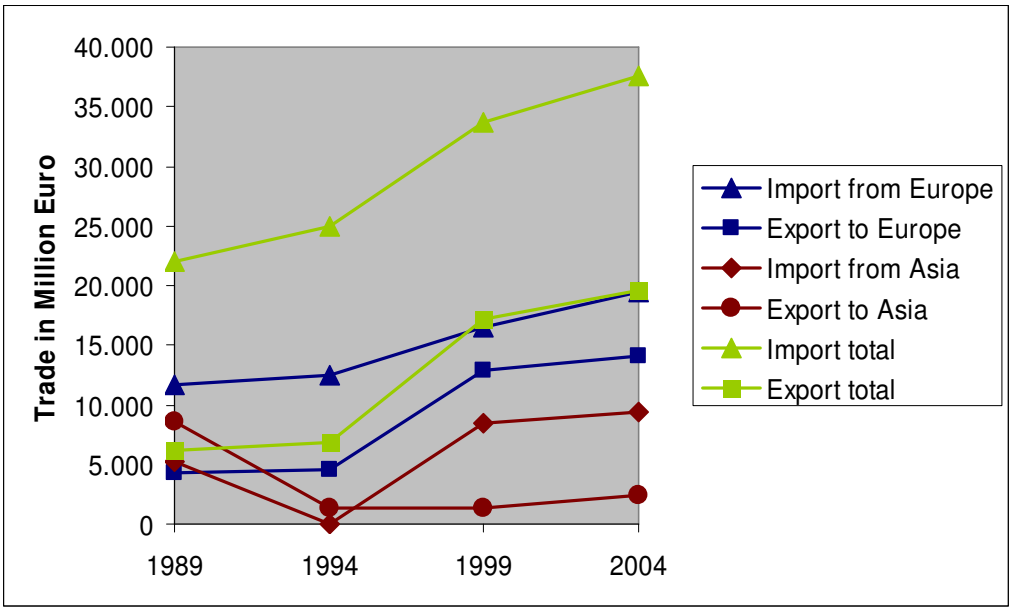

Figure 16-5: Import and export to and from Hamburg in million Euro, 1989–2004. Despite the high growth rates in trade with Asia in terms of container turnover (Figure 16-4), the actual value of goods imported from Asia grows only slowly in comparison with the import from Europe.

Russia was the six-most important trading partner of the port of Hamburg with 4.2 % of overall turnover in 2004. Since 1990, container turnover with Russia has increased by more than 4100 %[84], which is by far the highest growth rate of the 10 most important trading partners of the port of Hamburg. In terms of value of the imported goods, goods imported from Russia constituted 2.5 % of the overall goods imported to Hamburg in 2004 (Statistical Office of Hamburg and Schleswig Holstein, 2005a). Imported goods from Russia to Hamburg constitute 7.8 % of the German import from Russia (ibid and Federal Statistical Office, 2004).

In the case of the Baltic countries Estonia, Latvia and Lithuania, the value of presently imported goods to Hamburg only constitutes 0.38 % of the value of all imports to Hamburg[85]. Overall container turnover in trade with the Baltic countries amounted to 155.496 TEU in 2004, which equals 2.2 % of the overall turnover. However, the growth rates in the trade with the Baltic states have been high since the late nineties (Coker, 2001). Container turnover with the Baltic states has increased by 27.1 % from 2003 to 2004. In terms of value of the imported goods, imports from the Baltic States to Hamburg increased by a factor of 1.8 within one year

[84]Own calculations on the basis of data provided by Port of Hamburg Marketing, 2005b.
[85]Own calculations on the basis of data provided by Statistical Office of Hamburg and Schleswig Holstein, 2005b and 2005c.

– from 2003 to 2004 – while the overall imports to Hamburg have only increased by a factor of 1.2 over the last 15 years (Statistical Office of Hamburg and Schleswig Holstein, 2005b and 2005c).

According to the interviewed experts it is also plausible to expect other countries to experience phases of rapid economic growth with high benefits for container turnover in Hamburg. Likely candidates would be India and South America.

16.1.3 The competitive situation of Hamburg and Wilhelmshaven

In view of the likely developments of ship size as discussed in section 15.2, the port in Wilhelmshaven has several advantages compared to the port in Hamburg. Wilhelmshaven offers a vastly better accessibility, in terms of permissible draught, shorter travel time and lack of waiting times such as are given on the Elbe due to the tidal window. Another advantage is that the terminal is being built from scratch and can be designed right away according to newest technological standards – in terms of design of quay walls, size of container bridges, outreach capacity of gantries and the stacking of containers.

Consequential for Wilhelmshaven is the question which shipping company or companies will be accepted as investor(s) for the new terminal[86]. Eurogate is clearly highly interested in the new terminal. However, since Eurogate also has made major investments in a new terminal in Bremerhaven, the aim for Wilhelmshaven is to open the new terminal only once the terminal in Bremerhaven is in full use. This could be the case in 2007 or more likely only in 2009/2010. If another shipping company, such as Hutchinson were to invest in Wilhelmshaven, development of the new terminal could happen much faster and the aimed for capacity of 2.7 million TEU could be exceeded in the medium-term future. In both cases, due to the very high initial costs, the new terminal will be most profitable if it is successively expanded so that the presently aimed for capacities are exceeded.

Hamburg's strengths in logistics and port-related services such as wholesale and export trade, banks and insurance are often quoted as factors that Wilhelmshaven is lacking. However, worldwide developments in the last 2 decades have shown that these factors have significantly lost in importance (e.g. Läpple, 1998, Hoyle, 1996, Deeke, 2001). Expert opinions on the development of Hamburg and Wilhelmshaven confirmed this. A possibly more serious disadvantage for Wilhelmshaven is the insufficient hinterland connections. However, irrespective of whether these are expanded, almost all interviewed experts made clear that Wilhelmshaven is the ideal location for transhipment to feederships destined for the Baltic, Scandinavia and Russia. This could entail significant losses of turnover for Hamburg. At present, 29.1 % of the cargo arriving in Hamburg is transhipped to feederships (Port of Hamburg Marketing, 2004). Since cargo transhipped to feederships is counted twice in the overall turnover records – once as incoming and once as outgoing cargo – this accounts for approximately 58 % of the overall turnover in Hamburg.

In addition it is important to note uncertainties regarding the further development of capacities at the port of Hamburg. Probably the main critical aspect is the high share of port expenses carried by the city. A related bottleneck – that additionally depends on other resources such as available area – is given by the insufficient capacities for transfer to the

[86] An example for the speed at which a new port can develop with the help of corporate investment is Thamesport, a new offshore port in the UK which began operations in 1990 (Peterlini, 2001). After the takeover by Hutchinson ports, it quickly became one of the leading ports in the UK. Thamesport is the UK's most efficient and only fully automated port and can handle some of the largest container vessels in the world.

railway and freight vehicles. The Hafenquerspange – the planned highway transit route across the southern part of the city – will not be built by 2015 since it has not received sufficient priority in the Federal traffic route plan. In Wilhelmshaven a transfer hub can be built right from the start. The planned next Elbe deepening could well be delayed by lawsuits, which would be quite disadvantageous for the port if ship-sizes continue increasing. Lawsuits may also render a port expansion into Moorburg impossible[87]. Some experts stated that these bottlenecks in the port of Hamburg could be a reason for a shift of shipping companies to the new terminal in Wilhelmshaven. One representative of a shipping company added that there is the possibility to only ship goods to Hamburg that are intended to remain in the city. For this option feederships from Wilhelmshaven and Bremerhaven would be used. This could only come to pass, however, if the hinterland connections of the other two ports were ameliorated.

To complete this section, aspects of a possible cooperation or coordination of port activities between the two ports will be considered. If Eurogate succeeds to become the main investor for the new terminal in Wilhelmshaven, there will be corporate interest in the coordination of container turnover in the different Northern German ports. The city of Hamburg has repeatedly denied cooperation with the new terminal. If "official" cooperation is sought at some point this would most likely be announced only after cooperation or coordination on the corporate level is in place. An Asian investor in Wilhelmshaven on the other hand would imply heightened competition between the ports.

Finally, if the unlikely but plausible scenario of a Federal main port strategy should be carried out – motivated by the high costs of the different ports, waterways and hinterland connections – Wilhelmshaven may be the more likely candidate due to the considerably higher maximum permissible draught offered. Several experts stated, however, that the high growth rates of German trade will likely necessitate more than one port.

16.1.4 Competition with other ports

The interviewed experts agreed with each other that the other Northwest European ports – namely Rotterdam and Antwerp – do not constitute a comparable competitive threat to Hamburg. This is due to their different orientation, for instance in terms of hinterland. Certain shifts of market shares between the ports are likely to occur, however, in particular given technological changes and new requirements to ports. At present, Rotterdam and Antwerp are more cooperative with respect to preferences of shipping companies, such as dedicated terminals. Rotterdam is also a deep water port, like Wilhelmshaven. The main shortcoming in Rotterdam is presently the slow transfer to inland transport. It is expected that Rotterdam will make significant improvements within the next few years. Antwerp has a number of decisive advantages: the high quality of its administrative organisation and its transfer to inland transport, low prices and a highly cooperative attitude towards shipping companies. Due to these advantages, Antwerp has developed very well during the last few years and might overtake Rotterdam in the next few years according to some experts.

Another possibility voiced by several experts is shifts of cargo to Mediterranean ports. Mediterranean ports could for instance supply parts of Eastern Europe, Austria, Switzerland and Hungary. This may occur in connection with a generally accelerated economic growth in the Mediterranean in the next few years.

[87] In fact, the city had to begin building a new terminal in Hamburg Steinwerder in order to be able to say that all space reserves in the port have been used up and expansion in to the inhabited area of Moorburg has become inescapable.

16.2 Value creation and port-dependent jobs

Direct income through the port consists mainly of income from rents (approximately annual € 50 m[88]), port fees (approximately annual € 26 m) and approximately € 21 m received through the Federal financial equalisation scheme (Freie und Hansestadt Hamburg, 2005b).

Studies on port-dependent jobs have been commissioned by the city in 1991 and 2001. Both are not publicly available but have been quoted in reports (e.g. Pool, 1993) and can be viewed in certain cases. For this dissertation, the study of 1991 could be viewed. The results of the study of 2001 were made available by the department of trade and industry (see Table 16-1) and information on the approach of this study was given by several different sources. The studies use surveys designed to determine the number of port-dependent jobs in the core port economy (e.g. container handling, navigation, rail and road transport, storage), the wider port economy (e.g. trade, banks and insurance, public authorities and customs) and port industries. Input output analysis is used to estimate the number of jobs accruing from the supply of intermediate inputs and capital goods and from consumer spending. We will discuss some methodological problems of both studies in the following. The results of the two studies are listed in Table 16-1.

Sector /Tasks	**1991**	**2001**	**% loss**
Container handling, navigation and dock workers	23.766	16.088	**32.3**
Rail and road transport, storage[89]	24.052	21.989	**8.6**
Public authorities, customs	5.115	4.591	**10.2**
Banks, insurance, wholesale and export trade [90]	22.290	20.628	**7.5**
Port industries (ship-building, oil mills, mineral oil, metal processing and fisheries)[91]	19.774	11.892	**39.7**
Suppliers of intermediate inputs and capital goods	47.545	38.738	**18.5**
Total	142.524	113.926	**20.1**
Percentage of total jobs in the city	**18 %**	**10.9 %**	

Table 16-1: Port-dependent jobs in Hamburg and losses between 1991 and 2001 according to unpublished excerpts of the two studies commissioned by the city of Hamburg in 1991 and 2001. Data courtesy of the Hamburg department of trade and industry and Pool, 1993.

Different methodologies have been used for the studies of 2001 and 1991. However, the number of jobs resulting from the application of the methodology of 1991 to the situation of 2001 – 112.321 – is also indicated in the study of 2001 (Kerstan, 2005). When the jobs of industries *not* included into the study of 1991 are subtracted for 2001 as accurately as possible[92] we arrive at 113.926 jobs, suggesting that the major change in method may concern the choice of port-related industries considered.

[88]Joachim Nerling, Department of Trade and Industry Hamburg, personal communications 2005.
[89]The results quoted for 2001 additionally include inland navigation and transport related services. Due to the aggregation used by the study of 2001 the jobs accruing in these industries could not be subtracted here.
[90]The results quoted for 2001 additionally include accident investigators. Due to the aggregation used by the study of 2001 the jobs accruing in these industries could not be subtracted here.
[91]Instead of oil-mills the study for 2001 considers the food processing industry. Also, additional industries are considered – the jobs accruing in these are *not* included into the number quoted in the table, in order to allow the direct comparison of the two datasets.
[92]Not all industries omitted in 1991 can be subtracted for 2001 – compare Table 16-1.

In several industries the response rates for the study of 1991 were too low. The expected reliability of the results for different industries according to the response rates are indicated in Table 16-2. Response rates for the study of 2001 were not made available for this research but have been indicated as much more reliable by several sources. Another methodological shortcoming – most likely in both studies – concerns the fact that the survey questions are phrased in such a way that work force in port-related tasks is identified without consideration of how port-dependent these jobs really are. Firstly, there is no consideration of whether the jobs are likely to remain in Hamburg if parts of good turnover were relocated to the coast. In coastal locations like Wilhelmshaven advanced service functions would simply not find comparable locational factors and cluster properties. It appears reasonable to assume that in this case virtually no Hamburg-based jobs in banks and insurance would be lost, while a very small percentage of jobs in trade and wholesale and a relatively small percentage of jobs in transport could be lost. Secondly, the question whether the jobs considered are still port-dependent enough to require a port is not posed. Some loosely port-related industries might find a more suitable location elsewhere – as in the case of financial services relocating to Germany's 'financial capital' Frankfurt.

Sector /Tasks	**1991**	**2001**	**% loss**	**Reliability of results of 1991**
Public authorities, customs	5.115	4.591	10.2	**Very high** All authorities in charge of port-related functions were queried with survey.
Banks, insurance	5.793	4849	16.3	**Very high** Response rate of 41.7 %. Very good distribution over different company sizes.
Port industries	19.774	11.923	39.7	**Very high for industries considered**[93] Response rate 39.3 %. 32.1 %, resp. 28.6 % indicated volume of export, resp. import via port.
Container handling navigation, dock workers	23.766	16.088	32.3	**Relatively high** Response rate of 21.9 %, good distribution over company sizes and different tasks.
Intermediate inputs and capital goods	47.545	38.738	18.5	**Limited reliability** Response rate 7.4 % for core port economy, 15.4 % for port industries. 13.1 % response rate when aggregated according to size of investments, 8.8 % according to number of companies.
Transport, storage[94]	24.052	21.989	8.6	**Not reliable** Response rate 5.5 %. Very low response rate (2.2 %) for shippers.
Trade and export	16.497	15.779	4.4	**Not reliable** Response rate 4.1 %.
Total	142.524	113.957	20.0	**10.3 % overall response rate**[95].

Table 16-2: Reliability of the job losses from 1991 to 2001 according to the reliability of the study of 1991.

[93]Only metal processing, mineral oil and oil-mills were included into the assessment due to a too low response rate in the other industries, in particular with respect to volume exported/imported via the port. The study of 2001 includes additional industries that are *not* included into results in the table.
[94]The results quoted for 2001 additionally include inland navigation and transport related services.
[95]This does not include public authorities, customs, intermediate inputs and capital goods.

If the results derived from the application of the same methods for 1991 and 2001 are considered, the two studies indicate a loss of approximately 20 % of port-dependent jobs from 1991 to 2001. Losses occurred in fact in all port-dependent sectors and were least pronounced for service functions (compare Table 16-1). In the same time period, tax revenues – including income tax, sales tax, business tax and corporate income tax – have decreased by approximately 21 % from € 669 m to € 527 m96. The contribution to the gross value added in 2001 was 12.4 % including consumer spending by port-dependent employees, and 9 % without it. The industries for which the study of 1991 is regarded as highly or relatively highly reliable constitute 38.2 % of all port-dependent jobs (Table 16-1). Together with the jobs in intermediate inputs and capital goods (which are less highly reliable) we arrive at 71.6 %. The particularly high losses within port industries, container handling and navigation and the low losses in port-dependent service-function also appear plausible given known trends and developments between 1991 and 2001. Thus, the overall shift to the service sector involved losses of between 12.3 and 19.7 % from 1995 to 2000 in the core port-dependent industries: 19.7 % for the mineral oil industries, 14.2 % for metal processing and 12.3 % for food processing[97].

16.3 Future expectations of value creation and jobs

Given these windows on past developments, future expectations for port-dependent jobs and value creation are of great interest. The question, which categories of port-dependent jobs are likely to stay in Hamburg if some port activities are relocated to the coast has been discussed in section 16.2. A more general major factor for the development of port-dependent jobs will be the present transition to a service-based economy (compare Figure 16-6).

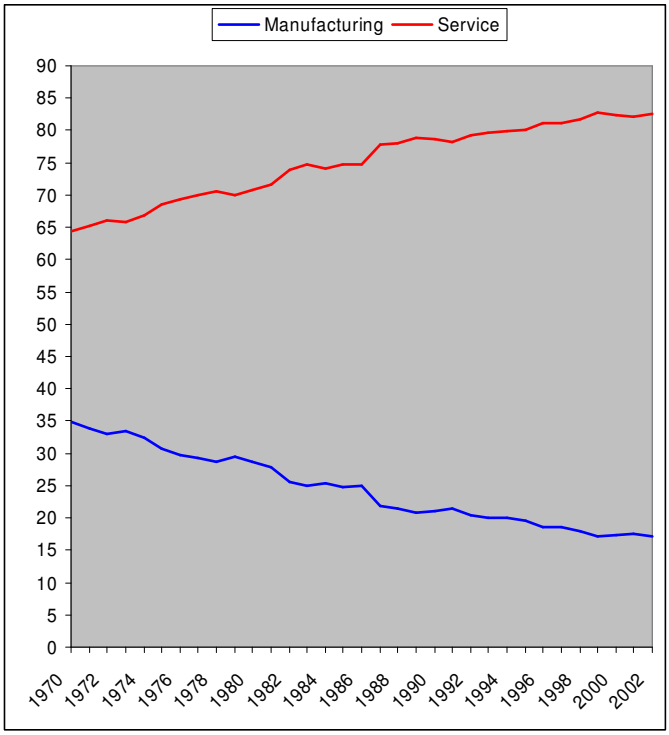

Figure 16-6: Share of the manufacturing and service sector in Hamburg in percent of the gross value added, 1970–2002. Based on data provided by the Statistical Office of Hamburg and Schleswig Holstein upon the author's request and Statistical Office of Hamburg and Schleswig Holstein, n.d.

[96]Numbers provided for the application of a consistent method for 1991 and 2001 by Jens Kerstan (personal communications, 2005). The department of trade and industry of Hamburg quotes slightly higher numbers for 2001 due to the application of a different method for 2001.

[97]Data courtesy of Statistical Office of Hamburg and Schleswig Holstein. Earlier data than 1995 is not available.

Also, Table 16-1 shows that the smallest losses have occurred in the more service-based port-dependent sectors – banks, insurance, trade and transport, and to a lesser degree customs and public authorities. Port-specific trends that accompany this transition and that are of importance to the development of port-dependent jobs and value creation in the future include increasing containerisation, rationalisation and automation, the decoupling of value creation from goods handling, the integration of the transport chain, and the further shifting of port functions towards the shipper's and recipient's ends of the chain.

Figure 16-7 shows the development of containerisation in the port of Hamburg since 1965. With a containerisation rate of 96.5 % in 2004, containerisation in Hamburg has probably reached a saturation point. The leap from 71 % to 94 % between 1990 and 1998 was a major factor for the above job losses.

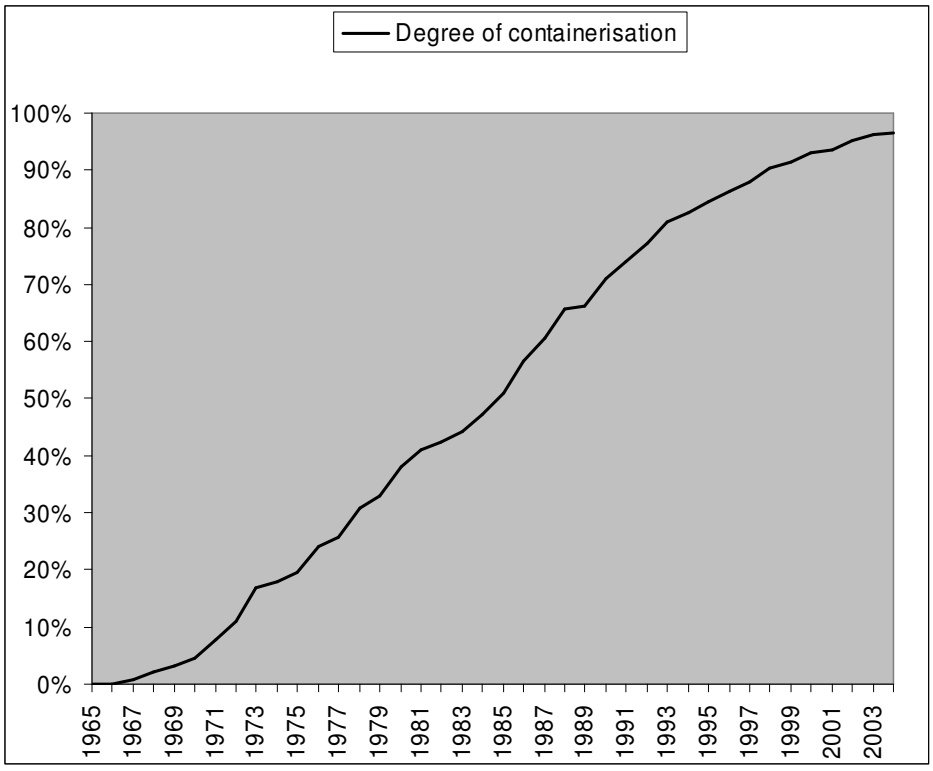

Figure 16-7: Degree of containerisation in the port of Hamburg 1965–2004.

According to the interviewed experts, the other major shifts related to port-labour became clearly noticeable during the mid-nineties. As a consequence, transport and formerly highly port-dependent sectors such as logistics or trade became decoupled from the actual turnover. Goods just passed through the port without entailing any further value-creating activities (Läpple 1998, Läpple and Deeke, 1990 and 1996, Dombois and Wohlleben, 2000). In addition, new types of transport nodes rose in importance, namely highly international airports and inland transport terminals. Thus, in Germany, jobs in logistics moved to regions like Frankfurt, Köln and Duisburg.

The decoupling of value creation from goods handling and the physical location of the port is expected to continue and spread more to service functions and functions on the management and administrative level. As a consequence, activities or offices may relocate within Hamburg or out of Hamburg – mostly depending on the city's success in securing locational advantages for advanced service businesses.

A trend with significant potential for intensification for all terminals except Altenwerder is automation. The terminal in Altenwerder has a very high degree of automation with approximately 25 % of the operating costs being labour costs[98]. The other two HHLA-operated terminals (Burchardkai and Tollerort) and the Eurogate terminal have a much lesser degree of automation[99] and thus employ more personnel. At present, a higher degree of automation does not necessarily save costs due to the high costs and wages related to the necessary IT. However, once costs fall and the related know-how becomes more widely available, further automation can be expected.

As noted by several experts, Hamburg has missed the ideal time for a significant shift of port activities to a coastal port. At present such a shift might need more than 2 or 3 decades. In scenario 3 we investigate the possibility to shift part of the port activities to the coast while maintaining the maritime flair and Hamburg's image as city of port and trade with excellent international relations.

16.4 The contribution of the port to the city's appeal as historic port city

Clearly, ports, ships and large water areas in a city can serve as attraction both for tourists and for the city's residents. During and after the processes of de-industrialisation and conversion of derelict port areas that occurred in many port cities in the last two or three decades it was found, however, that the appeal of former industrial ports in the form of museum ports and leisure ports may be even stronger than the appeal of actual industrial ports. Ports that were converted in this manner in fact made important contributions to the revitalisation of the city (Breen and Rigby, 1994, Bruttomesso, 1999, Hoyle, 1996, Koch, 2001, Norcliffe et al., 1996, Schubert, 2001). In port cities like Hamburg, large water areas that are used by the port are often not accessible to the public at all, and water areas are often polluted. In former port cities like Amsterdam, Stockholm or Birmingham on the other hand, large water areas and canals have been made accessible to the public and now constitute an asset of very high attractivity. Some former port cities offer museum ports where particularly interesting ships can be systematically selected for exhibitions or container ships and bridges can be actually explored. A particular attraction may be leisure boats. The former industrial port of Channel Harburg now serves as leisure port for a large number of sailing yachts and historic threemasters (Koch, 2001). These boats can be admired from much more close-by than containerships, and might be considered more picturesque than containerships or oil-tankers. The leisure port of Channel Harburg is widely regarded as an important contribution to its attractivity as business, leisure and living location (ibid).

Thus we can conclude that, depending on the course of port development taken, the port of Hamburg may contribute to the city's attractivity in different ways. Three of these are explored in the scenarios in part IV of the thesis. In scenario 2, an industrial port is maintained. In scenario 3, most port operations are shifted to the coast while the image of Hamburg as international city of trade is maintained and actually extended. In scenario 1, the maritime flair of the city is promoted by setting up a leisure port with sailing boats, ferries as well as houseboats, making larger water areas accessible to the public, and establishing a museum port.

[98]Personal communications with a representative of Eurogate Hamburg, 2005.
[99]For Eurogate the share of labour costs was estimated to be 50 %.

17 Costs and the related trends and changes

17.1 Direct costs

Direct costs consist of annual material and personnel expenses, investments, interest on existing credits, and balancing of payment obligations for previous investments. Material expenses and investments concern the maintenance and modernisation of port infrastructure, the maintenance and upgrading of parts of the flood protection in the port[100], the processing of dredge material and a contribution to the deepening of the Elbe (with the major share being paid by the Federal republic). The city also pays part of the construction and modernization costs of the berths, in particular container berths, of which Hamburg has 25. On the basis of exemplary costs for the planned modernization of the three terminals of the HHLA (Hamburger Hafen und Lagerhaus Aktiengesellschaft) and the Eurogate terminal, the modernization of a terminal in Hamburg with approximately 1.600–2.100 m quay walls and 4–7 container berths can be estimated at around € 200–270 m for the shipping company. The city bears an additional share of the overall costs[101].

Measure	Costs	To begin in	Scheduled completion
Regular annual expenses (e.g. smaller investments, dredge material[102])	€ 174.9 m	2005	2009
Expansion and modernisation of terminals	€ 78.9 m	2005	2012
Improvement of road network	€ 78.0 m	2005	Various
Improvement of the port rail	€ 107.6 m	2005	Various
Preparation of land for building	€ 49.6 m	2005	Various
Deepening of the waterway	€ 80.0 m	2007	2010
Construction of new terminal in Steinwerder, first stage	€ 137.0 m	2007	2015
New berth for feederships in the Petroleumhafen, first stage	€ 40.0 m	2007	2017
Completion of Steinwerder and Petroleumhafen	€ 350.0 m[103]	2010	2015 (Steinwerder) 2017 (Petroleumhafen)
Sum SIP 2005–2009	**€ 746.0 m**		
Sum SIP without regular annual expenses	**€ 571.1 m**		

Table 17-1: Measures of the Port Special Investment Programme and the associated costs. Source: Port of Hamburg Marketing, 2005a.

[100]E.g. barrage locks and flood gates. Flood protection in the port also includes privately financed polders that receive some support from the city.

[101]In the case of the Eurogate terminal approximately 45 % of the overall costs (based on the indication of a representative of Eurogate that this company invests approximately € 1.15 for each € 1 invested by the city, Eurogate, personal communications, 2005).

[102]€ 35 m per year which is at best barely sufficient: In 2005, costs for dredging and treatment of dredge material are estimated at € 60 m, of which € 32 m are planned to be paid in 2005. The costs of "small measures" are estimated at € 16.9 m (e.g. for the port rail or berth modernization not included in the SIP), of which € 14.5 m are planned to be paid in 2005, giving payments of € 46.5 m for 2005 (Freie und Hansestadt Hamburg, 2005b).

[103]Estimate by the city of Hamburg.

Investments are frequently carried out in the context of special investment programmes. Recent examples are the 'Special Asset City and Port' ('Sondervermögen Stadt und Hafen') and the 'Port Special Investment Programme' ('Hafen Sonderinvestitionsprogramm' – SIP). The former involved the financing of the port expansion in Altenwerder with property sales in the Hafencity104. The SIP involves the investment of € 262.4 m over the years 2005–2009 into the port, in addition to € 484 m that are already included in the medium-term fiscal planning. This will make € 746 m available for port-expansion during the years 2005–2009 (Port of Hamburg Marketing, 2005a). Costs and measures of the SIP are listed inTable 17-1. Within the SIP, requirements of € 262.4 m between 2005 and 2009 and € 350 m after 2010 have not been covered for yet. In addition, a terminal may be built in Moorburg between 2010 and 2020 at unknown costs. Financing strategies indicated by the city involve redeployment of capital and new capital appropriations. In addition the level of rents in the port area or relevant fees will be adapted.

Position	**Costs 2003**	**Costs 2005**
Interest and amortization Special Asset City and Port[105]	€ 22.0 m	€ 22.6 m
Port investments within Special Asset	€ 27.6 m	€ 5.1 m
Directly paid investments	€ 136.3 m	€ 91.9 m
Personnel expenses Amt für Strom- und Hafenbau (now: Port Authority)	€ 77.0 m	€ 81.8 m
Material expenses Amt für Strom- und Hafenbau	€ 30.0 m	€ 31.8 m
Port-related expenses department of port, services and economic infrastructure[106]	€ 14.8 m	€ 21.5 m
Port-related expenses department of economic and technology promotion	€ 8.2 m	€ 11.2 m
Allowances and port expenses not paid by the above departments	€ 19.7 m	€ 21.0 m
Sum	**€ 335.6 m**	**€ 299.2 m**
Together with current estimated share of SIP for 2005 (€ 64.2 m)		**€ 351.1 m**

Table 17-2: Annual expenses and smaller investments for 2005 plus the interest on the Special Asset City and Port. Note that the different items may be paid by different city authorities and offices. In accordance with the city's budget plan, regular annual expenses (e.g. for dredging) are considered direct investments for 2005 rather than part of the estimated share of the SIP for 2005. Not included are payment obligations and interest paid on credit outside the Special Asset City and Port. Source: Freie und Hansestadt Hamburg, 2003a, 2005b, 2005d, Port of Hamburg Marketing, 2005a, and Bürgerschaft der Freien und Hansestadt Hamburg, 2005.

Table 17-2 lists expenses and investments for 2003 and 2005, including the present official estimated share of the SIP to be paid in 2005. Altogether this gives expenses of € 351.1 m for 2005 and € 335.6 m for 2003. This does not include interest paid on credits for investments outside the "Special Asset City and Port", which involve payment obligations of € 249.6 m as of 2006 (Freie und Hansestadt Hamburg, 2003a and 2005b).

[104]This cross-financing scheme has been terminated in 2005. See our discussion in section 17.4.1.

[105]Now paid by the department of urban development, formerly paid by the department of trade and industry.

[106]Amt für Häfen, Dienstleistungen und Wirtschaftsinfrastruktur. This includes expenses directly used for the port and a portion of expenses that benefit not only the port (the respective expenses have here been multiplied with the proportion that is indicated for the port in the budget plan (67 %)).

17.2 Future expectations of direct costs

Both given observed trends and the city's estimates for port expansion costs the costs of port development show a tendency to increase. The costs of the construction of the new terminal Steinwerder and the new berth in the Petroleumhafen are expected to increase from annual € 35 m between 2005 and 2009 to annual € 50 m in the years 2010–2017 (Port of Hamburg Marketing, 2005a). The costly construction of a possible new terminal in Moorburg may begin while the terminal Steinwerder is still being built. Also, there is a growing debt due to the port, including the costs of the container terminal Altenwerder, parts of the SIP and the larger share of annual investments. A lowering of the costs carried by the city could occur if shipping companies were to be included in the financing of port infrastructure (Berger et al., 2000) or of dredging measures in the waterway. The most likely reason for this would be the accepting of bids for the new terminal in Steinwerder. The EU Port Package II pointed in this direction. This possibility has been declined in January 2005. A new version of the port package by the Commission is possible though.

The city's response to rising costs includes the establishment of the Hamburg Port Authority (HPA) in October 2005 with the intention to save costs. The HPA will take over all activities of port administration that were formerly the responsibility of the public authority "Amt für Strom- und Hafenbau" (Bürgerschaft der Freien und Hansestadt Hamburg, 2005). The port area will remain in the possession of the city while rents and port fees will be determined by the HPA. The HPA is an organization under private law that functions according to business considerations and is capable of insolvency. Decisions about rents have to happen in a transparent fashion. Ideally the income from rents should approach coverage of public investments in port infrastructure. However, present income from rents in the port is only € 50 m per year, and the port fees of around € 26 m are planned to be used for the annual operating expenses of the HPA[107], while annual directly paid investments range between € 92 m and € 135 m (compare section 17.1). The latter sum does not include the investments of the SIP, annual material and personnel expenses and credit on payment entitlements. Also the intense competition between ports in the Northwest European port range puts limits on the scope for raising rents and fees. With the EU Port Package – which has now been declined – these limits would have been called into question.

An unlikely but possible scenario in response to rising costs would be the gradual privatisation of parts of the port by selling shares to the Port Authority, involving private investors in port development or selling port area rather than just renting it out. At present the city is very disinclined to do so, as this is likely to imply a loss of control over operations in the port. A possibility of quite indeterminate outcome is the establishment of a nationwide port development policy, such as exists in the Netherlands. This seems unlikely at present, but may come about in response to the ports' rising costs and decreasing benefits or through shifts in the orientation of Federal politics. In particular, the deepening of the waterways and the hinterland to the various ports is almost entirely financed by the Federal Republic.

[107] Joachim Nerling, Department of Trade and Industry Hamburg, personal communications 2005.

17.3 Indirect costs

The identification of indirect costs in the city's budget plan is mostly not possible. We will give an overview of the different identified items in the following with a rough guess of the cost dimensions where possible, and without the claim for completeness. The main items are

1. costs related to the conversation of areas into port-area, e.g. population resettlement,
2. indirect costs related to the conversion of commercial port area into terminal area,
3. indirect subsidies to port businesses and
4. negative externalities.

Prior to the construction of the new terminal in Altenwerder in 1998, approximately 2500 people had to be resettled (Hamburger Abendblatt, 2002). The resettlement of the population of Moorburg for a possible further port expansion between 2010 and 2020 (Port of Hamburg Marketing, 2005a) would involve around 1000 people (Hoja, 1999) with possibly more complicated property rights. Company relocation costs accruing in the case of the new terminal Steinwerder are not included in the official costs of the SIP. A number of service and storage businesses are located in this area, including Unikai and Busgruppe (compare Figure 17-1). Port subsidies in the form of direct payments to port-related businesses have been included into our compilation in Table 17-2. Indirect subsidies include for instance low rents to port businesses. The average rent in the port can be estimated at annual € 2.2 per m²[108].

Negative externalities include social impacts through resettlement (Nuhn et al., 1983), flood protection and environmental impacts, quality of life impacts through traffic, congestion and major traffic corridors such as the planned highway transit route Hafenquerspange across Wilhelmsburg, noise in port-adjacent areas, and area-usage in Wilhelmsburg for the storing of containers. Environmental impacts on the river include the changed breadth and depth (from approximately 2.5 m in some places to presently 15.3 m), the increased tidal hub, the changed flow velocity, and losses of ecologically valuable areas such as shallow water areas, natural river banks, saltwater and freshwater mudflats and foreland areas. These impacts are due both to deepening measures and to dike building with river deepening making higher and wider dikes necessary (Arge-Elbe, 1984). An overview of the impact of river construction measures on the height of floods according to different sources has been given in Table 2-1 in section 2.1.

17.4 Opportunity costs[109]

Our definition of opportunity costs involves the question whether certain benefits derived from the port's usage of the city's resources fall short of the benefits that could be received if those same resources were allocated towards a different purpose. This could concern (Läpple and Deeke, 1990, Hoja, 1999, Deeke, 2001):

1. the usage of large, expensive inner city and waterfront areas,
2. the proportion of the city's expenses for the port relative to expenses for city development and
3. the proportion of expenses for the port relative to expenses for new economic sectors.

[108]Calculated on the basis of € 50 m annual rent (Joachim Nerling, Department of Trade and Industry Hamburg, personal communications 2005) received for the 66 % of the 3.428ha port utilization area that are used for general and bulk cargo, port industries and businesses. A reasonably close guess of € 2.5 was made by one interviewed expert (Herbert Nix, personal communications 2005).

[109]Opportunity costs are commonly defined as the costs of an action in terms of the opportunities foregone and the benefits that could have been received from that opportunity.

17.4.1 Area usage and conflicts with city development

The port uses 11.5 % of the total area of the city estate, that is 8.700 ha (Port of Hamburg Marketing, 2002). The lack of a proper area usage policy in the port is a known problem (Läpple and Deeke, 1990). A central reason is the lack of competition with other types of area usage. Also, land utilization in the port is determined according to the Port Development Law, which is the responsibility of the Department of Trade and Economics (Hoja, 1999) rather than of the city as a whole. Port area is only rented out, not sold, and contracts are often very long-term. This implies low benefits for investments that increase the profit per m² or enable a more efficient area-usage. A related problem is the fragmentation of the port area and the existence of a large number of rarely used areas. Areas that have been idle for several years are usually not taken out of the port area.

In the light of population shrinking and new demands, inner city space is getting more expensive and scarce, in particular if the area in question is adjacent to the Elbe. New usages such as new economic sectors, water front housing, tourism, recreation and culture offer in fact several important advantages: Aside from job perspectives in new sectors (Gornig et al., 2003) this involves rents for new usages that are usually much higher than the present average annual rent of € 2.2/m² in the port (compare section 17.3). In addition, the contribution of new uses such as recreation or culture, and of water and green areas to the city's quality of life is of high importance with respect to the increasing international competition between European metropolitan regions (Grossmann, 2000, Clark et al., 2002). Some limited port-adjacent areas in Hamburg are now employed for new uses; for instance the Musicalzelt ("Musical-tent") and the "Perlenkette" ("String of Pearls") on the northern riverbank. The Musicalzelt is a large tent with 1.400 seats for musical and theatre performances. It is located right next to the port, can be reached by exclusively operated ferries and has an inbuilt restaurant with stunning views over the Elbe and the city's skyline. The Perlenkette consists of a string of representative buildings with modern offices and luxurious living quarters on the waterfront. Such new forms of usage may be declined for port-adjacent areas however, as living areas that are directly adjacent to the port are seen to pose obstacles to further port development. A recent example are the "Harburger Seehäfen" south of the port.

Another conflict with city development concerns the Hafencity. On the basis of the "Special Asset City and Port", the construction of the new container terminal in Altenwerder was cross-financed with property sales in the Hafencity until 2005. This has been hindering the development of this new city quarter with respect to costly measures – such as the establishment of a good public transport connection. While the city has now decided that rail-based public transport will be provided, the financing has remained uncertain. This is a disadvantage for investors who need to know when public transport will be available. The financial ties to the port have also restricted the flexibility towards investors, in particular small investors. Another restriction has been a lack of freedom to incorporate elements that would be needed for the generation of a critical mass of companies in new sectors, or elements for a well functioning and attractive new city quarter – e.g. social infrastructure, affordable housing or schools.

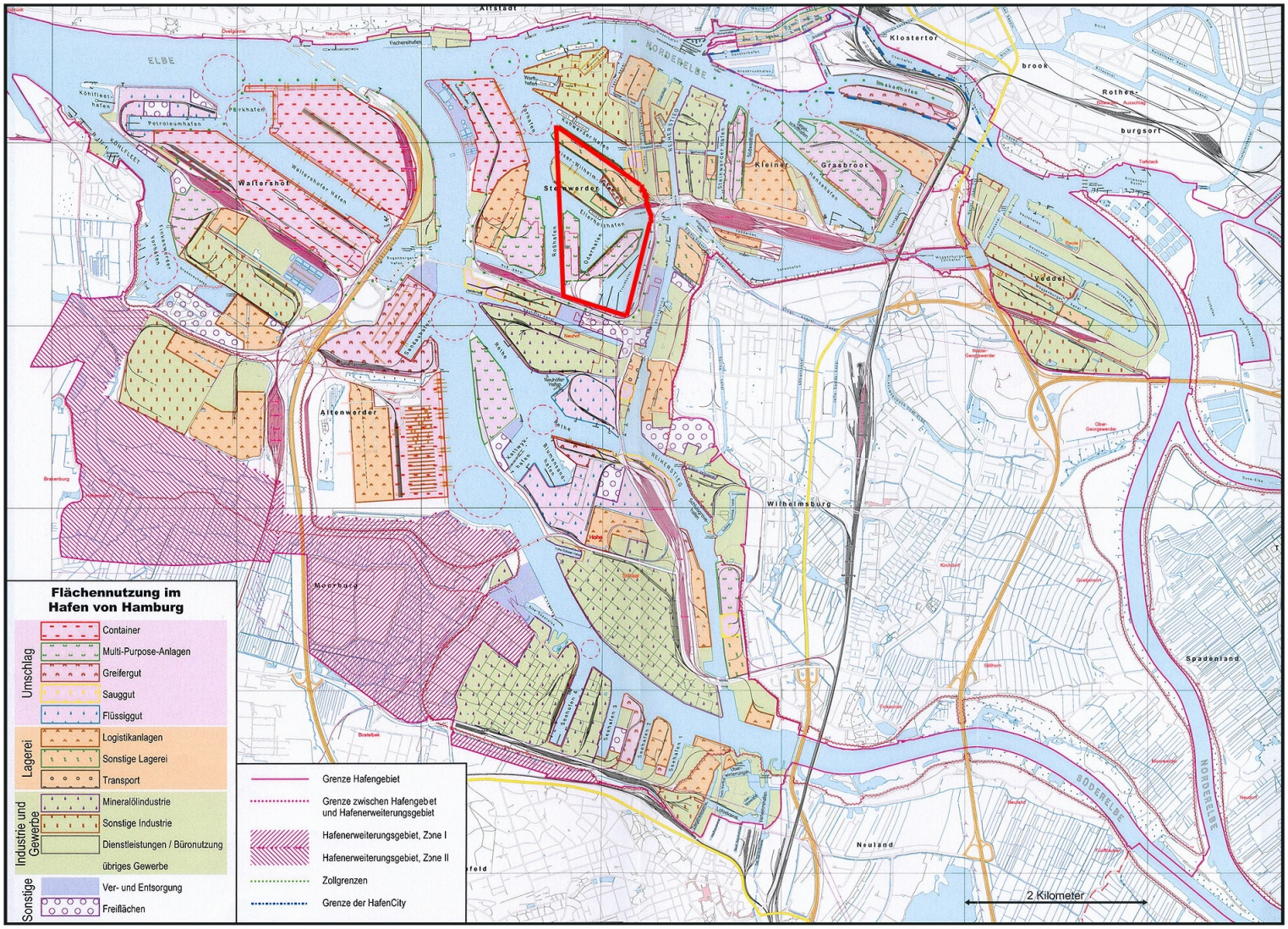

Figure 17-1: Area usage in the port of Hamburg – courtesy of Hamburg Port Authority. The new container terminal Steinwerder will be constructed in the area delineated in red (red lines added by the author). At present, parts of this area are used for service companies and office space (green), others for storage (light red with green pattern), others for multipurpose (pink with green pattern).

17.4.2 Competing possibilities of economic development

In section 16.2, the losses of approximately 20 % of port-dependent jobs in Hamburg between 1991 and 2001 according to studies commissioned by the city have been discussed. Over the same time period, overall turnover in Hamburg increased by 41 % (Port of Hamburg Marketing, n.d.). Arguably, job losses would have been much higher if the city had not registered such an enormous increase in turnover on the basis of the investments made. However, one needs to ask whether continuing to put considerable financial resources as well as central city space into port development is the most efficient way for the city to preserve and create jobs, regional income and quality of life (Grossmann, 2006). While not all results of the above studies are reliable, serious losses in jobs and tax revenues have occurred and are expected for the future. Tax revenues per wage earner in a port-dependent job are in fact lower than in other economic fields, with a contribution of approximately 8 % to the city's tax income in 2001, while the percentage of port-dependent jobs was 12 %.

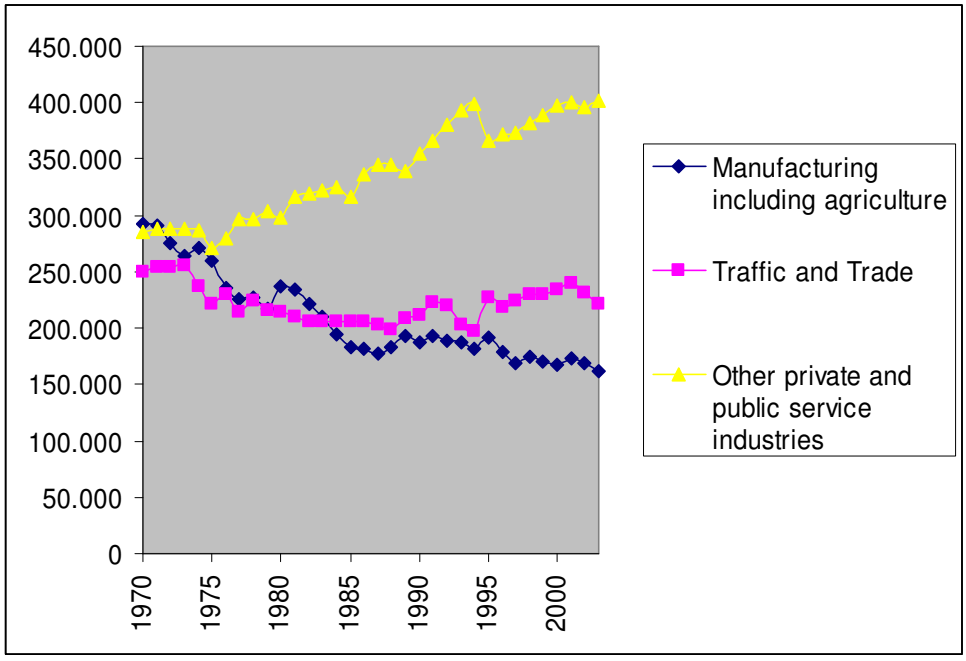

Figure 17-2: Time series of the number of people employed in the manufacturing (including agriculture), traffic and trade and other private and public service sector industries in Hamburg, 1970–2003.

As one places this question into the larger context of global economic developments and Hamburg's position as metropolitan region in competition with other European metropolitan regions, two points become evident. Firstly, we have a pronounced increase of service-related jobs as such in Hamburg (compare Figure 16-6 and Figure 17-2), and of certain advanced service industries in particular. On closer investigation our second point becomes apparent – different metropolitan regions perform differently well with respect to establishing a firm basis in new sectors and affirming their competitive position in a larger Europe. An investigation of the first point for Hamburg's economy is found in Gornig et al., 2003. According to this source, the so-called 'other service industries' ('sonstige Dienstleistungen') now contribute 50 % of the value created by the service sector. These include media, health services, education, research, culture, the hotel and restaurant industry and 'remaining service industries' ('übrige Dienstleistungen'). Within these, the so-called 'remaining service industries' – e.g. advertisement, consulting and technical consulting, accounting, auditing and legal advice – have developed in the most dynamic way (ibid). Current regional development and urban renewal research has established a number of factors that may be crucial for the

successful development of city regions with respect to our second point, the establishment of new economic sectors. We will discuss particularly relevant factors in the following in order to clarify the need for Hamburg to take certain strategic actions.

Probably the most critical lack for Hamburg concerns the absence of a high-capacity intercontinental airport. The runways for landing and takeoff intersect and the construction of a new runway is not possible due to the lack of expansion space. The airport is also surrounded by densely populated residential areas that require the closing of the airport before midnight. Therefore the capacity of hourly flight movements is restricted to approximately 45–55[110] and a frequent schedule of intercontinental flights cannot be set up. In addition to consequences for the city's vibrant presence in new economic sectors, this may also make it impossible for Hamburg to host the Olympic games (for example in 2016). The games would require the transport of approximately 400.000–600.000 additional passengers per month[111]. According to the airport's website, as of 2004, approximately 820.000 passengers are transported per month, indicating a required increase of capacity by approximately 50 to 75 % in order to be able to host the Games. This is definitely not possible without the purchase and conversion of large residential areas. The construction of a new airport would require investments of a scope that would exceed current port investments. However, these investments would only be necessary for a limited duration of time. Another necessity would be the willingness of the city to have the airport built outside the city-state (Grossmann, 2006). This is lacking so far, which was probably the main reason why the construction of a new airport in Kaltenkirchen just north of Hamburg as considered in the seventies did not take place.

Another crucial point concerns the necessary innovative power and education and research facilities for new sectors (Porter, 1999 and 2000). A number of studies assign Hamburg only a moderate performance with respect to innovative power, number of patent applications and different aspects of the research environment (European Commission Directorate-General Enterprise, 2002, Keller et al., 2004, Parkinson et al., 2004, Cushman and Wakefield, 2004, Handelskammer Hamburg, 2000). Related is the importance of a top-performing professional business environment and a supportive business climate (Porter, 1999 and 2000, Wolfe, in press). With respective to promoting itself as business location for new sectors, Hamburg has been found not competitive enough (Parkinson et al., 2004, Cushman & Wakefield, 2004, Keller et al., 2004). Also, measures in support of new economic sectors in Hamburg receive a lower score than in German city regions or Federal states such as Munich, Frankfurt or Nordrhein-Westfalia (Gornig et al., 2003, Handelskammer Hamburg, 2000).

Competition in new fields is extremely high and metropolitan regions need to communicate and demonstrate their committed interest in new economic sectors (Hall, 1997, Grossmann, 2000, Parkinson et al., 2004, Wolfe, in press). Through the high speed of developments and the increased market internationalisation within the global knowledge economy, the risk of "winners and losers" between countries and in particular between regions is higher than in a primarily industrial economy (Archibugi and Iammarino, 1999, Porter, 1999 and 2000). Due to spillovers and the cumulative character of technological progress, innovation processes often occur faster in countries or regions that specialise in specific new sectors (Archibugi and Iammarino, 1999)[112] or within clusters as such. This is due to positive feedback loops created

[110]According to Senat der Freien und Hansestadt Hamburg, 1998, flight movements are technically limited to 45 per hour. This number is (slightly) exceeded at present – it is not possibly to significantly exceed it, however.
[111]The estimates are based on flight movements at past Olympic games, e.g. in Sydney, 2000.
[112]An interesting outcome of this phenomenon is the ability of smaller countries and regions to act as global players in the post-industrial economy on the basis of the greater concentration of their industries in selected

between the new companies and surrounding factors such as (research) institutions, infrastructure and social capital (Porter, 1999 and 2000).

At present, Hamburg has a comparatively high share in distributive services and only a small share of employees in knowledge-intensive services (Läpple, 2004). Software development and data processing services that are central to the development of new sectors are presently underrepresented in Hamburg (Gornig et al., 2003, Handelskammer Hamburg, 2000). It is hoped that the resources for the establishment of a professional business environment for new sectors in the Hafencity will be expanded with the de-coupling of the budget for the Hafencity from port development.

advanced sectors (Archibugi and Iammarino, 1999). This can be observed for instance in the Oresund region and in general in the economic development of the Scandinavian countries during the last decade.

18 Conclusions

It is important to place port development plans of the city of Hamburg into the larger context of present or near future worldwide developments. The most consequential developments concern technological change and new requirements for ports, and the economic shift towards service and ICT-industries. This has led to losses in job and value creation across manufacturing and goods-intensive industries. Due to these developments, Hamburg and its port face two different risks. Firstly, Hamburg may not be able to keep up with the new requirements for the port and therefore lose market shares. Ship-sizes beyond 12.500 TEU (or less) will not be able to call at Hamburg anymore even after the next Elbe deepening. In addition, an increasing number of ships is delayed by the tidal window with waiting times of up to 8 hours. Other important new requirements which will be difficult to fulfil include efficient transhipment to other means of transport and flexibility towards the preferences of shipping companies, e.g. in the form of dedicated terminals. The latter is a possibility which Hamburg has not been willing to consider so far.

Secondly, and much more importantly, even if turnover expectations can be realized, job and value creation through the port are decreasing and value creation is shifting to new service-based sectors. We cannot establish final and definite numbers regarding past job losses, as the available studies are only reliable for at most 71.6 % of port-dependent jobs. According to these studies, job losses of 20 % have occurred between 1991 and 2001 while tax revenues have decreased by approximately 21 %. The smallest losses have occurred in the more service-based port-dependent sectors. Further job losses are expected to occur in the future due to the increase of rationalisation and automation, and a further decoupling of activities from the physical location of the port. At the same time, port maintenance and development imply substantial costs for the city, with a tendency of rising costs for future years. A possibility for cost reduction – which the city has not seriously considered so far, however – concerns the involving of private investors in the financing of the port.

Both monetary expenses and the port's space requirements have impacts on developments in other fields. Our investigation has focused on two central aspects of this: the port's usage of large, expensive inner city and waterfront areas and the fact that the service and ICT-industries – in which high job-generation occurred during the last 10 years – often have quite different locational factors than those of the port and port-dependent industries. Both new economic sectors and inner city waterfront space are crucial assets for the success of the city in the post-industrial society. This is particularly relevant given population shrinking and the increasing competition between Europe's metropolitan regions. New sectors will require investments which may indirectly compete with the financial requirements of the port. In our analysis we discussed typical success factors for post-industrial metropolitan regions with respect to the situation of Hamburg. A particularly critical lack for Hamburg concerns the absence of a high-capacity intercontinental airport. This would require investments of a scope that would exceed current port investments, albeit only for a limited time period. Another requirement concerns the modernization of education and research facilities in alignment with the needs of new economic sectors. Several sources also recommend the improvement of the professional business environment for new sectors and of the city's business climate. It would be advisable for the city to evaluate whether the high costs of the port restrict the city's support for new economic sectors and for urban renewal too much – given the decreasing contribution of the port to the city's economy and the need for the city to re-assert its position in the larger European and international context.

PART IV:

THREE SCENARIOS

FOR THE GREATER HAMBURG REGION[113]

[113]This part of the thesis has been published in Grossmann, 2006.

19 Introduction

In this final part of the thesis, three scenarios for the metropolitan region of Hamburg for the next 25 years are presented. The scenarios bring together developments and decisions occurring in the areas of economic restructuring, demographic and societal changes, city development, climate change and environmental changes. At the same time, the scenarios connect development in and planning for the different geographical parts of the region – with the city of Hamburg playing a central role. In this way, the scenarios form a synthesis of the results from the preceding three parts of the thesis that each either focused primarily on one specific question or on a certain geographic sub-area. In addition, new questions of concern to the city of Hamburg will be discussed.

In the first three parts of the thesis, different questions and issues of concern to Hamburg and the surrounding region have been discussed – namely climate and environmental change, perspectives for the rural area and perspectives for Hamburg as port-city. In order to construct different storylines for the metropolitan region out of these building blocks, we need to look in more detail at present changes in the city of Hamburg and possibilities for the city's future. The city of Hamburg – Germany's second largest city and home to Europe's second largest port – is presently going through a phase of fundamental economic and spatial changes and socio-cultural renewal based on major decisions about the future development of the port and new directions of economic and city development. The important – though somewhat ambiguous – role of the port for Hamburg's economic identity, the increasing competitive pressure on the port through new requirements and the necessity of a shift towards new economic sectors have been discussed in part III of the thesis. Hamburg is also involved in a number of large-scale city-renewal and -development projects that aim to revive the core city, revitalise abandoned port areas and address structural problems in certain city quarters. And, like many other major European cities, Hamburg is repositioning itself both in the larger European context and as part of a bigger region. As a city-state, Hamburg constitutes a German federal state on its own. Historically, this status was intended to give the city full authority in taking decisions related to port development (Harms, 2001). At present, however, the administrative separation of Hamburg from the surrounding region (compare Figure 21-5), and from the ports located at the coast, has become an impediment to comprehensive and long-term planning for the region as a whole (Lenkungsausschuss der gemeinsamen Landesplanung in der Metropolregion Hamburg, n.d.). This concerns mutually beneficial opportunities for collaboration – for instance with respect to regional marketing, scientific exchange or port politics. It also concerns the impacts of decisions taken by the city state on the economy, the environment, flood protection and quality of life in the surrounding rural areas.

Many of the challenges that Hamburg is faced with are common to Europe's major cities and metropolitan regions (Dekker and Kempen, 2000, Ache, 2000, Florida, 1995, Hall, 1997). Our aim here is to explore different possibilities of response to these challenges for the study region. These possibilities are presented in the form of three different scenarios for the next three decades. This choice allows, firstly, the comparison of the long-term outcome of different strategies. In addition, scenarios are extremely useful to illustrate the interconnectedness of the different fields within which decisions and changes occur and that have been investigated in previous chapters – such as port and economic development, city renewal and population patterns. The interrelatedness of economic, societal and political change has been a core insight gained in projects of urban renewal in Western countries within the last few decades (Dekker and Kempen, 2000, Carmon, 1999). The scenarios

illustrate this interdependence by depicting that different routes taken in one field, such as port development, enable – or enforce – entirely different outcomes in other fields such as city development, quality of life, the state of the environment and the development of the wider metropolitan region. For this thesis in particular, scenarios can make visible what the results of the different parts of the thesis may look like in reality – given parallel developments in other fields.

Lessons learned by other city regions in highly industrialized nations in the course of urban renewal processes may be of great interest for the situation of the Hamburg region. An overview of such issues and lessons will provide the starting point for the analysis (section 20.1). In section 20.2, an introduction to the role of scenarios within science is given (20.2.1) and the scenario methodology employed in this part of the study is introduced (20.2.2). In chapter 21, the current baseline in the region is presented. For fields that have been investigated in more detail already this takes the form of a summary (sections 21.1 and 21.3 on climate and environmental changes and on port development, respectively). Section 21.2 on environmental measures, section 21.5.1 on measures for economic development and section 21.5.2 on measures for urban renewal are given in more detail as they cover new material. Aspects of governance and regional cooperation are discussed in section 21.6, followed by a brief summary of relevant national and global trends in section 21.7. The three scenarios are presented in sections 22.1–22.3. They are presented in three decades, with the first looking more in depth at the decisions and measures taken and the emphasis of the third being on a description of the end-state. Conclusions are presented in chapter 23.

20 Materials and methods

20.1 Issues in urban renewal

High unemployment and the need to build up a functioning post-industrial economy, social polarisation and rising crime rates, and population shrinking and aging are common problems to cities in Western Europe. In the last few decades, approaches to urban renewal have changed significantly. We will give a brief overview of current approaches and lessons learned, and indicate where these issues are reflected in the scenarios.

Four core features of current urban policies can be identified: Firstly, economic, societal or political and physical renewal are increasingly recognised to be linked and pursued in conjunction (Carmon, 1999, Dekker and Kempen, 2000, Clark et al., 2002, Andersen and Kempen, 2003). Secondly, in most Western cities and city regions there is a shift from government to governance (Dekker and Kempen, 2000, Taylor, 2000, Andersen and Kempen, 2003, Rakodi, 2003). Thirdly, urban renewal strategies are based on a different time and spatial scale, with a tendency towards more long-term thinking (Puglisi and Marvin, 2002), and a decrease in importance of the nation-state, in favour of a shift both towards the European or global context (Hubbard, 1995, Beriatos and Gospodini, 2004, Parkinson et al., 2004) and the local level on which a city-region needs to operate as one entity (Walter-Roog, 2004, Parkinson et al., 2004, Lenkungsausschuss der gemeinsamen Landesplanung in der Metropolregion Hamburg, 2005). Finally, the requirements for city renewal and for economic competitiveness in the context of a global service-economy have undergone significant changes (Hubbard, 1995, Hall, 1997, Grossmann, 2000, Clark et al., 2002, Kamp et al., 2003, Parkinson et al., 2004, Hutton, 2004).

Early urban renewal policies, which began in the UK and US in the 1930s were centred around massive deconstruction and rebuilding of housing units. They have revealed that changes in the physical environment are blatantly insufficient to resolve social problems and stimulate new economic developments (Carmon, 1999, Andersen and Kempen, 2003). Later generations of urban renewal are gradually taking on a more integrated approach. Reconstruction measures in the physical environment are combined with measures directly tackling social problems, measures to create jobs and to stimulate the economy (compare Dekker and Kempen, 2000 for a discussion of the “Big Cities” Policy in the Netherlands). Also, “place-building”, the perception and marketing of the city’s identity, and cultural offers and amenities (Clark et al., 2002) have taken on a new dimension of importance against the background of growing mobility, population shrinking and the resulting fierce competition between city regions for qualified human capital (Hubbard, 1995, Andersen and Kempen, 2003). Consequently, a number of European cities are presently going through the process of re-creating their image and identity (Cochrane and Jonas, 1999, Beriatos and Gospodini, 2004).

In addition, factors specific to new economic sectors need to be provided. New sectors tend to evolve in clusters and networks in regions that offer a high-quality business environment and a core of critical size of qualified people (Hall, 1997, Grossmann, 2000, Clark et al., 2002, Hutton, 2004). The political will to attract new sectors and proactively approach investors and new companies is essential (Hubbard, 1995). Further factors are an education-system geared towards economic requirements (Parkinson et al., 2004), as has been established in the

successful Federal German state Bavaria, a good public transportation system and an airport of international importance.

Through the shift from government to governance, urban management can be handled by partnerships and networks between actors from the public, private and voluntary sectors instead of exclusively by public agencies (Taylor, 2000, Rakodi, 2003, Salet et al., 2003). Tasks in regional planning, economic development and locational marketing, transport or waste disposal can be contracted out to local businesses. Urban renewal can evolve in joint projects between different actors. The aim is to improve the effectiveness of urban government in terms of responsiveness to changing requirements, resource efficiency and capital recruitment, social inclusiveness, equity and participation (Rakodi, 2003). In some European cities, projects aim to empower residents to manage their own lives and continue to take action after the respective policy programme has ended (Carmon, 1999, Dekker and Kempen, 2000, Andersen and Kempen, 2003). In other cities we find intermediate levels of reforms in the public sector (Rakodi, 2003), for instance in the form of increased autonomy of public service providers or increased and more reliable financing for public sector programmes. Problems with new forms of governance often arise with respect to accountability and the need for clear responsibilities in cases of failure (Dekker and Kempen, 2000, Rakodi, 2003), as well as from conflicting goals or mismatches between the network partners and those whom they are supposed to represent. Network participants are usually not democratically elected (Andersen and Kempen, 2003). Also, the composition of decision-making groups may be biased towards those who are preferred as network-partners due to their resources or articulateness, or dominated by local authorities that use the initiative merely to gain public support (Taylor, 2000).

New forms of governance in Hamburg form part of the first scenario. All three scenarios explore possibilities for a re-positioning of the city in the European post-industrial context. Specific measures dealing with urban renewal, social polarisation and with strengthening the core city are discussed on city-level and on the scale of selected city quarters, namely the Hafencity which is presently being built, and Wilhelmsburg and Harburg which are directly adjacent to the port in the city's South.

20.2 The scenario methodology

20.2.1 Scenarios within science

Scenario development has very heterogeneous roots (Berkhout and Hertin, 2002) – including business and strategic management (Schwartz, 1991), operations research, risk analysis, and planning processes. Common to business and scientific scenarios is the assertion that the purpose of scenarios is not to predict. Scenarios are hypothetical, describing possible future pathways (Rotmans et al., 2000) or "possibility spaces" (Berkhout and Hertin, 2002). Important is to note that while the alternative futures described in scenarios may not necessarily appear probable, they have to be plausible and based on certain internally consistent assumptions (Reid et al., 2002, Rotmans et al., 2000). Another important aspect is the dynamic nature of scenarios, that is, their capacity to explore developments over time rather than mere snapshots or images of the future.

The scientific challenge inherent in attempts to address massive global changes within such different fields as climatic changes and environmental risks, natural resources, the economy, society and culture, politics and demographics is huge, especially due to the high uncertainty in each of these fields and their high interrelatedness with each other (Carter et al., 1994,

Ravetz, 1997, Rotmans et al., 2000, Reid et al., 2002). New approaches and methods are therefore needed and have been developed over the last several years. Scenario development is one such new approach. The particular strengths of the scenario approach could be summarised in four items:

1) Scenarios can make new aspects visible in order to inform decision-making: this concerns the consequences of trends that are difficult to visualize on the required temporal or spatial scale, or potential discontinuities and surprising events.
2) Scenarios offer ways to work with a high degree of complexity and interrelatedness between different fields. It is usually not sufficient to assume that only certain fields within a system change while others remain constant (Zon, 1992, Berkhout and Hertin, 2002). In fact, developments in each field may be turned completely upside down by a crisis, unexpected event or simply an obvious but ignored trend in another field (ibid, Schwartz, 1991). Scenarios also make the impact of different fields on each other visible.
3) Scenarios offer a framework to critically review and widen knowledge about the future (Berkhout and Hertin, 2002) and are thus particularly suited to work with uncertainty. Through the usage of different – and frequently antithetic – future storylines, options can be considered that were not thought of before but may be well possible. Schwartz, one of the founding fathers of strategic management scenarios refers to this effect as "thinking the unthinkable" (Schwartz, 1991).
4) Scenarios allow the combination of quantitative elements – from the natural sciences, economics, land-use, demography – and qualitative elements – usually from sociology, anthropology, political sciences or philosophy (Shackley et al., 1998). The latter kind of elements often take the form of attitudes, values, concerns as well as people's knowledge outside the classic realms of science, for example indigenous knowledge (ibid, Street, 1997). Often scenario development involves participatory elements (Street 1997, Rotmans et al., 2000, Berkhout and Hertin, 2002) in addition to quantitative elements.

Notten et al., 2003 suggest a classification of scenarios according to differences in the "project goal", "project design" and project content". The project goal, for instance may be normative or descriptive, forecasting or backcasting. The design may for instance include participatory elements or not, and be qualitative or quantitative in nature. Differences in content concern for instance the monodisciplinary versus integrated nature of the research question but also the breadth of ideas and scenario elements – often referred to as unconventional or alternative versus conventional (ibid). Bruun et al., 2002 establish a two-dimensional categorization of scenarios which further engrosses and systematizes this distinction. The four types of scenarios suggested here are "event-based conventional", "event-based unconventional", "trend-based conventional" and "trend-based unconventional" scenarios. Trend-based scenarios investigate foreseeable trends, either in domains known to have an influence on the topic in question (conventional scenario) or in domains that are not expected to have an influence on the topic in question (unconventional scenario). Event-based scenarios include the occurrence of surprising events, again either within domains that are known to be of influence on the topic in question or domains that are not expected to be of influence. Naturally, unconventional scenarios that also include events have a much greater potential to bring in new options and widen the reader's view. This is the approach pursued in this study. Arguably, when dealing with a highly complex and heterogeneous system like a city region, unconventional and event-based scenarios may prove more realistic and useful.

20.2.2 The methodology of this study

Scenario development usually progresses from the identification of the major driving forces, fields or key variables to the investigation of the associated trends, uncertainties, actors and their strategies and decisions. Driving forces are highly influential forces located *within* the geographic region or field of interest of the scenarios, whose direction and magnitude of development will take different forms in the individual scenarios. These elements and assumptions are then placed together into alternative storylines on the basis of the relationships between the different driving forces or actors (Rotmans et al., 2001, Berkhout and Hertin, 2002).

In the case of this study, the main driving forces are economic development and structural change, urban renewal and city development, political dynamics and societal changes, climate change[114] and selected environmental issues, as well as population development. In each field, trends and critical and strategic success factors were extracted on the basis of extensive expert interviews and a comparative analysis of the strong and weak points in the development of Hamburg and other cities or city-regions. Critical success factors are understood as highly significant factors that may constitute bottlenecks or risks, while strategic success factors are highly significant factors that constitute strengths of the region (Ringland, 2002). A summary of these factors is given in Table 21-1, Table 21-2 and Table 21-3. Associated measures are presented in sections 21.5.1 and 21.5.2.

The interviewed experts included business representatives, public agencies of port, economic and city development, representatives of bottom-up initiatives, a former school-director in the district of Wilhelmsburg, representatives of noted Hamburg families, researchers and academic experts of various fields, environmental NGOs, a city-design artist and a philosopher. Altogether more than 50 expert interviews were conducted. The more qualitative insights from the interviews and the comparison to other cities were highly useful for the devisal of necessary policies and practical measures in each scenario. Investigations of historical developments that function as conditioning causes of the present situation and comparisons with other regions helped to develop realistic ideas of what Hamburg's transition to a post-industrial port-city could look like. Interviews also provided information that is not available in written literature, concerning for instance attitudes and values, political motivations or the relations between different fields that are usually analysed separately within literature. Finally, expert estimations filled important gaps in situations where written information and data where unavailable or incomplete.

To actually develop the scenarios, as a first step the most relevant areas and driving forces were selected. These are economic and port development, structural change, city development and urban renewal, political and societal changes (including attitudes), population patterns and the state of the environment. Relevant boundary influences[115] are economic and technological changes, globalisation processes, increased mobility and lifestyle changes, demographic patterns and climate changes. Next, the critical and strategic success factors were identified (Table 21-1, Table 21-2 and Table 21-3), together with options of policy response, trends and uncertain elements for the different fields. Based on this, the developments were projected for each area or driver and put together into scenarios while taking into account the interdependencies between the different fields.

[114]This is a boundary influence, see footnote 115.
[115]Boundary influences are understood as influences that evolve *outside* the actual scenarios, for instance outside the respective geographic region.

21 The current baseline of the region

21.1 Climate and environmental change in the region

We will begin with a brief summary of the results concerning climate change from part I of the thesis. The IPCC A2 SRES Scenario considered in part I indicates an approximate increase of winter temperatures in the region[116] by 0.6 °C until 2030, and of summer temperatures by 0.7 °C. Summer precipitation is projected to decrease by 0.7 mm, while winter precipitation is projected to increase by 0.6 mm. According to the interviewed farmers, for the Geest-part of the region, a decrease of yields is expected which could significantly reduce profit margins – possible even to zero since these margins are already very narrow. The marshland-part of the region is not expected to be vulnerable to decreased summer precipitation and warmer summers, but would experience disadvantages through prolonged flooding and soil eluviation if winter precipitation increases. The warming of winters is expected to cause negative impacts in both parts of the region, in particular in the marshlands which require a breaking up of the clay soil through winter frosts.

An increase of 0.2 m has been projected for the mean annual maximum high tide at St. Pauli in 2030, giving a mean annual maximum high tide of 4.76 m. If the planned heightening of quay walls to 7.5 m is carried out, the port will be sufficiently protected. The heightening of dikes protecting the city of Hamburg itself to between 7.6 and 9 m (Freie und Hansestadt Hamburg, 2005a) is also sufficient according to our results. The projected mean annual maximum high tide at Cuxhaven in 2030 is 3.76 m, which implies an increase of 0.16 m. The opinions of interviewed farmers on flood protection given this increase were divided, with a few interviewees suggesting dike relocation and the re-establishment of naturally flooded areas in order to protect the marshlands and the coastal parts of the Geest. Summer-dike opening or dike relocation would also be of very high ecological benefit. This will be taken up as a scenario element together with the results listed in section 12.2 (part II of the thesis).

The strong climate change associated to the A2-scenario is only taken up in one scenario. This will be scenario 3, “Collaboration”. In the A2-scenario, the pace of technological change varies strongly for different countries and region. For our scenario “Collaboration”, this is adapted in such a way that the technologically faster developing Hamburg region is selling technologies for climate change adaptation and mitigation to China. In the first scenario, “The water city”, the EU is assumed to take a more active role in global climate change negotiations and environmental protection. In the second scenario, “Port at all costs”, there is neither such a shift of attitudes nor a noticeable change of climate within Europe. However, Hamburg is urged to carry out projects of dike relocation as compensation for the ongoing river construction measures associated to port development.

Environmental impacts due to river construction measures have been discussed in section 6.1. These include the loss of ecologically highly valuable areas such as mudflats, naturally flooded areas and shallow water zones and the increase of oxygen depleting processes in the river leading to fish die-off during summers. The latter effect will be amplified in the projected scenario of strong climate change. Environmentally beneficial measures will be discussed in the following section and will be included as scenario elements as appropriate.

[116]The region is here represented by the grid boxes A1–A4 (compare Figure 5-1), for the above numbers the means of the 4 values is taken.

21.2 Environmentally beneficial measures

Of high benefit would be an overall environmental concept for the entire region. So far, competition of the three Federal States for economic success is carried out at the expense of the environment. However, an overall environmental concept may require not only agreements in environmental matters but also with respect to the economic projects which the environmental measures are intended to compensate. Therefore our scenarios look at beneficial environmental measures in the context of regional cooperation, economic decisions and questions of attitudes, rather than just in isolation.

21.2.1 Specific environmental measures

These could include:

- the re-establishing of flooding areas through dike relocation or the opening of summer-dikes[117],
- the opening or reconnecting of side water bodies or side-arms to the Elbe,
- measures to unsilt water bodies and prevent further siltation,
- shoreline measures,
- extensification of farming activities,
- no more filling up of port basins and
- the protection of shallow water zones and mudflats.

Dike relocation or summer-dike opening would strengthen the self-cleaning and regeneration capacities of the river, and allow the redevelopment of wetlands, in addition to providing a new approach to rising water levels (Arge-Elbe, 1991 and 2004). The areas need to be large enough to enable the redevelopment of floodplain-dynamics with tideways and natural deposition processes. This may require some shaping of the ground in order to create tideways for freshwater mudflats, and to create areas that will constantly bear water (ibid). An area in Hamburg where dikes have been successfully relocated is the Spadenländer Spitze. The relocation of further dikes in adjancent areas (e.g. Ellerholz and Kreetsand) would be particularly beneficial for the effective regrowth of native ecosystems. An opening of summer-dikes has been advised for Hullen, Allwörden, Belum and Hadeln, together with the extensification or abandonment of agricultural activities[118]. Further suggested areas are the Twielenflether Sand, Asseler Sand, Krautsand and the area between the Elbe and the former dikeline east of the Oste-mouth.

Many water bodies of high ecological value – including side-arms, tideways and groynes – are threatened by siltation. The treatment of these would be highly beneficial. In some cases water bodies could be deepened carefully (Arge-Elbe, 1991 and 1994). An example for the latter is the highly valuable biotope Heuckenlock whose tideways drain at low tide. The opening of silted groynes is considered useful as groynes often have a high species richness due to the lowered stream velocity and good light conditions. Other areas suggested by Arge-Elbe, 1991 and 1994 for the re-establishment, deepening or re-connecting of tideways or other water bodies include areas behind the dike at the Allwördener Aussendeich (river km 676–683) and in Nordkehdingen (river km 683–705), and foreland in St. Margarethen (river km 699–691).

[117]These measures will also effect the behaviour of storm floods to a small degree – e.g. water levels of storm floods in Hamburg will be slightly lower.

[118]This had been partly envisioned by the former Amt für Strom- und Hafenbau as compensation for the previous deepening of the waterway, but had to be abandoned due to difficulties with proprietary rights.

Shoreline measures include the establishment of artificial bays on fortified shorelines (such as the one created at the Norderelbe near Rhee, Arge-Elbe, 1991). These could be particularly beneficial in areas where the entire shoreline has been fortified. In addition to providing shallow water zones and improving the regeneration capacities of the river, artificial bays also function as breeding and feeding biotopes for water birds (ibid). Suggested areas include the mouth of the Ilmenau and the mouth of the Stör.

21.2.2 The implementation of the European Water Framework Directive (WFD) in the Lower Elbe river basin

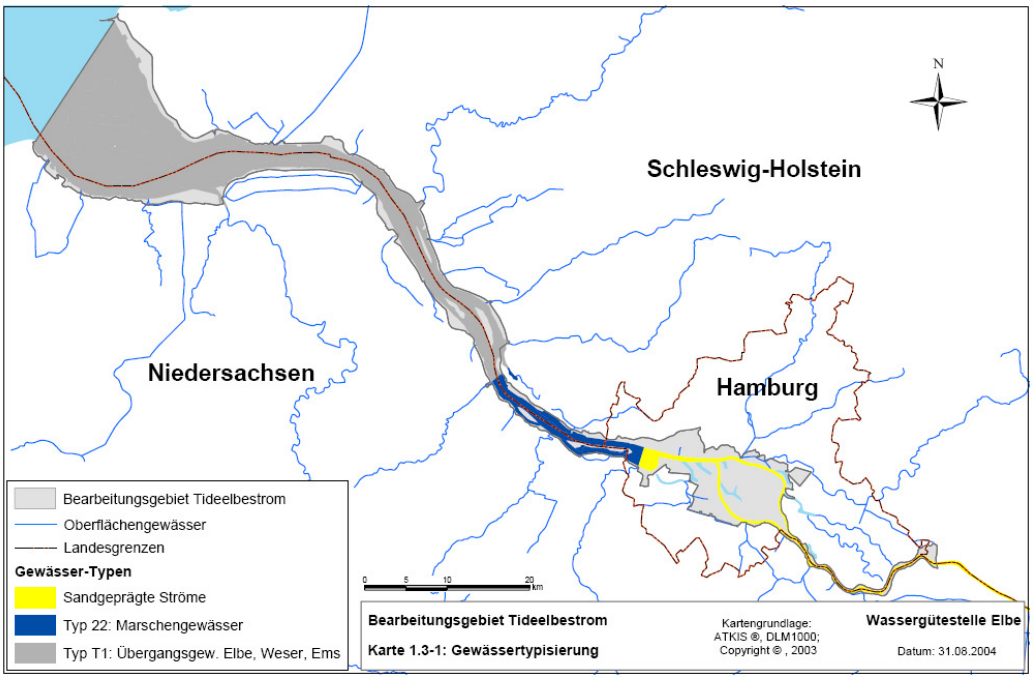

Figure 21-1: Water body types in the Lower Elbe river basin: lowland stream (yellow), marshland water (dark blue) and transitional water Elbe-Weser-Ems (grey). Courtesy of Wassergütestelle Elbe.

As part of the "Status Review" that precedes the implementation of the WFD in the Lower Elbe river basin (LAWA, 2003), three water body types have been distinguished: lowland stream, marshland water and transitional water Elbe-Weser-Ems (compare Figure 21-1 and Arge-Elbe, 2004a). Seven further types are represented among the tributaries of the Elbe (Freie und Hansestadt Hamburg et al., 2004). According to the assessment of environmental impacts (ibid and Arge-Elbe, 2004a), the achievement of a "good ecological status" is unlikely for 221 out of 405 water bodies in the Lower Elbe river basin. For further 136 water bodies it is "uncertain" whether this status can be achieved and only for 48 it is considered likely. Reasons include the "significant morphological changes" through the usage of the Elbe as waterway for ships and through flood protection, industrial and other direct discharges and non-point discharges (primarily agriculture). The river has mostly water quality class II–III between the weir in Geesthacht and the mouth of the Schwinge (with one small patch of water class III –compare Figure 21-2). Downstream of the Schwinge mouth we find water class I–II. The water quality of the tributaries ranges from II to II–III (with one small patch of water class III).

The next step will be the setting up of monitoring networks and the publication of a timetable and work programme (LAWA, 2003). A management plan and programme of measures will be published from December 2009 onwards and implemented from December 2012 onwards.

Figure 21-2: The water quality class of surface water bodies in the Lower Elbe river basin. Light blue denotes areas of class I–II, dark green class II, light green class II–III and yellow class III. Courtesy of Wassergütestelle Arge-Elbe.

21.3 Perspectives for the port

In part III of the thesis, costs and benefits associated to the port have been investigated against the background of current trends and changes. Central results will be briefly summarized here, as they constitute part of the baseline of the scenarios.

Two important risks for the port were identified. Firstly, Hamburg may not be able to keep up with the new requirements for the port and therefore lose market shares. Ship-sizes beyond 12.500 TEU (or less) will not be able to call at Hamburg anymore even after the next Elbe deepening. In addition, an increasing number of ships is delayed by the tidal window with waiting times of up to 8 hours. The maximum permissible draught for incoming ships using the tidal window is 15.1 m at present, 13.8 m for outgoing ships and 12.8 m for both incoming and outgoing ships independent of the tide (Port of Hamburg Marketing, 2002)[119].

Secondly, and much more importantly, even if turnover expectations can be realized, job and value creation through the port are decreasing and value creation is shifting to new service-based sectors. We cannot establish final and definite numbers regarding past job losses, as the available studies are only reliable for at most 71.6 % of port-dependent jobs. According to these studies, job losses of 20 % have occurred between 1991 and 2001 and formerly port-dependent jobs have become decoupled from the physical location of the port. Also according to the studies, tax revenues have decreased by approximately 21 % and income tax contribution is too low relative to the proportion of port-dependent jobs. These developments are due to containerisation, rationalisation and automation, outsourcing and the integration of

[119]The planned next Elbe deepening will raise these numbers by approximately 1.5 m.

the value chain. Further losses are expected to occur in the future due to ongoing rationalization and automation and a further decoupling of activities from the physical location of the port. In the case of a shift of goods handling activities to the new deep water terminal in Wilhelmshaven, the port-related service industries as well as a major share of the jobs associated to the production of intermediate inputs and capital goods would be expected to remain in Hamburg.

Baseline situation	**Critical success factors, bottlenecks, required measures**	**Strategic success factors and opportunities**
Port under increasing competitive pressure through new requirements (sections 15.2, 16.1.3 and 16.1.4). Rising costs of port (section 17). Decreasing contribution of port to regional value and job creation (sections 15.3, 16.2 and 16.3).	Required: • dedicated terminals and planning reliability flexibility of port authorities towards preferences of shipping companies (15.2) • accessibility of port (guarantee max. depth at all times). • improve transhipment to other means of transport and passing through customs by at least factor 2.6 (15.2). Bottlenecks: • Access will not be possible or too slow for big ships of 12.000–16.000 TEU and draughts of 15–21 m (Ircha, 2001). Time-loss through tidal window and travel through estuary • New transfer hub in Wilhelmshaven is expected to be superior. • Limited space for expansion. • Constant modernization of infra-, suprastructure and technology implies high and rising costs, including opportunity costs (sections 17.1–17.4). • Risks re port-financing: city may run out of money, if port package II[120] comes terminals will have to be put out to tender, possible restriction of Federal funding (17.2). • Loss of job and value creation through shift to service-economy and automation (16.3).	• Excellent image of port with highly modern equipment (in particular Altenwerder) • Excellent trade relations to Asia, in particular China (section 16.1.2) • Important position for feederships to Baltic and Eastern Europe (section 16.1.2) • Expertise in logistics and port-related services such as wholesale and export trade, banks and insurance. • Very good hinterland connections.

Table 21-1: Overview of the baseline situation and critical and strategic success factors for the port of Hamburg in a scenario of port expansion (detailed discussion in chapters 14– 18).

The costs of expanding and modernizing the port are high and show a tendency to increase (compare sections 17.1 and 17.2). Port expenses, investments and credit for the special asset "City and Port" amounted to € 335.6 m in 2003 and € 351.1 m in 2005. Additional costs are due to credit paid on investments outside the special asset "City and Port" (payment obligations of € 249.6 m as of 2006). As discussed in detail in sections 15.2 and 17.1–17.2, the rising tendency of costs is due to a number of far-reaching changes in competitive factors (Läpple and Deeke, 1996, Planco, 2000). These include the need for deep water ports for

[120]A main consequence of the EU port package II would be that Hamburg would be required to put out to tender several port businesses or terminals.

bigger ships, new technology to efficiently discharge large container ships (Ircha, 2001, Dellinger and Klinge-Habermann, 2002), efficient access to the port without delays, efficient transhipment to other means of transport and the rising importance of the preferences of shipping companies – for instance dedicated terminals. Relevant competitive factors are summarized in Table 21-1. In addition to direct costs, opportunity costs arise through area usage (11.5 % of the city area), and the requirement of limited resources that are also needed by city development and new economic sectors (compare 17.4).

On the basis of this analysis, a port-expansion course is explored in scenario 2. An alternative to port expansion would be a reorientation of the port or the entire city in its role as port-city. A number of port-cities in Europe and worldwide have undergone such a transition and with it profound economic, cultural and structural renewal (Airriess, 2001, Bruttomesso, 1999, Breen and Rigby, 1994, Norcliffe et al., 1996, Hoyle, 1996) and a redefinition of the city's international status. For instance, at present, Hamburg is regarded as 'world port' rather than 'world city' (Friedmann, 1986). Scenario 1 will explore such a possibility. Scenario 3 investigates a reorientation through cooperation with the port of Wilhelsmhaven and through a specialisation in new technological solutions for electronic identification and tracking of goods (ISL, 2000) that are sold to other ports, value-adding logistical and other service tasks (Notteboom and Winkelmans, 2000) and trade and international relations. Strategies involving cooperation with other ports, with inland terminals or satellite facilities (Slack, 1999) are becoming more common among the world's bigger ports (ibid, Hayuth, 1988, Notteboom and Winkelmans, 2000, Song, 2003), given the extremely high costs and externalities of ports located right within cities.

21.4 Processes of urban renewal and economic development in Hamburg

The city is presently involved in several large-scale urban renewal projects, namely the Hafencity, the initiative "Wachsende Stadt" (the 'growing city') and the integration of the city's south and revitalisation of Wilhelmsburg – the city quarter adjacent to the port and the Hafencity in the south. These projects aim to meet the challenges of globalisation, the worldwide transition to a post-industrial high-technology and service economy, population aging and shrinking and the expansion of the European union (Freie und Hansestadt Hamburg, 2002 and n.d., Altrock and Schubert, 2004, Zukunftsrat Hamburg, 2002). In the following we will first give a brief overview of the situation of Hamburg with respect to new economic sectors and population aging and shrinking. Thereafter, the current main projects of urban renewal as well as regional cooperation and governance will be briefly presented. Of particular relevance for the scenarios are critiques of these projects or amendments of the included strategies. The most relevant amendments and critiques as brought forward in expert interviews or within literature will be presented in section 21.5. A brief summary of strategic and critical success factors for urban renewal and economic development is compiled, respectively, in Table 21-2 and Table 21-3.

Baseline situation	Strategic success factors	Critical success factors / Measures recommended by experts and literature
Challenges of globalisation, worldwide transition to post-industrial high-technology and service economy and society, and population aging and shrinking.	• Projects Hafencity, "Wachsende Stadt" and reintegration of the city's south. Hafencity and inner city to benefit from rapid development in Channel Harburg. • Special asset of large water areas. • Image of historic port city and maritime flair. • Relatively high quality of life and high internationality. • In Wilhelmsburg potential for attractive waterfront housing, Gardening Exhibition in 2013.	Hafencity: • Rail-based public transport, • improvement of investor conditions, • extension of public participation, • clear communication of economic concept, establishment of professional business environment and critical mass in new fields and • efforts to achieve good mixture of usages. Structurally weak city quarters: • Integrated, locally oriented and empowering policies: physical infrastructure and reconstruction, social infrastructure and image, placement agencies, networking, qualification measures. Wilhelmsburg: • Masterplan Elbe Islands with overall housing concept and new district "Elbinseln", • preserve assets like cultural landscape and water bodies and make them more accessible, • address problem of 3 major dividing traffic corridors, • extended support for schools and kindergartens.

Table 21-2: Overview of the baseline situation and critical and strategic success factors for Urban Renewal in Hamburg. The recommended measures are discussed in detail in section 21.5.2.

The service sector, most notably new media and information communication technology (ICT) industries has displayed rapid growth in Hamburg since the early nineties (Läpple and Kempf, 2001, Gornig et al., 2003). However, competition between city regions in the new fields is extremely high (compare section 17.4.2), leading to the emerging of certain regions emerge as strongholds of the respective new sectors after an initial phase of rapid

development in new sectors (Hubbard, 1995, Hall, 1997, Archibugi and Iammarino, 1999, Porter, 1999 and 2000, Grossmann, 2000, Clark et al., 2002, Hutton, 2004, Parkinson et al., 2004). At present, Hamburg usually ranks in the third or fourth out of four categories in international rankings (Parkinson et al., 2004, Altrock and Schubert, 2004 p.23). In particular, the city has been found to perform rather moderately with respect to innovative power, research and development expenditure in new fields, modern education, employment in high-tech sectors, but also investment climate and success in promoting itself as business location (ibid, European Commission Directorate-General Enterprise, 2002, Cushman & Wakefield, 2004, Handelskammer Hamburg, 2000). In comparison with other German metropolitan regions, Hamburg has only a small share of employees in knowledge-intensive services (Läpple, 2004) while the share in distributive services is comparatively high.

Figure 21-3: The port with the Hafencity (circled area) and Wilhelmsburg. Courtesy of the Landesamt für Geoinformation und Vermessung.

In the following, the main projects that the city or its population designed in response – the "Hafencity"-project, the development and integration of the city's south and the "Wachsende Stadt" – will be presented.

The initiative Wachsende Stadt has three main aims (compare Freie und Hansestadt Hamburg, 2002):

- to sustain and expand the city's population – countering expectations of noticeable population losses (Empirica Institute, 2001)[121] due to population aging and shrinking, suburbanisation and migration,
- to promote the city's international attractivity and
- to promote economic growth in future-oriented sectors.

Building blocks of this initiative include the promotion of economic competence clusters and of medium-sized businesses, a strengthening of science and education, city development and the improved management of housing areas and industrial estate, the promotion of international events, and an improvement of the family policy (Freie und Hansestadt Hamburg, 2002). The suggested economic competence clusters are life sciences, nano and optical technologies, IT and media, aviation, port and logistics and the promotion of Hamburg as the European bridge to China.

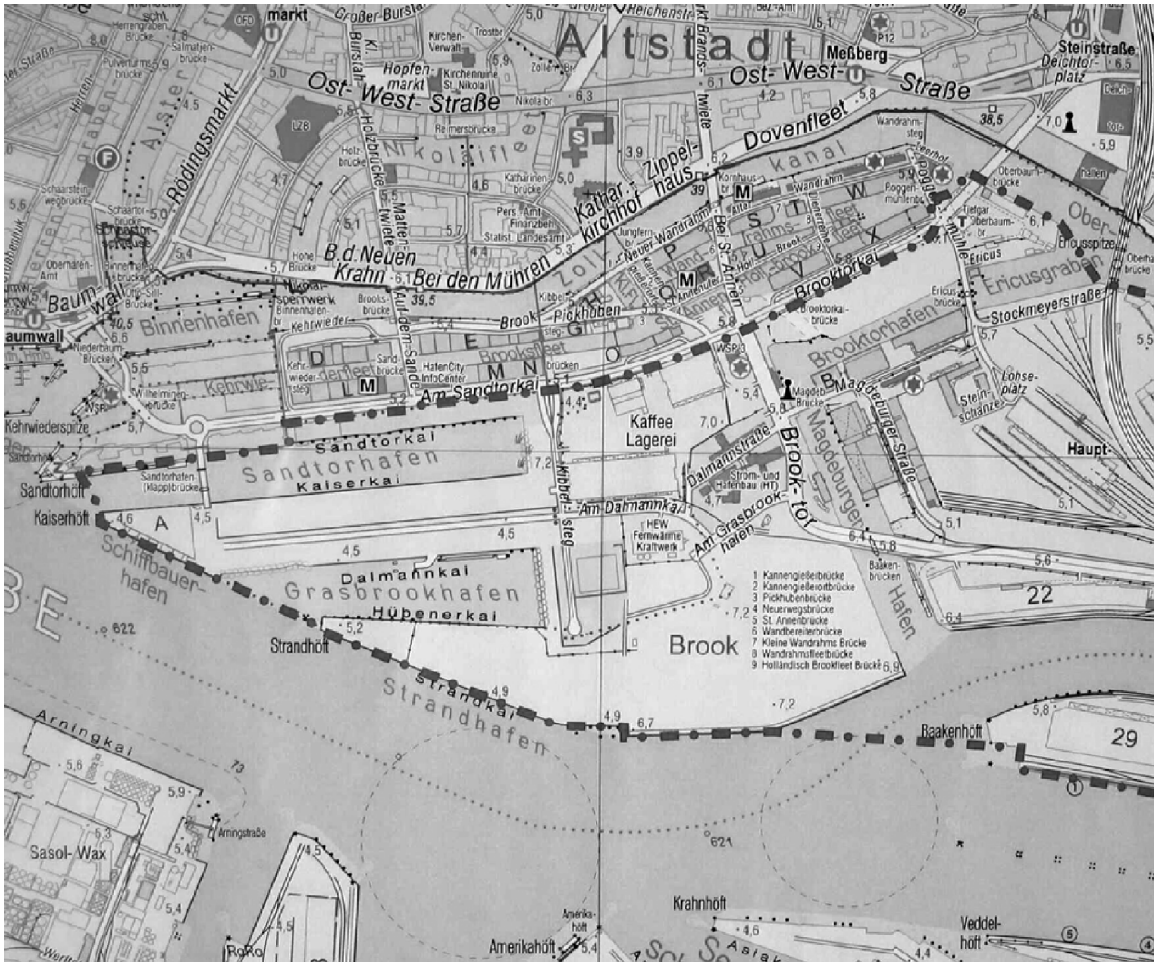

Figure 21-4: Map of the Hafencity area. The dotted line indicates the border of the duty free harbour. Courtesy of Amt für Strom- und Hafenbau (now Port Authority) Hamburg. The actual Hafencity area stretches between the border of the duty free harbour in the West, South and North and the rail area.

The Hafencity (GHS, 2000 and 2002, Figure 21-3 and Figure 21-4) is considered to be the largest city development project in Europe and will extend the inner city by 40 %. Built on 155 ha of former port area, it will be characterized by a metropolitan and maritime mixture of

[121]Empirica Institute, 2001 indicates a loss of 100.000 until 2015 and a more pronounced loss thereafter.

living, culture, leisure, tourism, business and trade with flats for up to 12 000 people and office space for more than 20.000 jobs. Building measures in the Hafencity have begun and are scheduled for completion around 2025. Possibly the main bottleneck in the Hafencity is due to financial restrictions. Until 2005, the new container terminal in Altenwerder has been cross-financed with property sales in the Hafencity (Hoja, 1999). This has slowed developments and led to inflexible planning, higher property prices and a lack of offers for small investors. The establishment of a rail-based public transport connection to the Hafencity has also been delayed. With the decoupling of the Hafencity from port development, the situation will most likely improve. Strategies for the development of the Hafencity that have been suggested either by interviewed experts or within literature will be presented in section 21.5.2.

Harburg in Hamburg's south has developed rapidly in recent years both in terms of its attractivity as a place to live, and in terms of attracting new sectors such as biotechnology, new media, communication technologies and consulting to the new business and living area Channel Harburg[122] (Koch, 2001, Bezirksamt Harburg, n.d.). Channel Harburg, which began to form in the early nineties, has already become one of the most important high-tech locations in Northern Germany. It is located on the area of the former Harburger Binnenhafen – formerly an industrial area and river-port. Of particular importance is the proximity to the Technical University of Harburg and the centre for microelectronics applications (MAZ). The development of Channel Harburg began during the early nineties, when a number of hive-offs from the MAZ formed in rapid succession and began to form a dense network of businesses, agencies and professionals in new fields. The hive-offs found their business premises in converted industrial buildings that combine a highly modern design with reminiscences of the history of this city quarter. Channel Harburg is known as a location that combines tradition and modernity, old and modern architecture. The historic harbour, for instance, is now used as anchorage site for sailing yachts. Channel Harburg is also a very lively living and leisure area with restaurants and other amenities as well as highly attractive – and affordable – housing close to the water. Channel Harburg continues to expand. One of the most distinguished projects that were recently begun is the China-Centre with a "China-tower"[123] as its central attraction, built on the foundations of former silos. It will include a China business centre, a Chinese trade forum with an office for contact and export exchange, a Chinese health centre and a centre of Chinese culture and art (HC Hagemann, 2003).

The neighbour of Harburg to the North, the river-island Wilhelmsburg (Figure 21-3 and Figure 14-1) is now regarded as very promising due to its central location in combination with large green and water areas. Wilhelmsburg also has a number of structural weaknesses and social problems. Through the dynamic and knowledgeable work of the people's initiative "Zukunftskonferenz Wilhelmsburg" (Zukunftskonferenz Wilhelmsburg, 2002), the city quarter has won the support of the senate (Freie und Hansestadt Hamburg, 2003b) and has been chosen to host the Gardening Exhibition in 2013. Possible measures to improve the situation of Wilhelmsburg are presented in 21.5.2.

[122] www.channel-harburg.de
[123] www.chinatower.de (Available in English, Chinese and German).

21.5 Strategies for urban renewal and economic development

The measures listed here are derived from literature and from the consultation of experts in interviews. For measures that were found only or almost only in one particular literature source, the source concerned will be indicated. Further measures that have been applied successfully in other Metropolitan regions but were not suggested for the Hamburg region will be used as scenario elements in chapter 22.

21.5.1 Economic development

Baseline situation	Strategic success factors	Critical success factors / Measures recommended by experts and literature
Transition from industrial port- city to European service metropolis. Unemployment in established versus growth in new sectors. Increased European competition for people and capital.	• Projects like Hafencity and Wachsende Stadt provide opportunities to renew economic orientation. • Existing strengths in new sectors such as new media, medial technology, nano- and optical technologies. These can be consciously promoted. • Hafencity to benefit from rapid development of adjacent Channel Harburg in new economic sectors. • Relatively high quality of life, opportunity to enhance this through projects such as Wachsende Stadt and waterfront housing.	• Improvement of the city's business climate: legal frameworks for company formation, contact person or agency to assist newly forming companies. • Improvement of quality of life in order to attract and maintain highly qualified people for new sectors: skilfully use water areas, possibly create (new) landmark, improve recreation and cultural offers, promote city's internationality. • Investments in education, research, know-how, technology transfer (R&D to receive 3 % of GDP instead of 2 %) and in • infrastructure (e.g. airport: increase capacity of intercontinental flights).

Table 21-3: Overview of the baseline situation and critical and strategic success factors for economic development in Hamburg.

The majority of recommendations for economic development made by experts and a major part of the strategies for economic development discussed within literature concern the efficient support of new economic sectors. A frequent suggestion is the improvement of legal frameworks for company formation and reduction of bureaucratic barriers – ideally in the form of a one-stop shop system for starting companies. This not only eases company formation, but also communicates a modern business climate. At the least, a contact person on the governmental level or the level of the city's economic promotion should be nominated who is equipped with the necessary competencies to efficiently resolve permit procedures. Also, investment conditions should be improved, in particular for the Hafencity (compare 19.5.2). The marketing of the city as modern business and high-technology region should be improved – preferably for the entire metropolitan region.

Several experts noted that the lack of an airport with the capacity for frequent intercontinental flights creates a significant bottleneck for the establishment of a vibrant presence in new economic sectors. The airport of Hamburg is located at a distance of only 8.5 km of the city centre and surrounded by densely populated residential areas of Hamburg and Norderstedt

that require the closing of the airport before midnight. The need for noise protection and lack of expansion space – in particular for a parallel runway for landing and takeoff[124] – restrict the capacity of hourly flight movements to approximately 45–55[125]. Due to these reasons it will not be possible to establish a frequent schedule of intercontinental flights. The construction of a new airport would require investments of gigantic scope. Another serious obstacle is posed by the unfortunate split of the city region into the city-state and parts of the two adjacent Federal states (compare Figure 21-5). Despite the obvious limitations of the present Hamburg airport, the city of Hamburg clearly prefers the main northern German airport to be located within the city's borders. This was probably the main reason why the construction of a new airport at a site in Kaltenkirchen in Schleswig Holstein – which had been seriously considered in the seventies – could not be carried out. If Hamburg were to host the Olympic games – for example in 2016 – the transport of approximately 400.000–600.000 additional passengers per month would be necessary[126]. As of 2004, approximately 820.000 passengers are transported per month[127]. Thus the airport would need to increase passenger capacity by approximately 50 to 75 %, which is definitely not possible without the purchase and usage of large residential areas.

Education, research, know-how and technology transfer are of crucial importance for new economic fields and should be adjusted or opened to economic needs. This could include further corporately financed universities like the Northern Institute of Technology or new endowed chairs in relevant new fields (Keller at al., 2004), as well as the possibility for commercial utilisation of university patents. Important is also the establishment of technology parks in close connection with the universities and research institutes (Handelskammer Hamburg, 2003). The public research and development (R&D) infrastructure in core areas should be extended – with the city's (R&D) expenditure constituting 3 % of the GDP (at present it amounts only to 2 %, Keller et al., 2004).

Quality of life is essential in order to attract and maintain a sufficiently large pool of highly qualified people for new economic sectors. Components that could be improved are recreation and cultural offers, the education system (see previous paragraph), and the skilful use of green and water areas in the city – e.g. through waterfront housing, extensive walkways along water areas, boats and houseboats. Important is also the improvement of the housing situation through high quality housing in particular in the city centre, owner-occupied houses, suitable houses for families and affordable housing. Another important component is the conscious promotion of the city's internationality. In addition, a number of experts noted that Hamburg seems to lack a landmark (apart from the Aussenalster) and that it consequently leaves a less lasting impression than other large European cities.

Further measures directed specifically towards the development of new economic sectors in the Hafencity are listed in the next section.

[124]The two runways intersect so that parallel operation is not possible.
[125]According to Senat der Freien und Hansestadt Hamburg, 1998, flight movements are technically limited to 45 per hour. This number is (slightly) exceeded at present – it is not possibly to significantly exceed it, however, due to the lack of a parallel runway for takeoff and landing.
[126]The estimates are based on flight movements at past Olympic games, e.g. in Sydney, 2000.
[127]Source: Website of Hamburg airport, http://www.ham.airport.de/de/flugdaten.html.

21.5.2 Urban renewal

Urban renewal is an extremely multi-facetted field. The topics selected as particularly relevant here are the development of new waterfront-based city quarters, namely the Hafencity, strategies to improve the situation of city quarters with particular structural problems – with Wilhelmsburg being a special case here due to its outstanding potential –, the integration of the city's south into the inner city and the integration of city development with environmental and social concerns within the framework of the "Wachsende Stadt".

We will begin with strategies suggested for the development of the Hafencity: The provision of efficient rail-based public transport to the Hafencity was seen as indispensable by virtually all the interviewed experts, in particular once the Hafencity-areas further away from the city will be accessed for construction. Investors need to be able to rely on public transport being in place – preferably *before* their construction work finishes. Several experts criticised investment-conditions in the Hafencity. A major restricting factor has been the cross-financing of port expansion with property sales in the Hafencity until 2005 (compare Hoja, 1999). This has led to the need to demand maximum price levels for property in the Hafencity. Some investors have been forced to withdraw their bids as they couldn't get the required loans. Ideally, with the decoupling of the Hafencity from port development, special offers will be made to particularly attractive investors – with the intention in mind to establish a functioning professional business environment in the Hafencity. The collaboration of small investors or small companies in order to finance their presence in the Hafencity should be supported. The need to extend public participation in the Hafencity was also underlined (compare Zukunftsrat Hamburg, 2002). An interesting observation by one expert situated in Channel Harburg is that so far, the city's large pool of very wealthy people has not shown a particular interest in the Hafencity[128].

An opinion stated repeatedly is that the Hafencity needs a clearer economic concept. More effort needs to be made to establish a professional business environment and density of related services, such as already exists in the neighbouring Channel Harburg. New economic sectors such as new media need a critical mass of professionals situated in the respective new field, networking initiatives like Hamburg@work[129], technology and company formation centres and other services in their close surroundings (e.g. Läpple et al., 2004). Experts did not take for granted that the aimed for mixture of usages in the Hafencity will actually be achieved. This is, again, due to the fact that development decisions are taken according to the need to cross-finance the terminal in Altenwerder with property sales in the Hafencity, rather than according to the question what a functioning new city quarter needs – e.g. a kindergarten or even a school, housing for a mixture of income classes or shops, restaurants and other amenities at an affordable price level.

With respect to strategies for the revitalisation of city quarters with structural problems, the orientation and manner in which they are conducted seems to be at least as important as the actual type of strategy. Three qualities were named in particular[130]:

[128]Note: this interview has been conducted in 2003.
[129]Hamburg@work is an initiative and internet-platform that aims (and succeeds) to improve networking between professionals, companies, associations, event organizers and others situated in the area of new media. It provides among other things job and training offers, news on developments within the field of new media and a large variety of information on work groups, associations, events, multimedia technology and hotspots in Hamburg: http://www.hamburg-newmedia.net/.
[130]Compare in particular Menze and Ossenbrügge, 2000.

- *locally oriented* policy complexes that take into account spatial differences in the city's labour market and the living situation of specific city quarters and specific target groups,
- *integrated* policies that connect strategies for the development of new job potentials with strategies for social integration and for the revitalisation of the city quarter as such,
- policies should be as *empowering and bottom-up* as possible and represented in local offices. Cooperation and networking between businesses and agents such as trade-unions, trade associations or sectoral planning agencies should be encouraged.

These strategies will include infrastructural measures, reconstruction and the creation of green spaces, the improvement of the social infrastructure, the improvement of the image of problem quarters, the development or management of industrial land, consulting services for businesses, networking and the development of new fields of activity. Education and qualification measures are also central. This includes placement agencies and qualification measures tailored to the needs of specific city quarters or specific target groups (Menze and Ossenbrügge, 2000), as well as the upgrading of the city's polytechnic schools. For unskilled people in structurally weak quarters – in particular young people and foreign nationals – these schools often offer the only possibility for higher school education and are thus a pivotal point to slow down processes of impoverishment and segregation in the respective city quarters.

Regarding the development of Wilhelmsburg, a central measure suggested is the development of a Masterplan for the Elbe Islands (Zukunftskonferenz Wilhelmsburg, 2002, Breckner and Gonzalez, 2003). In order to revitalise Wilhelmsburg, it is necessary to attract more well-situated as well as German inhabitants. The emerging waterfront areas, and water areas with houseboats to come may be highly attractive, but require that the surrounding areas are also improved. Thus, an overall development and housing concept should be devised within the framework of a Masterplan. Wilhelmsburg and Veddel should be united into a new district "Elbinseln". The Masterplan should aim to develop Wilhelmsburg into the green centre of the business and living areas Hafencity and Harburg. One expert remarked that this could be carried out within an EU-project[131]. The assets of Wilhelmsburg, in particular the numerous green areas, water bodies and the cultural landscape in the east of Wilhelmsburg should be preserved and made more accessible. This includes the cleaning of canals and the decontamination of areas, the relocation of storage places, the unsilting of the Spreehafen and the preservation of waterways whose filling up has been considered. A considerable problem is posed by the existence of three major traffic corridors[132] in Wilhelmsburg that cut right through its centre. Ideal but too costly would be the relocation of the Reichstrasse (Zukunftskonferenz Wilhelmsburg, 2002). As a less costly (and less efficient) alternative, adjacent green and water spaces may be accentuated, a noise barrier could be established, and bridges across the dividing lines could be built (Freie und Hansestadt Hamburg, 2003b). Of high importance for Wilhelmshaven is the provision of special support for schools and kindergartens in the form of a German language course for the large number of foreign children *and* the children's mothers[133]. Industries that are seen to have a particular potential for growth in Wilhelmsburg include environmental technologies – for housing, energy and industrial equipment –, retail, handcraft, tourism and recreation and possibly health and wellness services (compare Breckner and Gonzalez, 2003, Zukunftskonferenz Wilhelmsburg, 2002). The spread of houseboats in Wilhelmsburg would also lead to opportunities for supply

[131]This would be either within the EU Initiative Regional or the Initiative Urban.
[132]the railway, the Reichsstrasse and the Georg-Wilhelmstrasse.
[133]The author is grateful for this suggestion to a retired school director of Wilhelmsburg.

and waste water disposal businesses, wireless networks and other ICT-equipment for the boats.

Further suggestions relate to the integration of city development with environmental and social concerns. The Zukunftsrat strongly suggests the inclusion of the departments of environment and health and of social and family affairs into the taskforce “Wachsende Stadt” (Zukunftsrat Hamburg, 2002). One expert remarked that the city of Hamburg has a surprisingly high biodiversity – due to the large share of green areas and in particular of extensively cultivated agricultural areas, as well as to the combination of different types of landscapes and soils. It would be of very high environmental benefit to preserve this diversity of landscape types. Another point brought forward by different sources concerns the investigation and discussion of trade-offs between the usage of allotment gardens and agricultural areas for construction works on the one hand, and their environmental potential and contribution to inner-city recreation and quality of life on the other hand.

21.6 Governance and regional cooperation

Regional cooperation towards the shared management of resources that are of high relevance for all three Federal States could be of extremely high relevance for the region. This concerns the exchange of knowledge and know-how – for instance in the area of life sciences and medical technology in which both Hamburg and Schleswig Holstein possess impressive research facilities. Another very important possibility is the construction of a high-capacity Northern German airport outside Hamburg, and a possible division of labour between the region’s ports.

Figure 21-5: Hamburg and the 13 administrative districts of Lower Saxony (green) and Schleswig Holstein (yellow) that form the Metropolitan Region of Hamburg as represented in the Regional Development Council.

However, a number of obstacles exist towards the establishment of new forms of regional governance such as those that have been established in German regions like Stuttgart and Hannover (Walter-Roog, 2004, Salet et al., 2003). One obstacle is the unfortunate division of the region between the city-state of Hamburg and parts of the Federal states Schleswig Holstein and Lower Saxony (Figure 21-5), as well as the presence of *two* city states – Hamburg and Bremen – that each have complex linkages with the rural areas between and

around them. In fact, administrative borders in the region appear mostly arbitrary (Mantell and Strauf, 1997). Another obstacle is the low emphasis on public participation (Zukunftsrat Hamburg, 2002) versus high emphasis on governmental control. Thus, decision-making in the Hafencity rests with the government-owned "Gesellschaft für Hafen- und Standortentwicklung" (GHS).

Attempts to establish forms of cooperation between the three Federal states and to manage the region's urbanization processes in a way that is acceptable not only for the city, but also for the other two Federal states, dates back to the end of the 18th century (Mensing and Thaler, 1997). In 1991, the Regional Development Concept (RDC, compare Figure 21-5) was established. The RDC consists of representatives of the three respective governments (Lenkungsausschuss der gemeinsamen Landesplanung in der Metropolregion Hamburg, n.d., Mantell and Strauf, 1997). It is intended to foster comprehensive planning and beneficial projects for the region as a whole. So far the scope of its work has been somewhat restricted due to its informal character and the lack of an authorized institutional framework and binding guidelines for municipalities and the governments of each Federal state (Handelskammer Hamburg, n.d., Mensing and Thaler, 1997). Changes have occurred mostly on the level of informal networks. Recent changes in the structure of the RDC appear to begin to address some of these limitations (Lenkungsausschuss der gemeinsamen Landesplanung in der Metropolregion Hamburg, 2005). The Regionsrat – the highest decision-making board within the RDC – is now formed by all 14 district administrators[134] and representatives of the boroughs instead of just one representative of the district and borough level. A permanent office to efficiently administer and execute cooperative tasks is established, and different endowment funds are synthesised into one pool in order to simplify and centralize processes. Through these changes the decision making bodies of the region hope to be better able to respond to global requirements (ibid).

21.7 Relevant national and global trends

It is assumed that the shift of Western countries towards a post-industrial society (Hall, 1997, Grossmann, 2000, Jorgensen, 2001, Jalava and Pohjola, 2002, Hutton, 2004, Parkinson et al., 2004) continues, implying job creation in new sectors, and unemployment and profit losses through rationalisation and outsourcing in established sectors. European integration and expansion and elimination of market barriers are equally assumed to continue. Germany-wide issues are the need for economic reorientation (Hamburg Institute of International Economics, 2003, Parkinson et al., 2004), population aging and shrinking, and the high average age (Federal Statistical Office, 2003). Important measures would be a reform of the tax system and of employment regulations, the cutting of non-wage labour costs and an improvement of the conditions for company formation (Ache, 2000, Hamburg Institute of International Economics, 2003). Present reform plans of the Federal Republic as proposed in the Agenda 2010 (Federal Republic of Germany, 2003) point in this direction.

[134] German "Landräte".

22 The Scenarios

22.1 The water city

The Lower Elbe Region 2005–2010:

The core assumption of this scenario is a withdrawal of support for the port: Federal support for the next Elbe deepening is withdrawn as part of a reform of the Federal infrastructural programme – which includes a German main port strategy – and in response to a reorientation of EU port policies (European Commission, 1997 and 2002). Port-subsidies and other payments granted by the city are withdrawn in response to the widening gap between costs imposed by the port and actual benefits. This leads to the rapid decline of the port and the restructuring of the city's economic landscape and its socio-cultural identity. Investments of considerable grandeur are now directed into the building up of an economic base in high-tech industries and advanced service industries, in particular new media, nano- and optical technologies, medical technology and life-sciences. At the same time, measures are designed to establish the city's image in the wider European context as highly international multicultural city, known for its long history as port-city and its high quality of life. The decision of the Federal Republic to establish a transrapid train connection that links Hamburg with Frankfurt, Munich and other major German cities is very helpful in this respect, as it provides a partial compensation for the lack of an intercontinental airport in Hamburg.

In addition to the Hafencity and Channel Harburg, the now abandoned port area southwest of Wilhelmsburg – Hamburg's "Docks" – becomes the location of choice for advanced technology and service industries. Planning flexibility and investment conditions in the Docks and the Hafencity improve significantly as city development is released from financial ties to port expansion[135]. This serves to attract more investment and a much more active response from the public, including the more wealthy part of the population that had hitherto remained surprisingly unconcerned by the proposed developments in the Hafencity.

A council for city development and the overseeing of tasks in economic development and locational marketing, transport planning, education and job training similar to the "Verband Region Stuttgart" (VRS) in Southern Germany's Stuttgart (Walter-Roog, 2004, Salet et al., 2003) is successfully established. An important difference to the VRS is the clear restriction to the political borders of the city-state. The council in particular supports the formation of public-private-partnerships to spur developments in the Docks and the Hafencity. Public transport to the Hafencity, the Docks and further south to Wilhelmsburg and Harburg is established at an early stage in the less expensive variant of a *Stadtbahn* – a modern version of a tramway (Barth, 1991). Technology and company formation centres and promotion agencies are established – including an agency formed by unpaid honorary professionals such as retired managers and bankers, that specialises in assisting newly forming companies in a variety of ways.

Additional resources from public-private partnerships enable the construction of an attractive artificial water area between Wilhelmsburg, the Hafencity and the Docks, which functions as beach and new landmark for the city. Part of the port is transformed into a museum-port. Extensive use is made of the large water areas through new bridges and walkways, frequent

[135]This ideas has originally been devised in 2003 as scenario element. In 2005, the city decided to decouple the financing of port expansion and the Hafencity, thus releasing the Hafencity from financial ties to the port.

ferry connections to the new city quarters as well as houseboats, barges, tour boats and sailing boats. The Docks begin to function as connecting link between the Hafencity and the city's south. Wilhelmsburg and Veddel are integrated into a new district "Elbinseln". A Masterplan for this district succeeds to attract funding as EU-project within the EU-initiative *Regional*. The Masterplan includes the relocation of the Reichstrasse and an overall living and housing concept, as well as support for the schools and kindergartens in Wilhelmsburg that are known for their particularly high percentage of foreign children.

The protected areas on the eastern and southern edge of Wilhelmsburg are extended to form a large continuous area in which dikes are relocated and floodplain forests can re-grow. This is in particular of high benefit for the existing 100 ha nature reserve Heuckenlock, which is the city's most species-rich nature reserve with more than 700 different plant species – including endemic and highly endangered species (Freie und Hansestadt Hamburg, 1993). Wilhelmsburg specialises in alternative energy, environmental technology for housing, energy and industrial equipment, as well as recreation, and health and wellness services. As these measures begin to bear success, German citizens and higher income groups are gradually attracted back to Wilhelmsburg. The reintegration of Wilhelmsburg as the city's historic immigrant quarter into the inner city also leads to a more conscious appreciation of Hamburg's internationality.

The EU has begun to take a much more active role in global climate change negotiations, starting with the *Emission Trading Scheme* that comes into effect in 2005. The new Federal German flood protection law (Federal Republic of Germany, 2005) leads to the establishment of retention areas and the opening of summer-dikes in many parts of Germany, including the Middle and Upper Elbe, but not the Lower Elbe in which public resistance to possible summer-dike opening or dike relocation is too high.

The Lower Elbe Region 2010–2020:

Due to the notable growth of new economic sectors and the strengthening and renewal of its socio-cultural identity, Hamburg ranks among the economically most successful cities in Germany. The unemployment rate has fallen below the level of the early nineties. The city also notes a population increase, in particular in the younger age groups. The situation in the rural part of the region is much less favourable. In fact, the thinning out of the rural space and the decline of the number of farms continues.

Both economic keyplayers and the government of Schleswig Holstein express strong interest in the construction of a new airport with the capacity for more frequent intercontinental flights outside of the city's borders. However, the city's government maintains a clear preference for the main northern German airport to be located within the city's borders, even if this means that a parallel runway for landing and takeoff[136] and a frequent schedule of intercontinental flights cannot be set up. An interesting bifurcation in this context is given by a nomination of Hamburg as hosting city for the Olympic games in 2016. The city's repositioning in the European context, its increased international attractivity and the successful waterfront revitalisation projects make Hamburg a much more likely candidate than previously. In a scenario variant where Hamburg hosts the games in 2016, the balancing of the city's budget could be achieved at a much earlier state. The city's international attractivity and investment climate would receive a further boost. Moreover, the nomination for the Olympic Games would necessitate the construction of a new airport if the Olympic guests are to reach

[136]compare section 21.5.1.

Hamburg by air[137]. In the other scenario variant, the lack of an intercontinental airport will probably constitute the major bottleneck[138].

The Lower Elbe Region 2020–2030:

Building projects in the Docks and the Hafencity reach a saturation-point during this decade. Hamburg ranks among the German cities with the lowest unemployment rate, and is particularly attractive to young people. Quality of life is very high, as indicated by economic perspectives, the city's cultural identity and international image, vastly better housing conditions and a good education system, recreation and the noticeable presence of green and water areas in the city.

[137]Compare our analysis of the airport situation in section 21.5.1.

[138]Budget restrictions are assumed to imply only a minor bottleneck, as very active involvement from the wealthy part of Hamburg's population and the formation of a number of highly productive public-private partnerships is assumed.

22.2 Port at all costs

The Lower Elbe Region 2005–2010:

The core economic strategy of Hamburg in this scenario is the expansion of the port and the consolidation of port-related and other established industries. The port transit route is constructed, a next Elbe deepening carried out and turnover capacities are increased through modernisation and the construction of new container terminals in Steinwerder (until 2012) and later in Moorburg (planned until 2017). This involves expenses of approximately € 380 m in 2005 (compare 13.2.1) – including direct costs, indirect costs accruing for company relocation measures in Steinwerder and credit paid on measures from previous years. The expenses in the following years are even higher, given the need to finance two new terminals.

Hamburg is urged to carry out compensation measures for the deepening of the waterway in the form of dike relocation or summer-dike opening, following the style of the new Federal German flood protection law (Federal Republic of Germany, 2005). However, the unfortunate set-up of the city-state as initiator of these measures, and the Federal Republic as the executive body imposing the measures on the rural areas of Schleswig Holstein and Lower Saxony, results in such problems of proprietary rights that the plans have to be abandoned. Instead, compensation in the form of aquatic and ecological measures is devised. The new container terminal in Steinwerder is cross-financed with further property sales in the Hafencity, leading to an aggravation of development conditions in the Hafencity. In particular, the establishment of a professional business environment for technology- and service-oriented companies in the Hafencity is delayed. The nearby Channel Harburg which already has a functioning and qualified business environment and offers lower rents receives a further headstart. While the building of a China cluster in the Hafencity is postponed, a Chinese trade centre is established in Channel Harburg that successfully attracts trade businesses as well as Chinese residents, shops and restaurants.

Funding and support for Wilhelmsburg fall short of expectations as it is decided that the gardening exhibition in 2013 will take the form of a Federal, rather than International, Gardening Exhibition. Wilhelmsburg particularly suffers from the construction of the port transit route across this city quarter, its ongoing usage as container storage area and the lack of new economic opportunities. The situation in the public schools of Wilhelmsburg also remains problematic. Consequently, few new tenants are attracted to Wilhelmsburg. German citizens and higher income classes in particular withdraw.

The Lower Elbe Region 2010–2020:

Containerships with a capacity of 12.000 or 14.000 TEU are now predominantly used on the route to and from Asia and several shipping companies have ordered the first 16.000 TEU ships with a draught of 19 m[139]. Ships with a capacity of up to 12.500 TEU are able to call at Hamburg but face delays due to the tidal window. Ships of a capacity of 14.000 TEU or more – featuring a draught of at least 17 m[140] – are not able to call at Hamburg. As capacities in Bremerhaven, Rotterdam and Antwerp have been increased and Wilhelmshaven now offers a new deep water and highly modern dedicated terminal, Hamburg begins to lose market shares for cargo from East-Asia and feedership transhipment to the Baltic and Eastern Europe. More significant for Hamburg is the incisive loss of jobs through outsourcing and rationalisation in

[139]Compare Ircha, 2001 for estimates of the draught of 16.000 TEU ships.
[140]Ircha, 2001, indicates a draught of 15–21 m for ships of 12.000–16.000 TEU. It appear reasonable to assume that ships of at least 14.000 TEU will then have a draught of 17 m or more.

established sectors – not just in the port and port-related industries but in nearly all manufacturing and some service industries. In the port itself, about 150 new jobs are created in the new terminal[141], however at the same time automation in all terminals and other trends leading to job losses progress (compare section 16.3), resulting in a loss of approximately 13.750 port-dependent jobs until the end of the decade[142].

Growth industries for Western Europe are biotechnology, life sciences, nano-technology, new media and other ICT-industries, advanced software and the application of new technologies and new methods to areas like construction or housing. Compared to the most successful European regions, investments in these sectors have been too low in Hamburg. As a result, Hamburg exhibits slow economic growth and high unemployment. In addition, the city has not made enough efforts to re-position itself in the context of a unified, post-industrial and highly mobile Europe.

The Lower Elbe Region 2020–2030:

Trends like weak economic performance, suburbanisation, derelict housing in the city's core, an oversupply of office-space and population shrinking and aging become more apparent. Due to its high price level, the Hafencity is also affected. City quarters like Harburg and the city's west still develop well. In Wilhelmsburg and some other known problem quarters, unemployment has led to social unrest and a soaring crime rate. The sustained job losses in the port are particularly disappointing for the population of Wilhelmsburg, as the port has historically provided employment for a large percentage of the population of Wilhelmsburg.

Backed by Federal support, the city begins to design measures to counter these trends. Central housing areas are redeveloped, efforts are made to modernise the education system and restock teaching and research staff. In the middle of the decade, local governments in the region but also the federal German government begin to seriously discuss the establishment of a *Nordstaat* – a confederation of Germany's federal states in the North that will enable effective cooperation between these[143]. The region would then be able to set up a regional economic development programme that is not blocked by political borders, and possibly even find new approaches to the long standing issue of a Northern German main port.

[141]Like Altenwerder, Steinwerder is a highly modern terminal with a high degree of automation. The number of people employed in Altenwerder could not be made known, but the Eurogate terminal which is comparable in terms of size to Steinwerder, employs approximately 450 people (personal communications with representative of Eurogate Hamburg, 2005). Since Eurogate has a considerably lower degree of automation, 150 jobs seems a reasonable assumption.

[142]This is a careful projection based on the assumption that job losses in *all* port-dependent industries slow down in comparison with the previous decade (that is in container handling and navigation from a loss of 32.3 % to a loss of 25 %, in transport and storage from 8.6 % to 5 %, in public authorities and customs from 10.2 % to 5 %, in banks, insurance and trade from 7.5 % to 5 %, in port industries from 39.7 % to 30 % and in intermediate inputs and capital goods from 18.5 % to 10 %). The 150 jobs gained are then subtracted. The author is aware that the main job-creation potential of a new terminal is due to inter-industry linkages. However, these are supposed to be accounted for by studies such as those for 1991 and 2001 (see 14.1.2), on which the above calculation is based.

[143]Compare the expert opinion by Scharpf and Benz, 1990 which advises the establishment of a Nordstaat.

22.3 Collaboration

The Lower Elbe Region 2005–2010:

The core assumption of this scenario is a re-orientation of the city's economic and city development strategies, and emphasis on regional cooperation. Hamburg and the surrounding districts are reorganised into a "regional county" in the form of a democratically elected parliament representing the entire Metropolitan region. Due to the hitherto division of the region into three Federal states, shifting responsibility to the parliament is a very gradual process. Economic developments, however, support this shift.

A division of labour with the port of Wilhelmshaven is established, following the recognition that value creation through the port has shifted to advanced logistics, service industries and data handling, all of which can be performed in considerable physical distance from the port. Wilhelmshaven is to become the main container-hub, equipped with highly modern terminals and efficient transhipment facilities owned by Maersk and Eurogate together with Asian shipping companies. Road and rail access to Wilhelmshaven is given priority in the Federal traffic plan. Hamburg specialises in the development of advanced logistics and supply chain management, insurance services, trade and international relations and most notably the development of information-based port technologies, and of new technological solutions for electronic identification and tracking of goods that are sold to other ports.

It is understood that an effective intercontinental airport is indispensable to support this economic shift. Since expansion capacities at the airport of Hamburg are used up, a site in Schleswig Holstein just north of Hamburg is selected. This is clearly a project of gigantic scope that is only possible through the kind of regional cooperation that is afforded by the region's reorganisation as "regional county", the backing of the Federal Republic and the raising of credits that actually exceed those previously raised by the city for port development.

Global climatic changes are much more pronounced than in the other two scenarios. In particular draughts, rising sea levels and an increase of extreme floods and storms pose a problem to many countries. The Kyoto-protocol is ratified by more and more countries, including the US and China. Hamburg has rapidly gained expertise in technologies related to emissions saving[144] and water desalination. Based on the city's excellent relations to China, China becomes one of the main export countries for these technologies.

Other sectors that receive effective promotion are medical technology and life sciences, nano- and optical technologies and new media. The development of the Hafencity is regarded as absolutely crucial. Efforts are made to improve development and investment conditions in the Hafencity and encourage the cultivation of the necessary know-how. Companies and research institutions in Hamburg and Schleswig Holstein begin to pool their strengths in these fields. The education system is reformed based on a dialogue with universities and companies. Universities are given more autonomy with respect to financial and organisational matters and curricula are increasingly developed in coordination with corporate needs. In addition, the situation of the city's polytechnic schools[145] is improved which is expected to be particularly beneficial for the city's structurally weak quarters.

[144]In the framework of the 'Wachsende Stadt', emissions saving was postulated as one out of three main strategies to ensure sustainability (Freie und Hansestadt Hamburg, 2002). Also compare the suggestions of Zukunftsrat Hamburg, 2002.

[145]German: Fachhochschulen.

City renewal is reoriented towards a selection of area-based and highly comprehensive and integrated programmes in the Hafencity and the city's south, as well as efforts to improve conditions in structurally weak city quarters. Expenses for the *Wachsende Stadt* are cut, in particular for projects such as building measures in the green peripheral city quarters that have raised public outcries from the start. Instead, the budgets for the Hafencity and the city's south are extended. The China-initiative in the Hafencity is successfully extended, encompassing a Chinese trade centre, a Chinese culture centre and a centre for traditional Chinese medicine. In Wilhelmsburg, water areas are decontaminated and attractive waterfront housing is developed. The overall living standards in Wilhelmsburg are raised, including extended support for schools and kindergartens. Harburg continues to develop very well, and Harburg and Wilhelmsburg are gradually integrated into the inner city. Wilhelmsburg becomes the green and attractive centre between the two locations, where professionals can meet and events are hosted.

Through the increase of temperatures – in particular summer temperatures – fish die-off in the Elbe has become more frequent. Valuable bird habitats are also threatened. In response, the city and the neighbouring Federal States agree to revive the concept of an *enquete-commission Unterelbe.* The *commission* will oversee the improvement of water quality in accord with the Water Framework Directive, and the protection of fish refuge areas and other habitats in the region. In addition, flood protection is revised. Members from all parties concerned are represented in the *commission* – e.g. farming and tourism representatives, environmental NGO's and flood protection authorities. Through the presence of farming representatives in the commission, the farmers' point of view with respect to dike relocation can be better taken into account. After repeated consultation with farmers, several areas for dike relocation and summer dike opening are selected. The land is left in the possession of the farmers against compensation for the accruing losses[146]. New agri-environmental programmes to improve the region's water balance and to cultivate hedgerows and trees that increase soil moisture in the dry Geest areas are designed[147]. Crop cultivation close to the river is extensified.

The Lower Elbe Region 2010–2020:

The new airport north of Hamburg is now in full operation – offering a frequent schedule of travel connections between Northern Germany and the U.S., Asia and South America. This boosts Hamburg's important position as centre of international trade and as high-tech- and service-metropolis.

Hamburg has distinguished itself through its expertise in advanced technological fields and its advancement of port-technologies. The Hafencity sees rapid development during this period of economic upswing. The presence of new economic sectors combined with elements of culture, leisure, tourism and trade in a maritime environment receives international recognition.

The Lower Elbe Region 2020–2030:

With the finalisation of the areas in the far south and west of the Hafencity, the project is completed at the onset of the decade. Hamburg is among the few German cities that register a population increase. This is due to the comprehensive urban renewal that has taken place, encompassing measures to tackle social problems, effectively reform the education system

[146]Compare the results of section 11.2.
[147]Compare the results of section 5.3.1.1.

and establish a lively, interesting living environment in the Hafencity in addition to the economic re-orientation.

A plan to establish a Lower Elbe biosphere reserve is developed during this decade based on recommendations presented by the *enquete-commission Unterelbe*. The new biosphere reserve extends the existing reserve *Flusslandschaft Elbe,* which covers the upstream area between Lüneburg and Magdeburg. It is expected that with this extension of protection the return of species that inhabited the Lower Elbe river basin before the river construction measures of the sixties will be reinforced.

23 Conclusions

Current urban futures literature points to the similarities between problems experienced by European cities. In this part of the thesis, possibilities of response on a regional level have been explored in the form of three different scenarios. The inseparability of economic, social and physical renewal is a central insight in current urban futures literature. The scenario methodology is a powerful tool to illustrate this through the impacts that decisions and developments in fields such as port and economic development, city renewal and population patterns have on each of the other fields. In this study, beneficial outcomes in terms of quality of life, economic development and the state of the environment are generally found to depend on a combination of economic, societal and political requirements and conditions. These interdependencies are established on the basis of critical and strategic factors for the region that have been identified as crucial to the described developments. These factors are not limited to economic aspects but also comprise elements of city development and urban renewal, quality of life, aspects of governance and societal orientation, and attitudes. In each scenario, different measures in response to these factors are described on the level of the city and of selected city quarters. It is expected that many of the critical factors and in particular the linkages found between different fields will be valid also for the development of future strategies for other city regions.

PART V:

SUMMARY

AND CONCLUSIONS

24 Summary and conclusions

In this thesis, future perspectives for the metropolitan region of Hamburg within the next 3 decades in the context of present and anticipated regional and global changes were investigated. Core areas include:

1. Climatic changes – namely the increase of maximum storm surge levels, and changes in temperature and precipitation.
2. Socio-economic developments, structural change, urban changes and political decisions within the city itself and in the rural part of the region,
3. Changes in the natural environment – both in the form of the destruction of ecologically valuable areas with (often not performed) compensation measures in other areas, and in the form of intensifying restoration of valuable areas.

These areas have been investigated in four parts. In part I, an IPCC A2 SRES scenario of climate change has been localised for the region and expectations for impacts in the region have been derived. In part II, future perspectives for the rural area in the light of present global or European changes have been explored. In part III, the elements that should inform decisions about port development – most notably costs, benefits and perspectives for the future – have been assessed. Finally in part IV the results of the preceding parts of the thesis have been put together with an analysis of urban renewal in Hamburg in the form of three integrated scenarios for the region.

As a result of this investigation we can derive

1. threats and problems that the region is highly likely to encounter and therefore needs to be ready to respond to,
2. perspectives for the region as a whole and for specific parts of the region or of the city in the form of development scenarios and
3. strategies that would be advisable in order to minimize likely problems and to actively make use of new opportunities.

In the following three sections 24.1–24.3 we will briefly summarise the results of the first three parts of the thesis – which may include repetitions of central conclusions stated at the end of each part. In section 24.4, synthesising conclusions will be given, following the above format of threats, problems and recommended strategies.

24.1 Climate change and its impacts in the Lower Elbe region[148]

In the first part of the thesis, a simple approach to estimate changes in extreme water levels at the tide gauge of Hamburg St. Pauli, and changes of temperature and precipitation patterns in the study region was presented and applied to an A2 IPCC SRES scenario of climate change (Houghton et al., 2001). On the basis of this, selected impacts occurring as consequence of the projected climate changes were investigated in a next step. This included impacts of rising water levels for the port of Hamburg, and impacts of changes in precipitation, temperature and water levels on agriculture and the Elbe ecosystems. The central impacts are as follows:

1. Rising temperatures and the decrease of summer precipitation are expected to affect the rural area in one of its weakest points, namely the income situation of farmers in the dry Geest part of the region.
2. Rising temperatures are also expected to affect the river ecosystem in one of its presently weakest points, namely an amplification of oxygen depleting processes – adding to the pressures through constant dredging measures and the decimation of fish refuge areas. This is expected to lead to more frequent and longer fish-die off.

In the following these results and the methodology will be explained in some more detail.

24.1.1 Storm surge scenarios for Hamburg in 2030 – Methodology

For our aim to project changes in storm surges in Hamburg, St. Pauli in 2030, storm surge scenarios for North Sea near-coastal locations are available for the interval 2070–2100. These have been obtained through the downscaling of results of the global General Circulation Model HadAM3H of the Hadley Center processing the IPCC A2 SRES scenario with the regional climate model CLM, and the subsequent calculation of water levels and currents in the North Sea with the barotropic hydrodynamic model TRIMGEO (Woth et al., 2005). Our projection of changes in storm surge levels in St. Pauli in 2030 involves two steps:

1) A transfer function to map water levels at the coast simulated by the TRIMGEO model (as described above) in a hindcast-run to historic water levels in Hamburg, St. Pauli during the same time period.
2) The estimation of water levels in an A2-scenario in 2030 given water levels in an A2-scenario in the interval 2070–2100.

For the first step, a curve consisting of a linear and a quadratic component is calculated such that the differences between the curve and the historic water levels in St. Pauli are minimized, while fulfilling additional constraints concerning the continuity of the curve, the mapping of the multiyear annual maximum at the coastal location onto the multiyear annual maximum at St. Pauli, and the continuity of the derivative of the curve. For the second step, a development of storm surge heights parallel to the increase in temperature in the A2-scenario is assumed. The resulting values suffer from significant uncertainty due to the employed emission scenarios and the series of downscaling steps, but can be regarded as upper boundaries.

[148]The results on storm surge scenarios have been derived in collaboration with Hans von Storch and Katja Woth at GKSS. Excerpts of this part of the thesis have been submitted to *Die Küste* with co-authors Katja Woth and Hans von Storch: Grossmann, I., Woth, K., Storch, H.v., 2005: Localization of global climate change: Storm surge scenarios for Hamburg in 2030 and 2085, Die Küste (in review).

24.1.2 Storm surge scenarios for Hamburg in 2030 – Results

The implications of the projected scenario – increases of the mean annual maximum water level of up to 15 cm in Cuxhaven and up to 20 cm in St. Pauli for the time horizon of 2030 and of up to 84 cm in St. Pauli in 2086 – were discussed with experts and port representatives.

According to interviewed shipping companies and other corporate representatives, at present, water levels of 5 m or more result in business interruptions in parts of the port of Hamburg. It is intended to heighten all quay walls to 7.5 m during the next few years. If this is consequently carried out, dock sites will be well protected from flooding until at least 2030, even under a scenario of relatively strong climate change such as the one projected in this part of the thesis.

24.1.3 Temperature and precipitation changes in the Lower Elbe region until 2030 – Methodology

To project changes in temperature and precipitation in the region until 2030, data provided by the PRUDENCE data archive on the basis of simulations with the regional climate model CLM for 2070 to 2100 is employed. The data is available as monthly average for the years 2070 to 2100 for six grid points located within the study region. In order to establish a projection of the results onto our time horizon 2030, a development of temperature and precipitation parallel to the increase in temperature that is stated in the global IPCC A2-scenario (Houghton et al., 2001) is assumed. A t-test conducted for the difference between the monthly means of the projected scenario and of the control-run yields significance for the temperature-scenario, while for the precipitation scenario significance can only be established for the months December, January, February, July, August and September, and to a much lesser degree.

24.1.4 Temperature and precipitation changes in the Lower Elbe region until 2030 – Results

Figure 24-1 depicts the mean of the temperature changes projected for the six grid points until 2030, Figure 24-2 the mean of precipitation changes.

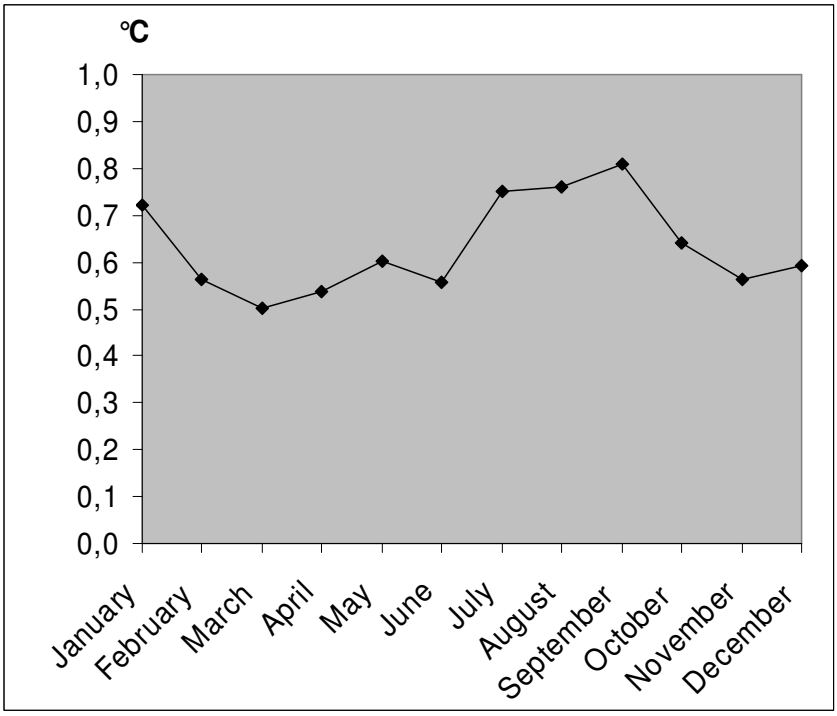

Figure 24-1: Mean of the temperature changes projected for the 6 grid points A1–A6 until 2030, in °C. Changes are significant for all months and gridpoints at the 5 % level.

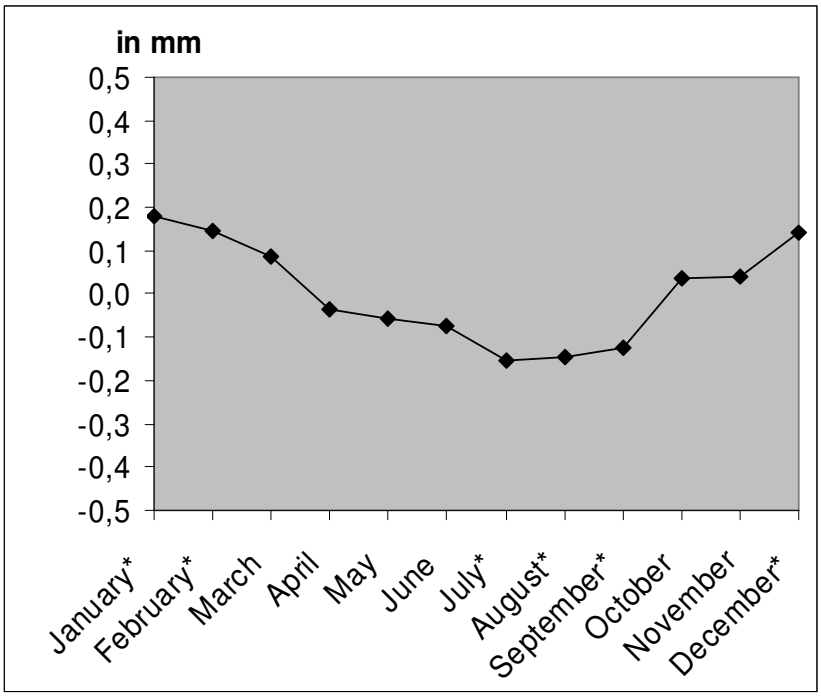

Figure 24-2: Mean of precipitation change projected for the 6 grid points A1–A6 until 2030, in mm/day. Changes are significant at the 5 % level for the months marked with an asterisk *.

24.1.4.1 Expected impacts on agriculture

Farmers' expectations of impacts and their perception of possibilities of response were of particular interest for this part of the thesis, since such expectations and attitudes are crucial in determining what adaptation might look like in reality. To investigate these, interviews with farmers from both sides of the Elbe and located both in the marshland and in the Geest, and with a dike-reeve were conducted. The marshlands are close to the river with some agricultural areas being situated below sea level and characterized by very good soils. The Geest is situated on a higher elevation further inland and is characterized by dry, sandy soils of low soil quality[149]. According to the interviewees, the following impacts are particularly likely and particularly consequential:

1. A decrease of yields for the Geest-part of the region together with the aggravation of soil conditions as a consequence of the decrease of summer precipitation and of the temperature increase. The decrease in yields can be considered significant given the very low soil quality and low profit margins (estimated to be at most 4–5 % of overall turnover). This would be difficult to compensate. The irrigation of fields is not economically feasible. A costly compensation strategy that would require promotion from the government is the cultivation of hedgerows and trees in the fields in order to improve the soil's water storage capacity and prevent erosion.
2. A rise of winter temperatures such that winter frosts are lessened or even discontinued is expected to have negative impacts for both parts of the region. This is due to the positive effect of winter frosts on the quality of the soil and to keep pests in check. These effects cannot really be compensated.
3. An increase of precipitation in the marshlands is expected to cause negative impacts through prolonged flooding of agricultural areas and soil eluviation.

Farmers' opinions on the level of flood protection were divided. Some interviewees felt that dike relocation and the re-establishment of naturally flooded areas could become advisable in order to protect the marshlands. Interviewees who felt that floods pose an increasing risk also wished to receive more information on the findings of the respective governmental authorities and that the authorities should take flood protection issues more seriously.

24.1.4.2 Expected impacts on the Elbe ecosystems

Rising temperatures definitely pose threats to the river ecosystem, as they will further amplify oxygen depleting processes in the river. In the past few years, oxygen concentrations have frequently fallen below the threshold that is necessary for the survival of fish in the Elbe (3 mg/l O_2) during summer, especially while dredging measures where carried out. These measures are necessary to maintain the required depth of the waterway. An aggravation of oxygen conditions through a rise in summer temperatures is likely to lead to increased fish die-off. Measures to improve the oxygen content or to provide fish refuge areas are advisable. These may include the opening or reconnecting of side water bodies or side-arms to the Elbe, measures to unsilt water bodies and prevent further siltation, shoreline measures, the extensification of farming activities, no more filling up of port basins, and the protection of shallow water zones and mudflats. In addition to an amplification of oxygen depleting processes through rising temperatures, migration of species that are used to a warmer climate may occur and new species may compete with species that are defined as native to the region.

[149] 20–40 'Bodenpunkte' on a scale between 20 and 100, with 100 indicating the highest and 20 the lowest soil quality, compare section 5.3.1.1.

24.2 Future perspectives for the rural area[150]

In the second part of the thesis, future perspectives for the two Lower Saxon districts Cuxhaven and Stade were investigated against the background of current large-scale structural and legal changes that are common to agricultural areas throughout Western Europe. The two districts are located on the southern side of the Elbe between Hamburg and the Elbe mouth. Both are primarily rural in character with agriculture playing an important role. The main changes of relevance are:

1. Increasing pressure on the agricultural sector and the rural space as such due to the extension of the European Union, and due to a further shift from a production-based economy to a service based economy and from rural to urban lifestyles.
2. The reform of the Common Agricultural Policy of June 2003 with the consequence of a decoupling of payment entitlements for farmland from production and the need for cross-compliance with standards in the fields of environment, food safety and animal health and welfare.
3. New environmental regulations. This includes the establishment of Natura 2000 sites on the basis of the birds and habitat directives, the European Water Framework Directive, as well as additional environmental laws on the Federal German level.
4. New income opportunities through diversification into tourism, agri-environmental programmes, and a growing demand for high food quality and safety and organic food.

The following research aims were extracted from this situation:

1. The clarification of the meaning of these changes for the farmers together with the identification of new requirements and ways to meet them and of strategies to make use of new opportunities.
2. The identification of the possibly contradictory concerns of the different actors and interest groups involved and ways to synthesise these.
3. The clarification of the match or mismatch of agri-environmental programmes with farmers' needs and with region-specific environmental characteristics together with the exploration of possibilities of improvement.

24.2.1 Methodology

To meet these aims, a Focus Group with a heterogeneous group consisting of nine participants from agriculture, environmental and flood protection and local administration was held. The Focus Group involved both discussions and the input of information through three expert talks on new legal requirements, new opportunities, structural changes and attributes of the region's ecosystems. The discussions began with an analysis of the main challenges or problem areas for the region as seen by the Focus Group. On the basis of this analysis, two scenarios of future viability were developed. The results from the Focus Group were later complemented with results from a series of face to face interviews with selected participants.

The participatory methods employed proved useful in particular with respect to the following aims:

1. The identification of farmers' concerns and regional environmental characteristics that determine the acceptability of agri-environmental programmes and their effectiveness in protecting the region's particular ecosystems.

[150] A paper based on this part of the thesis has been submitted to Agriculture, Ecosystems and Environment: Grossmann, I., 2005: Structural change and nature conservation in the agricultural landscape of the Lower Elbe region – a case study. Agriculture, Ecosystems and Environment (in review).

2. The development of suggestions for policy amendment in order to better match these requirements.
3. The inclusion of members of different interest groups into the discussion.

The Focus Group process confirmed earlier results on the usefulness of participatory methods to gather region-specific knowledge and develop strategies of response that are applicable to the local situation (e.g. Kasemir et al., 2003, Shackley et al., 1998, Robertson and Hull, 2003, Prager and Nagel, 2004).

24.2.2 Scenario possibilities for the rural area

The core problem complexes that were identified for the region are agricultural restructuring, conflicts between different interest groups, structural weaknesses of the region and problems of governance within the region itself or in relation to the city-state. In the first scenario, the region seeks to ensure its future viability through specialising in produce for which it is internationally competitive. Bottlenecks include the competition with lower prices that may be offered by new Eastern European member states, the possible decline of the rural space, a lack of opportunities for areas with marginal land, and problems due to possible German environmental regulations that surpass the European minimum standards. In the second scenario, these bottlenecks will most likely not arise but some policy amendment will be necessary. The core strategy here is diversification into agri-environmental programmes, tourism and regional marketing of a variety of high quality and organic produce.

24.2.3 Suggestions for policy amendment

24.2.3.1 Agri-environmental programmes

Improvement of existing agri-environmental programmes could be made with respect to

- the communication process between farmers and environmental authorities,
- the present restrictedness of the governmental budget for these programmes resulting in too low availability of the programmes,
- the short-term and unreliable nature of the programmes,
- complicated application and accounting procedures,
- the need for clear product standards and clear and reliable promotion programmes for organic produce.

The first item in particular is very important to remedy conflicts between programme requirements and the farmers' needs, e.g. through conservation contracts that can be adapted by the responsible local authority. Transparent communication processes with farmers are also essential in cases where programmes are rejected because they are perceived to sabotage farmers' traditional rights or because of a lack of belief in their economic profitability.

Further suggestions towards the improvement of agri-environmental programmes were made on the basis of ecological considerations. There is a lack of programmes that improve the region's water balance – for instance through the consolidation of existing protected sites, reengineering of ditches and a restriction of drainage. Also, further traditional elements of the region's landscape should be included into the protection programmes in addition to grassland. This includes reed, various water bodies and small woods.

24.2.3.2 Dike relocation

Dike relocation as compensation measure for projects carried out by one of the two neighbouring city-states, Bremen and Hamburg, is highly problematic as this entails that authorities outside the region itself – the city state and the Federal government – design and implement the measures. Adequate preparation of and communication with the affected landowners is indispensable, but is usually not practiced. It needs to be made clear that people's security still has first priority. Also, landowners prefer to remain owners of the flooded land against compensation. Following the example of earlier times where the nutrient-rich naturally flooded areas were cultivated with produce suited to the shorter cultivation season, the flooding could occur on the basis of a contract with guidelines that take into account the farmers' needs and can then be adapted by a local public authority according to weather conditions or the specific needs of individual farmers. This would significantly increase the acceptability of dike relocation or summer dike opening measures.

24.3 Future perspectives for Hamburg as a port-city[151]

Decisions about the future development of the port of Hamburg may be decisive for the success or failure of the Metropolitan region of Hamburg to establish itself in the emerging European and global post-industrial service society and economy. On the one hand, the port provides regional benefits through job and value creation and its contribution to the city's image. On the other hand, the port entails substantial costs for the city. These considerations need to be placed into the context of global developments and changes, mainly:

1. Technological changes outside the city's control leading to rising costs, new competitive requirements and a favouring of (coastal) deep water ports.
2. The worldwide transition to a post-industrial service economy. This implies firstly a decline of port-dependent tax revenues and jobs. At the same time, new high-tech and advanced service industries arise, in which competition tends to be much higher. Competition is particularly pronounced between worldwide metropolitan regions that seek to establish themselves in these new sectors and to attract and maintain a qualified workforce despite population aging and shrinking. Regions and clusters that specialise in specific new sectors may be able to grow at a particularly fast pace. For more slowly developing regions it may be much more difficult to gain access to new sectors in which other regions have already established themselves[152]. Like other major cities, Hamburg needs to establish itself firmly in new sectors in order to provide sufficient income and job opportunities for its population also on the long run. It can be expected that the time-span of approximately the next 7–12 years will be decisive for Hamburg's success or failure in this respect. The main ingredients of success are investments in new sectors, in quality of life and the clear communication of a modern orientation with flexibility and cooperativeness towards investors and future-oriented businesses. Thus, the allocation of a sufficient share of the city's presently very restricted budget and of the highly valuable and scarce inner city space towards such measures is a crucial task.

These central results will be explained in more detail in the following[153].

24.3.1 Methodology

Data on the above questions is mostly non-existent, has not been systematized or – as in the case of data on value- and job-creation through the port – is not publicly available. To address this problem, in addition to extensive literature research and data analysis, structured face to face interviews were conducted with 20 port experts. These included representatives of the relevant shipping companies, the Hamburg Port Authority, the department of trade and economics and Port of Hamburg Marketing, researchers dealing with development

[151]A research paper based on this part of the thesis has been submitted to Geoforum: Grossmann, I., 2006: Perspectives for Hamburg as a port-city – a critical assessment on the basis of a cost-benefit analysis. Geoforum (in review).

[152]This also concerns decisions such as the possible relocation of the port to the coast or the construction of a new high-capacity intercontinental airport outside the city's borders. Both possibilities (in particular the new airport) were seriously discussed at a point in time when their carrying out would have been much easier than at present.

[153]A number of the findings listed in this section are consistent with findings of previous studies conducted at the technical university of Hamburg-Harburg. This concerns Läpple, 1998, and Läpple and Deeke, 1996 with respect to job losses and the decoupling of transport and value creation, and Läpple and Deeke, 1990 with respect to the need for a strategic re-orientation of port development in conjunction with an overall integrated city development concept that takes into account competing resource and space requirements.

perspectives for the Northern German ports, with regional economic impacts, economic trends or developments within logistics, a politician leading the port and economics department of his party and two port-related NGOs. In addition, semi-structured interviews on city development, the development of new economic sectors and the connection of these to port development were carried out.

24.3.2 Changes in competitive factors

The last two decades have seen significant changes in competitive factors related to shipping and the organisation of ports – based on technological progress, the reorganisation of transport chains and a strong increase in the authority, power and scope of services offered by shipping companies. For Hamburg, the following issues are of particular relevance:

1. Hamburg is involved in a highly costly race determined by its location and technological developments beyond its control. Most likely, this race will be lost if ship-sizes continue to grow beyond 12.000 or 12.500 TEU, as the Elbe cannot be deepened beyond this. If ship-sizes stop growing before that, all ships will be able to call at Hamburg once the next deepening of the waterway has been carried out, but costly time-losses will occur due to the tidal window and the travel-time up the estuary. A new deepwater terminal without these restrictions is presently being built at the coast in the port of Wilhelmshaven.
2. For cargo that will be transported to the Baltic, Russia and Eastern Europe with feederships, it is more economic to load feederships in Wilhelmshaven rather than in Hamburg. Cargo destined for feederships constitutes 29.1 % of incoming cargo in Hamburg, that is 58.2 % of the overall turnover.
3. A number of traditional competitive factors that historically constituted Hamburg's strengths have lost in relative importance or have become decoupled from the port (e.g. the existence of port-related industries adjacent to the port). Meanwhile there are new factors that Hamburg can only fulfil with great efforts. This concerns item 1 from above (port accessibility for big ships) and the growing power of shipping companies to which ports need to respond. At present there is not enough awareness among Hamburg port authorities of the importance of being flexible towards the shipping company's preferences. One important new factor are dedicated terminals[154] which Hamburg has so far not been willing to provide.

24.3.3 Job and value creation through the port

Even if turnover expectations can be realized, the benefits in the form of value and job creation may be lower than expected by both citizens and public authorities. We cannot establish final and definite numbers regarding past job losses, as the available studies are only reliable for at most 71.6 % of port-dependent jobs. According to these studies, job losses of 20 % have occurred between 1991 and 2001, while tax revenues decreased by approximately 21 % from € 669 m in 1991 to € 527 m in 2001. According to the studies, the most pronounced losses have occurred in the port industries (39.7 %) and in the category container handling, navigation and dock workers (32.3 %) while losses in port-related services were much lower (between 7.5 % and 10.2 %). In addition, the actual port-dependency of the remaining jobs has decreased significantly.

The following trends can be expected to be decisive for the future development of port-dependent jobs:

[154] to external shipping companies, not the HHLA in which the city still holds a major share.

- The continuation and intensification of the worldwide transition to a service- and ICT-based economy.
- The intensification of automation and rationalisation. This will lead to further significant job losses in particular within the category container handling, navigation and dock workers (16.088 jobs in 2001 with a loss rate of 32.3 % between 1991 and 2001) and in the port industries.
- Changes in the organisation of transport and the further decoupling of port-related or transport-related activities from the physical location of the port. Some formerly port-related activities may be performed in more suitable locations than Hamburg – e.g. Frankfurt in the case of financial services. On the other hand, if shipping activities would shift to Wilhelmshaven, many port-related services can be expected to remain in Hamburg by virtue of Hamburg's locational factors and cluster properties.

24.3.4 Costs of the port

Altogether, direct port expenses, port investments and credit for the special asset "City and Port" amounted to € 335.6 m in 2003 and € 351.1 m in 2005. This does not include credit paid on payment obligations of € 249.6 m for investments outside the special asset "City and Port" A quantitative estimate of indirect costs is often not possible or only with great difficulty. Indirect costs include, firstly, monetary costs related to the relocation of companies (e.g. for compensation), or subsidies to port businesses, for instance in the form of the low average rent of annual € 2.2/m² in the port. Further indirect costs include social costs for population resettlement, environmental externalities, traffic and congestion, noise, pollution and container storage areas in port-adjacent city quarters such as Wilhelmsburg.

Our discussion of opportunity costs involved the question whether certain benefits derived from the port's usage of the city's resources fall short of the benefits that could be received if those same resources were allocated towards a different purpose, namely new economic sectors and city development and urban renewal. Both opportunity costs and indirect costs are of great importance for our overall analysis for two reasons. Firstly, such an approach makes clear that the port is one component of a larger system – namely, the metropolitan region with its overall economic situation, the living situation in the city and in the rural area, the quality of life, and the state of the regional ecosystems. Secondly, our investigation of opportunity costs takes into account that the costs and benefits of economic and other activities change over time. Thus, despite the pronounced growth in overall turnover, benefits through port-dependent tax revenues and jobs are decreasing, and tax revenues are lower than they should be relative to the number of port-dependent jobs. Meanwhile, economic growth is taking place in service- and ICT-based sectors that require the city's support. Necessary strategic actions for Hamburg in order to set into place a number of competitive factors and locational requirements for new economic sectors that are presently lacking in the European comparison have been discussed in section 17.4.2 (and are summarized again in the overall conclusions, section 24.4.2). It would be advisable for the city to evaluate whether the high costs of the port restrict the city's support for new economic sectors and for urban renewal too much – given the decreasing contribution of the port to the city's economy and the need for the city to re-assert its position in the larger European and international context.

24.4 Conclusions to the scenarios and overall conclusions

24.4.1 Likely threats and problems

A decisive element for all three scenarios is the present worldwide transition to a service- and technology-based economy and society. Connected to this is the increased competition between city regions worldwide. The city and the region need to take these developments into account more clearly. The worldwide transition to a post-industrial economy implies that the decisive investment in new economic sectors is considerably more important for city regions than a more short-term outlook may suggest. Competition in the post-industrial service society tends to be much more pronounced, typically leading to the emergence of certain regions as strongholds of the respective new sectors after an initial phase of rapid development. City regions need to make clear efforts to defend their place in new sectors. Thus, Hamburg is at a crucial point with respect to urban renewal and economic re-orientation.

The following two most decisive threats can be extracted:

1. With respect to port development, global developments may outrun Hamburg in two ways: Firstly, Hamburg may not be able to keep up with requirements for the port and therefore lose market shares (compare scenario 2). Secondly, and much more importantly, there is the risk that through the high costs of port development the city's support for new economic sectors and for urban renewal will not be sufficient in order to re-assert Hamburg's position in the larger European and international context. Two possibilities of a re-orientation of port development are explored in scenarios 1 and 3.
2. Present processes of urban renewal in Hamburg provide important opportunities to renew the city's economic orientation. But there are also a number of risks. This concerns the grand scale of the projects that are pursued simultaneously – the Wachsende Stadt, the Hafencity and the integration of the city's south – as well as specific threats related to the Hafencity and Wilhelmsburg. Budget restrictions and somewhat inflexible, non-participatory planning pose risks for the development of the Hafencity. Until 2005, port expansion has been cross-financed with property sales in this city quarter. This had slowed down development, led to inflexibility towards investors, and excluded or postponed the development of components that a new city quarter needs – be it a kindergarten or even a school, housing for a mixture of income classes, and shops, restaurants and other amenities at an affordable price level. The city has now decided to establish the very much needed rail-based public transport connection to the Hafencity, but the financing of this and the time when it will be available are still uncertain. With respect to several of these elements, the neighbouring Channel Harburg shows how successful development of a new city quarter with a modern economic orientation can come about. Channel Harburg is developing well although investments from the city are negligible.
   The development of abandoned port areas in scenario 1 and of the Hafencity in scenario 3 explore the application of some of these elements while the second scenario illustrates the risks for the Hafencity as described above.
   For Wilhelmsburg, two courses of development appear possible and plausible. Due to the abundance of green areas and its favourable location in the central city next to large water areas and right between the prospering Channel Harburg and the rising Hafencity, Wilhelmshaven might develop into a highly attractive city quarter that generates advantages for the rest of the city. Different possibilities towards this end are explored in scenario 1 and 3. However, scenario 2 illustrates that Wilhelmsburg could

also fall into more pronounced decline and pose a threat to other parts of the city through social unrest and a high crime rate.

24.4.2 Necessary strategies

Decisions need to be informed by the observation that in leading metropolitan regions growth occurs in particular in modern service and ICT-industries. If the city of Hamburg were to put half of the 400 million € that are allocated to the port for 2005 into the improvement of locational factors, a multiple of the present benefits through new sectors can be expected to be gained[155]. A list of core locational factors and strategies is presented in the following together with an indication of the scenario(s) in which the respective factor is taken up:

1. The clear communication of support for new economic sectors and the marketing of the city as modern business and high-technology region (scenarios 1 and 3) – preferably for the entire metropolitan region (scenario 3).
2. The provision of an intercontinental airport. This option is carried out in scenario 3. In the first scenario, the failure of Hamburg and Schleswig Holstein to agree on the construction of a new airport outside Hamburg constitutes a serious bottleneck – which is remedied only to some degree by the establishment of a Federal transrapid train connection.
3. The improvement of the city's business climate through the amelioration of legal frameworks for company formation and the reduction of bureaucratic barriers, and measures such as the establishment of a contact person or agency to assist newly forming companies (scenarios 1 and 3).
4. A more supportive and inviting attitude towards investors – in particular in the Hafencity, and in particular also towards smaller investors.
5. Education and research facilities, facilities for the generation of know-how and technology transfer should be modernized in such a way that they can actively support the flourishing of technologically advanced industries in Hamburg (scenarios 1 and 3). This could include further corporately financed universities like the Northern Institute of Technology, new endowed chairs in relevant new fields, and the establishment of technology parks in close connection with the universities and research institutes. R&D should receive 3 % of the city's GDP instead of the present 2 %. Of importance in particular for structurally weak city quarters is also the upgrading of Hamburg's polytechnic schools[156].
6. The extension of regional cooperation in such a way that the region can present itself on the international economic stage as one entity and carry out comprehensive and long-term planning for the region as a whole (scenario 3).
7. The improvement of quality of life in order to attract and maintain highly qualified people for new sectors. This includes recreation and cultural offers, good schools and universities, a high quality health care system, the skilful use of green and water areas in the city, the improvement of the housing situation, a conscious promotion of the city's internationality and possibly the construction of a landmark for the city. These factors are explored in all three scenarios.
8. A relaxation of rigid governmental structures towards governance and increased public participation (scenario 1 and to some degree scenario 3).

[155]This is of course only possible in a scenario such as the scenario 3, 'Collaboration' discussed in this dissertation, or possibly scenario 1, 'The water city'.
[156]German „Fachhochschulen".

24.4.3 Concluding remark

Many of the challenges that Hamburg and the greater city region are presently faced with are common to Europe's major cities and metropolitan regions. The scenarios present different possibilities of response to these challenges. In particular, the long-term outcome of different strategies and the interconnectedness of the different fields within which decisions and changes occur are made clearly visible. It is hoped that the collected success factors and the linkages found between different fields will be helpful for the development of future strategies for the city of Hamburg as well as for other city regions. Also our results emphasize the value of combining very different quantitative and qualitative methodologies in order to adequately treat and connect very different fields which in a real city and region act together. It is hoped that the results may be of interest to planners or decision makers involved with the creation of a highly viable and attractive future for the region.

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