AVEC

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A vulnerability assessment of two regions in Germany

Lüneburg and Magdeburg: regions of former West and East Germany along the river Elbe

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Contents

1 Introduction

Recent floods and droughts have raised the awareness of vulnerability to global change in German society. In a case study undertaken during the AVEC summer school in 2003, we wanted to address the question of how a selected region in Germany would be affected by global change. The decision for choosing the region was based on two criteria:

1) what regions have been affected recently and deserve attention?
2) what is unique in Germany?

While thinking about global change, two recent events came to our minds: the flooding of the Elbe in 2002 and the droughts in the summer of 2003. The flooding strongly affected communities living close to rivers while the main impact of the recent drought was on the agricultural sector. Therefore, we selected an agricultural area that was located along one of the major rivers in Germany, the river Elbe. Furthermore, we selected a region that was located partially in former East Germany and partially in former West Germany. The administrative region of Magdeburg is located in the eastern part and the administrative region of Lüneburg is located in the western part (Fig. 1). The focus in this assessment is on the rural areas of these regions.

At the moment, and most likely in the future, too, both regions have a similar climate, while socio-economic conditions are still strongly influenced by the historical differences (i.e. a market economy in West Germany and a socialist, planned economy in East Germany). The current climate is temperate oceanic, with a mean annual temperature of about 8.6º C and a mean annual precipitation of 730 mm. Both regions are flat, low lying and dominated by agricultural land use. However, the soil in Magdeburg is much more fertile than in Lüneburg. Magdeburg is characterised by a higher unemployment rate and lower economic and technological development compared to Lüneburg. Agricultural management units are larger in Magdeburg as a consequence of the aggregation of fields into cooperatives during the former socialist regime.

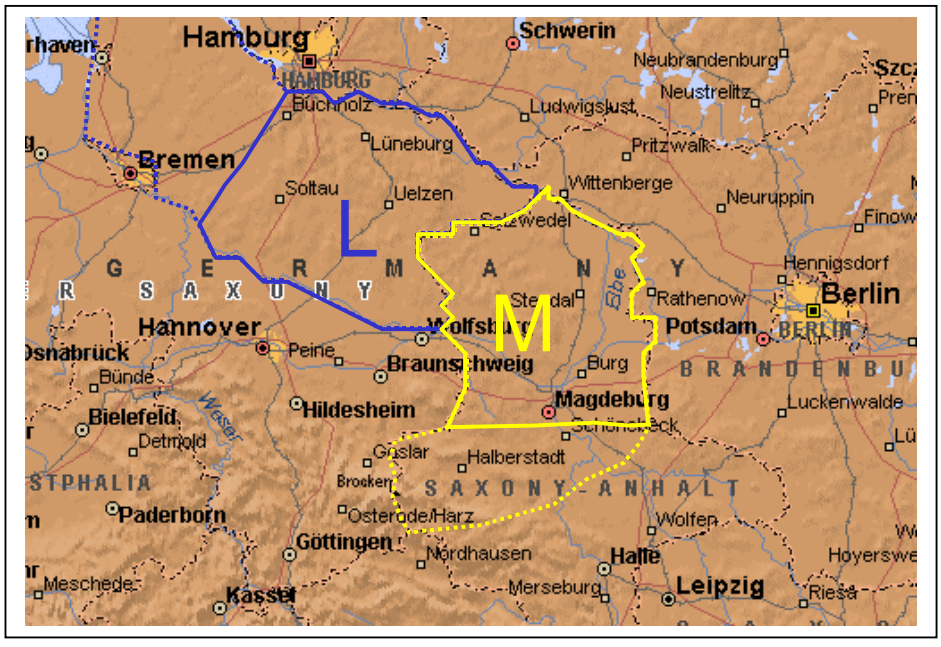

Figure 1: Location of the selected region (solid lines) which are part of the administrative districts (solid plus dotted lines). Lüneburg (L, former West Germany) and Magdeburg (M, form-er East Germany).

The main questions of this vulnerability assessment are:

1) how will this region be affected by global change?
2) is there a difference in vulnerability between the eastern and western German parts?

In the next section the approach to answer these questions is outlined.

2 The vulnerability framework

To structure the assessment of the vulnerability of Lüneburg and Magdeburg to global change, a vulnerability framework has been developed (Fig. 2).

Vulnerability is a function of exposure, sensitivity and adaptive capacity. *Exposure* is the nature and degree to which human-environment system are exposed to global change. To assess exposure, the drivers of global change have to be identified. These drivers can be biophysical or socio-economic. Biophysical drivers are mainly drivers which are exogenous to the regional system. They can be influenced by humans in an indirect way but not by the region itself. Socio-economic drivers are partly exogenous, partly endogenous, depending on the action of people in the region.

Sensitivity is the degree to which a system is affected to the same extent, either adversely or beneficially, by global change. This depends on the rate of change of ecosystem services due to exposure and their autonomous adaptation. *Adaptive capacity* (in this framework) is the ability to implement planned adaptation measures.

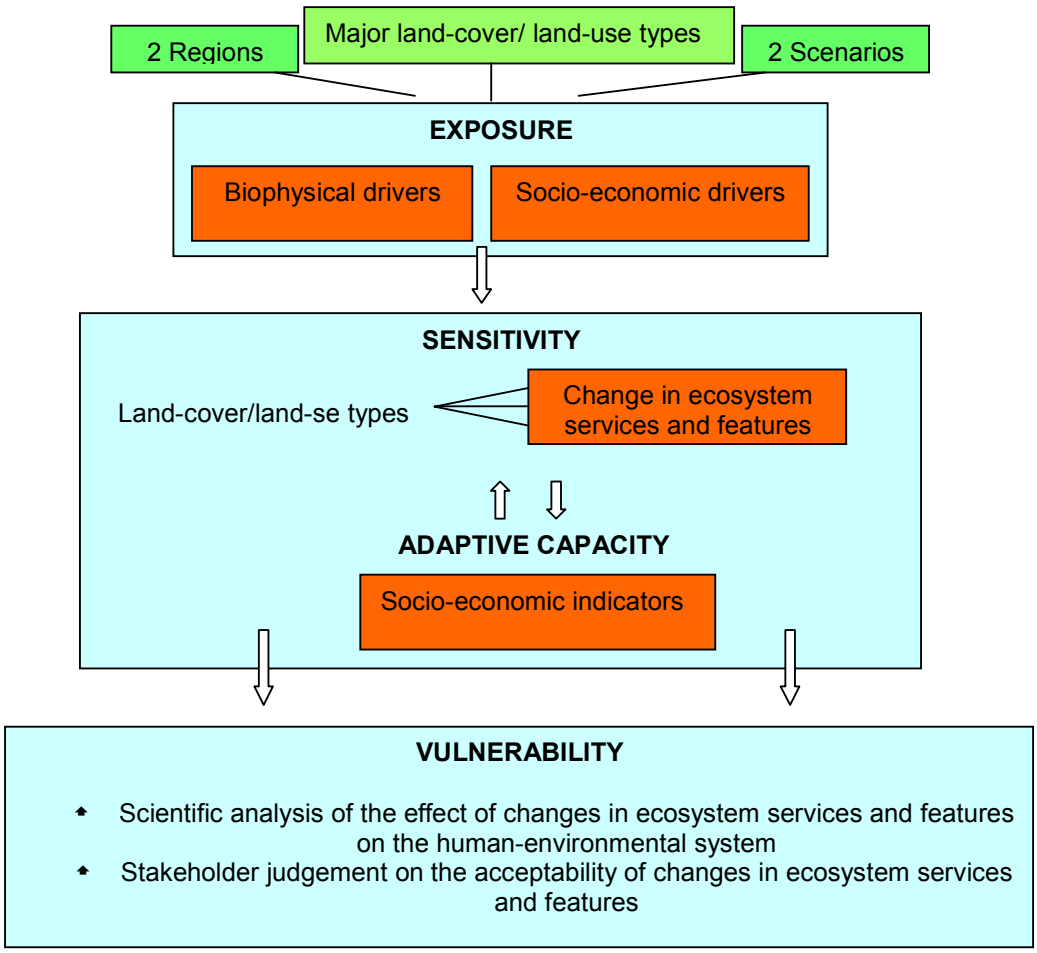

Figure 2: Vulnerability framework used for the vulnerability assessment of Lüneburg and Magdeburg.

In Chapter 3 the two regions are divided in the major land-cover/land-use types. Subsequently, the ecosystem services and features provided by these land-cover/land-use types are identified. Ecosystem services and features are the services provided by the ecosystem as well as other features that are important to humans. For each of the land-cover/land-use types, the major stakeholders are then identified. Stakeholders are people and institutions who have an interest in the ecosystem services and features provided by the land-use/land-cover types. A stakeholder dialogue was organised to discover the worries

of the stakeholders. This proved to be a useful way of identifying the major drivers of global change in these two regions.

The next step, described in Chapter 4, is to make regional scenarios of global change for both regions. Two scenarios are developed, one with more rapid climate change and economic/technological development (based on SRES[1] scenario A1), and the other with a lower rate of change and stronger regionalisation (based on SRES scenario B2). In Chapter 5 the impact of global change on the human-environmental system is assessed for the major land-cover/land-use types for the two different regions and two different scenarios. Chapter 6 assesses the acceptability to the stakeholders of the rate and amount of change in the ecosystem services and their features. The vulnerability of the regions depends on the scientific analysis as well as on the stakeholders' judgment of acceptability. Conclusions on the vulnerability of the two regions are made in Chapter 7.

3 Ecosystem services, stakeholders and exposure

The four major land-cover/land-use types identified for the study region are agricultural land, nature (terrestrial ecosystems), water bodies and urbanised area (including infrastructural land). In all land-cover/land-use types humans are explicitly included. Table 1 lists the main features or services of the human-environmental system that are associated with each land-cover type. Services with "negative" consequences for the ecosystem and/or the human system are marked with a minus sign (-).

3.1 Services and features associated with the four main land-cover types

Table 1: Services and features of the four main land-cover types

Agriculture	**Nature**	**Water bodies**	**Urbanised area**
Farmer income	Tourism	Recreation	Living and recreation
Food quality	Energy production	Flood protection	Employment
Food production	Carbon sequestration	Biodiversity	Income
Employment	Biodiversity (species richness, endangered species, habitats)	Tourism	Tourism
Biodiversity	Land-owner income	Water supply	Transport
Living and recreation	Fuel wood	Water quality	
Emissions and leaching (-)	Cleaning buffers, e.g. water & air purification	Transport	

3.2 Stakeholder dialogue

The most important stakeholders were identified for each land-cover type. They are considered to be the same for both regions. They are listed in Table 2.

Table 2: Stakeholders

Agriculture	**Nature**	**Water bodies**	**Urbanised areas**
Farmers	Nature conservationists	Water managers	Inhabitants
Nature conservationists	Landowners	Nature conservationists	Industry & commerce
Food industry	Land managers	Tourist industry	Local authorities
Local authorities	Tourist industry	Fishing industry	Tourist industry
Other inhabitants	Scientists	Scientists	
	Other inhabitants	Insurance companies	
		Other inhabitants	

[1] **S**pecial **R**eport on **E**mission **S**cenarios, IPCC 2001

A stakeholders' meeting was held to generate awareness of the major concerns of the different stakeholders. Stakeholders present at the meeting were a local authority (the rural council chair (*Landrat)* of Lüneburg), a representative of the inhabitants of the region, a representative of an NGO for nature conservation, a farmers' representative, a representative of the tourist industry and a representative of industry and commerce. Table 3 lists the issues that were regarded as most important by the different stakeholders present.

Table 3: Important issues from the points of view of the stakeholders

	We want	**We don't want**
Local authority	Flood protection. To attract EU funds, in particular for wetland establishment: to improve flood protection, enhance natural attractivity and offer additional income to farmers. To preserve high natural attractivity.	Impoverishment and depopulation of rural areas, in particular in the light of increased competition in the agricultural sector of the enlarged EU.
Inhabitants	Flood protection. To improve regional income. To ensure a sustainable future, preserve the region's high natural attractivity. To improve educational conditions in schools. Security (military).	Depopulation of rural areas and aging population.
Nature conservation	Protection of the region's high biodiversity (in particular rare and threatened species). Extensification of the region's agriculture. Re-establishment of wetlands.	Construction and road building, as this results in destruction or fragmentation of highly valuable habitats.
Agriculture	Flood protection. Given overproduction in the EU's agricultural sector, farmers would be willing to extensify and manage wetlands against payment.	High unemployment in rural areas.
Industry and commerce	To enhance economic development. To improve infrastructure and accessibility.	Environmental restrictions. Shrinking of the population.
Tourism	To improve the region's accessibility and infrastructural conditions. To make sure there are enough hotels. Water as a major asset for tourism, establishment of wetlands.	

The exposure of the land-cover types to global change depends on biophysical and socio-economic driving forces. Stakeholders identified the driving forces they regarded as the most important for their sector. These are listed in Table 4.

Table.4: Main drivers of global change identified by stakeholders

	Biophysical	**Socio-economic**
Agriculture	Climate change with regard to floods and droughts Change in mean temperature and precipitation CO_2 increase N deposition	Technological development Cutting of subsidies EU enlargement Consumer preferences Environmental policies Population change (structure & size)
Nature	Climate extremes N deposition CO_2 increase Change in mean temperature and precipitation	Military actions Urbanisation & infrastructure Environmental policies Tourism Society's attitude to nature Resource competition (water, wood)
Water	N deposition Climate extremes Policies (mainly EU) Pollution	Environmental policies Infrastructure and urbanisation Water supply competition Tourism Trade Engineering of rivers
Urbanised area	Climate extremes	GDP growth Technological development Infrastructure and urbanisation Population change

4 Scenarios 2050

4.1 Selection of the scenarios

Technological and economic change can be identified as most significant socio-economic drivers for changes and trends in the region's agricultural sector while climate change constitutes the most important biophysical driver, affecting both agriculture and the flood safety of the region. In this assessment two scenarios are developed which differ in these main driving forces. The first is based on the SRES A1 scenario with a focus on economic development. The second scenario is based on B2 and has its focus on environmental issues. Due to this difference in ways of thinking and acting, climate changes faster in the A1 scenario than in B2. In the following, these two scenarios will be investigated for the western and eastern parts of the region respectively. We selected a time frame of 50 years to allow for a recognisable change in climate, while also taking into consideration that socio-economic changes occur on short time scales.

4.2 Development of the region in the two scenarios

Five main drivers have been selected: population change (size and structure), economic development, technological development, climate change and change in regional or – where applicable – national policies. Land-use change is recognised as a secondary driver.

A1: characteristic of economic development in this scenario is the rapid and successful development of new technology-intensive economic sectors that display a strong global orientation with decreased competition between regions. The regions typically specialise in some selected industries. Present examples would be the highly successful region of Bavaria in southern Germany specialising in medical

technology, biotechnology and life sciences or the Oeresund region with its strengths in medical and biotechnology ("Medicon Valley") as well as in communication sciences and the new media. In the scenario based on the SRES A1 scenario, Lüneburg with its close proximity to Hamburg and its interesting research landscape becomes even more integrated into the greater Hamburg area. It is able to benefit immensely from this, resulting in a noticeable increase in patents and considerable GDP growth. Magdeburg does not have a similarly favourable geographic location and thus falls behind – even though the differences between eastern and western Germany are disappearing over time. Climate change is quite noticeable in the A1 scenario, leading to a temperature increase of 2° C, an average prediction of a 20mm increase in precipitation and a high increase in climate extremes (see Fig. 3). The predictions for temperature development show a high degree of consistency between different models, giving confidence in the predictions. The predictions for precipitation development, however, are highly variable between different models. They also show an interannual variability which is clearly larger than long term climatic changes, suggesting a conservative interpretation of potential changes in precipitation.

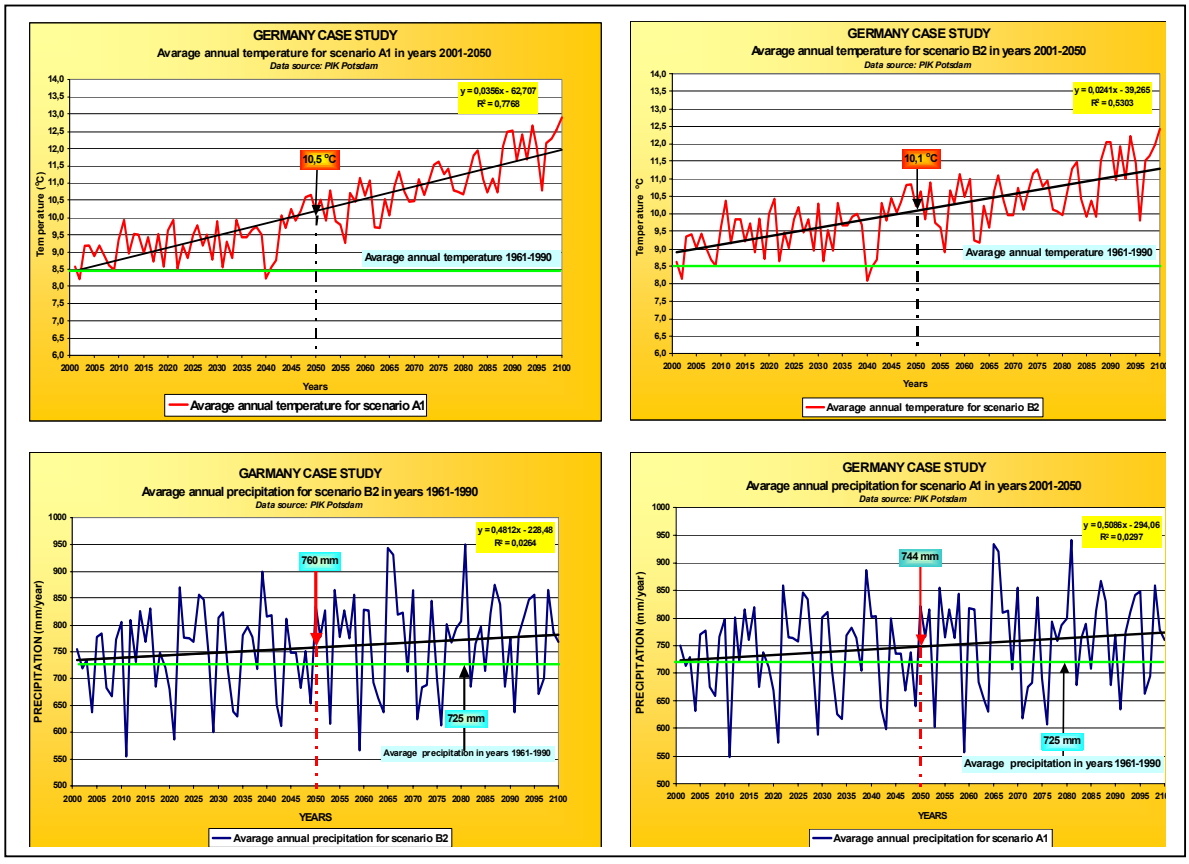

Figure 3: Climate change in the two scenarios

B2: Due to the continuous decrease in population growth in the B2 scenario aging takes place. Young people – in particular young families – are inclined to move to the favoured green rural areas, which results in less pronounced aging in rural areas. In both parts of the region, economic growth is relatively slow. Patents are deployed mostly for inventions in environmental technologies. There is a less pronounced increase in temperature, a higher increase in precipitation and only a medium increase in climate extremes.

Data on the development of population size for both scenarios and both regions was available in downscaled scenarios of the SRES scenarios. With regard to population structure, the present trends are extrapolated and combined with the effect of socio-economic changes – namely, the relative economic success of the western part of the region (Lüneburg) and the relatively weak economic development of the eastern part (Magdeburg). Downscaled scenarios on GDP growth were available only for Lüneburg.

Table 5 gives a quantification of the changes expected in each driver in the two selected scenarios and the western (Lüneburg = L) and eastern (Magdeburg = M) parts of the region.

Table 5: Global change scenarios

	Present		**A1**		**B2**	
	L	**M**	**L**	**M**	**L**	**M**
Population : **Pop. size** **Pop. structure**	1.5 mill stable	1.2 mill aging	-2% more young people	-1% increased aging	-15% Aging but less pro-nounced than in cities.	- 20% Aging but less pro-nounced than in cities.
Economy: **GDP/capita**	15,000	10,000	80,000 =+433%	45,000 = +350%	55,000 =+260%	36,000 =+260%
Technology: **patents [per 1000]** **R&D [% of GDP]**	129 0.5	30 1.3	300 0.8	110 0.7	110 0.7	50 0.65
Climate change: **Temperature** **Precipitation** **Extreme events [floods, droughts]**	8.6°C 730mm		+2° C / +25% +20mm / +2.5% high increase in extremes.		+1.5° C / +13% +30mm / +3.2% medium increase in extremes.	
Policy			Agricultural subsidies are cut (due to fast development of technology and trade). Emphasis on food quality, not on environmental standards.		Subsidies tied to environ-mental standards and food quality. Emphasis on agro-environmental measures and multi-functional land use.	

4.3 Impact of the scenarios on land cover/land use

In the A1 scenario the rapid technological development leads to a high increase in crop yields. In Europe in general, the agricultural area needed will reduce drastically and agricultural subsidies will be reduced as well. Around 30% of the agricultural land in Europe is no longer needed. Cross-compliance applies to the remaining subsidies with regard to food quality – though not with respect to environmental standards. In the western part of the region, only little of the agricultural area remains in use as the soils here are not very good. Some of the former agricultural area is converted into wetlands as a form of flood protection or into forests. Soil quality and also climate conditions in the region's eastern part, on the other hand, are highly favourable for agriculture. Consequently, the agricultural area here remains constant.

In the B2 scenario, emphasis is on regional self-sufficiency, variation in land-use and organic production. Here, the agricultural area in both parts of the region remains almost constant in size. Fields tend to become smaller and more varied in types. The percentage of natural areas increases.

4.4 Scenarios of adaptive capacity

Adaptation can be divided into autonomous adaptation and planned adaptation. Autonomous adaptation is taken into account in the sensitivity of the ecosystem services, as it occurs spontaneously and does not constitute a conscious response to global change. Planned adaptation depends on the adaptive capacity of the human-environmental system.

The scenarios of adaptive capacity are based on the developed regional scenarios. These scenarios indicate the rate and amount of change of socio-economic and biophysical drivers. Adaptive capacity depends on socio-economic indicators. People have to be aware of the problem, they have to be able to adapt and they have to have the finances to act. The population structure and the direction of policies indicate awareness. Ability to adapt is indicated by technological development. Economic development indicates the financial potential to act. Based on the scenarios, story-lines can be developed which reflect adaptive capacity.

In an A1 scenario, people are focused on economic and technological development and not on environmental issues. They think the way they live is the right way and they do not have a great awareness of the impacts of global change. On the other hand, if and when an extreme event occurs, they have a strong ability to react as the technology and infrastructure is available. In addition, the financial reserves for adaptation are high. The adaptive capacity of Lüneburg is greater as economic and technological development is stronger than in Magdeburg. Besides this, in Lüneburg the farmers own their own farms and can make their own decisions. In Magdeburg the farms were state owned before the reunification of Germany and this still influences decision making. As agriculture is the main land-cover/land-use type in both regions, this influences the adaptive capacity. In a B2 scenario there is a high environmental consciousness, so awareness is high. As technological and economic development is not very strong, the ability and finances to act are relatively weak. This means that they are only able to adapt if the rate of global change is not too high.

When assessing the changes in ecosystem services and features, the adaptive capacity is taken into account. It is not explicitly indicated in the figures. Per land-cover/land-use type the adaptive capacity can change according to the drivers and indicators which are most important for this specific ecosystem service or feature.

5 Impacts on the human-environmental system

The vulnerability of the regions depends on exposure, sensitivity and adaptive capacity. Exposure is different for the two scenarios while sensitivity and adaptive capacity vary between the two regions. In Fig. 4 the change of the ecosystem services and features is presented for 2050 related to the present state. The present state is taken as a reference, which is set at 100%. Changes for 2050 are depicted as changes in percent of this reference state.

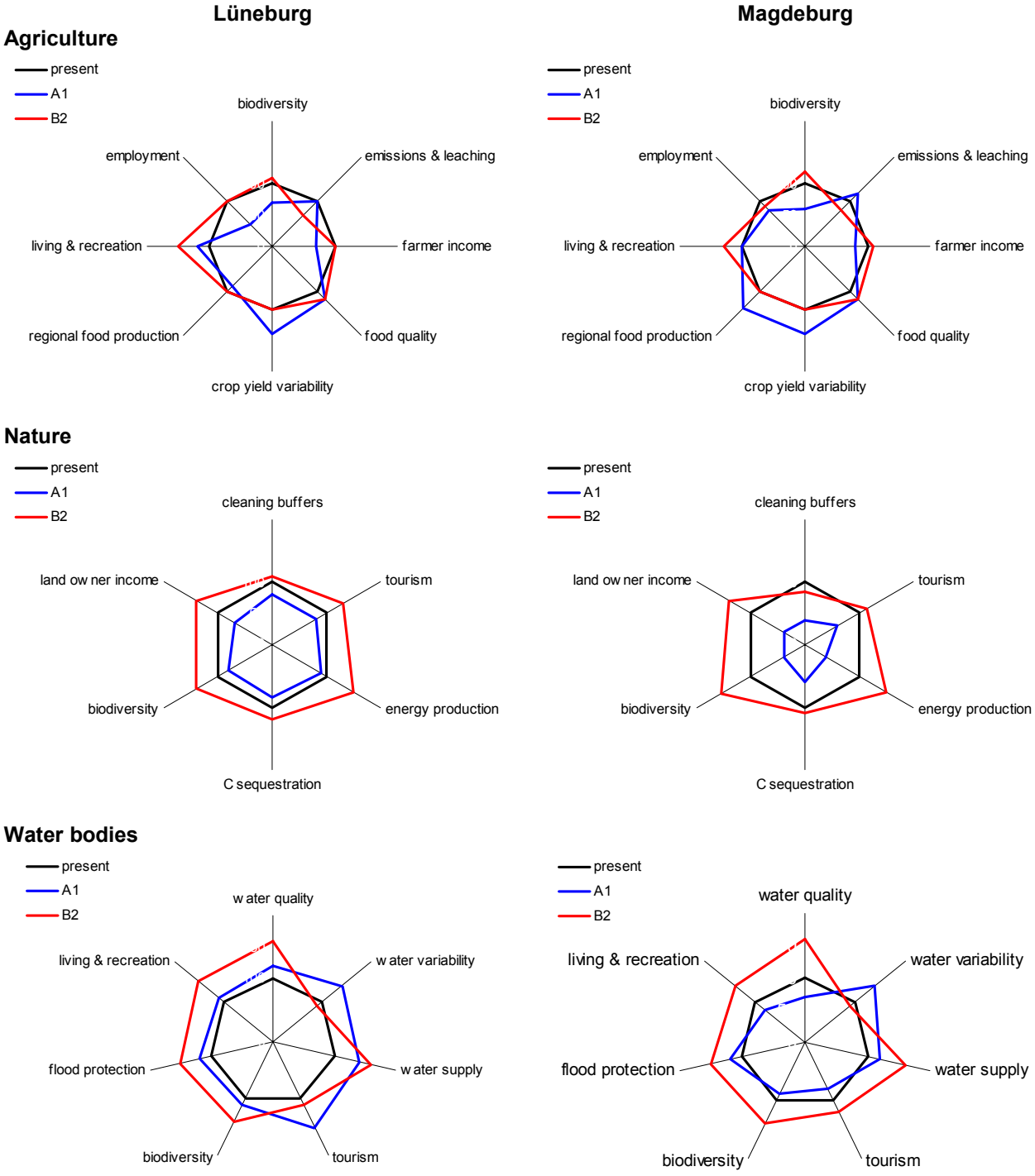

Figure 4: Changes in ecosystem services and features in 2050.

6 Acceptability of changes for the stakeholders

6.1 Importance of ecosystem services and features of the human-environmental system for the different stakeholders

In the stakeholder dialogue the stakeholders were asked about their interest in the different ecosystem services and features. Table 6 illustrates the importance of different ecosystem services and features of the human-environmental system for the different stakeholders.

Legend: ++ essential
+ interested
0 neutral
- negative interest
-- very negative interest

Table 6: Importance of ecosystems services and features to the stakeholders

Ecosystem Services /Features	**Farmers**	**Tourist industry**	**Industry & commerce**	**Local authorities**	**Nature con-servation**	**Other inha-bitants**
Agriculture						
Employment	++	+	0	++	0	0
Farmer income	++	0	0	+	+	0
Food quality	++	++	++	++	+	++
Food production	++	0	+	+	0	+
Biodiversity of agro-ecosystems	A1: - B2: ++	+	0	+	++	+
Emissions and leaching	0	-	-	-	--	-
Living and recreation	-	++	+	++	+	++
Nature						
Cleaning buffers	-	+	+	+	++	+
Tourism	+	++	+	++	-	+
Energy production	-	0	++	A1:+ B2:++	A1:- B2:+	+
Carbon sequestration	-	0	0	+	++	0
Biodiversity terrestrial ecosystems	0	++	+	+	++	+
Land-owner income	++	0	0	++	0	+
Water						
Living and recreation	0	++	+	+	-	++
Flood protection	++	+	++	++	-	++
Biodiversity water	0	+	+	+	++	+
Tourism	0	++	+	++	-	+
Water supply	++	+	++	++	+	++
Water quality	+	+	+	++	++	++

6.2 Acceptability of the changes to the stakeholders

In the stakeholder dialogue a survey was held to answer the question of whether the changes in ecosystem services and features (Fig. 4) were acceptable to the stakeholders. The results are shown in Tables 7 and 8.

Scale of the assessment:
1 – barely acceptable
2 – slightly acceptable
3 – neutral
4 – quite acceptable
5 – fully acceptable

Table 7: Acceptability of the changes to the stakeholders for the A1 scenario

Scenario A1	***STAKEHOLDERS***													
	Farmers		**Tourist industry**		**Industry & commerce**		**Local authorities**		**Nature conser-vationist**		**Other inhabitants**		**Average**	
	L	**M**	**L**	**M**	**L**	**M**	**L**	**M**	**L**	**M**	**L**	**M**	**L**	**M**
AGRICULTURE														
Employment	1	2	2	2	3	3	1	2	3	3	3	3	**2.2**	**2.2**
Farmer income	1	1	3	3	3	3	1	2	2	2	3	3	**2.2**	**2.2**
Food quality	5	5	5	5	5	5	5	5	4	4	5	5	**4.8**	**4.8**
Food production	2	5	3	3	2	4	2	4	3	3	2	4	**2.3**	**3.8**
Biodiversity of agro-ecosystems	5	5	2	2	3	3	2	2	1	1	2	3	**2.5**	**2.7**
Emissions and leaching	3	3	4	2	4	2	4	2	2	1	4	2	**3.5**	**2.0**
Living and recreation	2	4	5	4	4	4	5	4	4	4	5	4	**4.2**	**4.0**
Crop yield variability	1	1	3	3	3	3	1	1	3	3	3	3	**2.3**	**2.3**
NATURE														
Cleaning buffers	5	5	2	2	2	2	2	2	1	1	2	2	**2.3**	**2.3**
Tourism	2	2	1	1	2	2	1	1	5	5	2	2	**2.2**	**2.2**
Energy production	4	4	3	3	2	1	2	2	4	4	2	1	**2.8**	**2.5**
Carbon sequestration	4	4	3	3	3	3	2	2	2	1	3	3	**2.8**	**2.7**
Biodiversity terrestrial ecosystems	3	3	2	1	2	2	2	2	2	1	2	2	**2.2**	**1.8**
Land-owner income	1	1	3	3	3	3	1	1	3	3	2	2	**2.2**	**2.2**
WATER														
Living and recreation	3	3	5	2	4	2	4	2	1	5	5	2	**3.7**	**2.7**
Flood protection	3	3	4	4	4	4	3	3	2	2	3	3	**3.1**	**3.1**
Biodiversity water	3	3	4	2	4	2	4	2	5	1	4	2	**4.0**	**2.0**
Tourism	3	3	5	1	4	2	5	2	1	5	4	2	**3.7**	**2.5**
Water supply	4	4	4	4	4	4	5	5	5	5	5	5	**4.5**	**4.5**
Water variability	1	1	2	2	2	2	2	2	4	4	1	1	**2.0**	**2.0**
Water quality	4	2	4	2	4	2	5	1	5	1	5	1	**4.5**	**1.5**
Averages	**2.8**	**3.0**	**3.2**	**2.5**	**3.1**	**2.7**	**2.7**	**2.6**	**3.0**	**2.8**	**3.1**	**2.5**	**2.9**	**2.6**

Table 8: Acceptability of the changes to the stakeholders for the B2 scenario

Scenario B2	STAKEHOLDERS													
	Farmers		Tourist industry		Industry & commerce		Local authorities		Nature conser-vationist		Other inhabitants		Average	
	L	M	L	M	L	M	L	M	L	M	L	M	L	M
AGRICULTURE														
Employment	2	2	2	2	3	3	2	2	3	3	3	3	**2.5**	**2.2**
Farmer income	2	5	3	3	3	3	2	4	3	4	3	3	**2.7**	**3.7**
Food quality	5	5	5	5	5	5	5	5	4	4	5	5	**4.8**	**4.8**
Crop yield variability	2	2	3	3	3	3	3	3	3	3	3	3	**2.8**	**2.8**
Food production	2	2	3	3	3	3	3	3	3	3	3	3	**2.8**	**2.8**
Biodiversity of agro-ecosystems	5	5	4	4	3	3	4	4	5	5	4	4	**4.2**	**4.2**
Emissions and leaching	3	3	4	4	4	4	4	4	5	5	4	4	**4.0**	**4.0**
Living and recreation	2	2	5	5	4	4	5	5	4	4	5	5	**4.2**	**4.2**
NATURE														
Cleaning buffers	2	4	4	2	4	2	4	2	5	1	4	2	**3.8**	**2.2**
Tourism	4	4	5	5	4	4	5	5	2	2	4	4	**4.0**	**4.0**
Energy production	2	2	3	3	5	5	5	5	4	4	4	4	**3.8**	**3.8**
Carbon sequestration	2	2	3	3	3	3	4	4	5	5	3	3	**3.3**	**3.3**
Biodiversity terrestrial ecosystems	3	3	5	5	4	4	4	4	5	5	4	4	**4.2**	**4.2**
Land-owner income	5	5	3	3	3	3	5	5	3	3	4	4	**3.8**	**3.8**
WATER														
Living & recreation	3	3	5	5	4	4	4	4	2	2	4	5	**3.7**	**3.8**
Flood protection	5	5	4	4	5	5	5	5	2	2	5	5	**4.3**	**4.3**
Biodiversity water	3	3	4	4	3	3	4	4	5	5	4	4	**3.8**	**3.8**
Tourism	3	3	5	5	4	4	5	5	2	2	4	4	**3.8**	**3.8**
Water supply	5	5	4	4	5	5	5	5	4	4	5	5	**4.7**	**4.7**
Water variability	5	5	4	4	4	4	4	4	2	2	5	5	**4.0**	**4.0**
Water quality	4	4	4	4	4	4	5	5	5	5	5	5	**4.5**	**4.5**
Averages	**3.3**	**3.5**	**3.9**	**3.8**	**3.8**	**3.7**	**4.1**	**4.1**	**3.6**	**3.5**	**4.0**	**4.0**	**3.8**	**3.8**

7 Conclusion

The main questions of this vulnerability assessment are how this region will be affected by global change and if there is a difference in vulnerability between the eastern and the western German part.

The vulnerability of the region is based on two analyses:

a) scientific analysis of the effect of changes in ecosystem services and features on the human-environmental system.

b) stakeholder judgement of the acceptability of changes in ecosystem services and features.

Changes in ecosystem services give an idea of the changes in the region. A decrease in an ecosystem service will not always mean the region is vulnerable, though. Some ecosystem services are more important than others. For this reason the acceptability of the changes in ecosystem services for the stakeholders is assessed. In this context the stakeholders' willingness or unwillingness to live with changes – i.e. the acceptability of these – can be considered part of the adaptive capacity and thus can contributes to the overall vulnerability.

Under both scenarios, global change has an environmental as well as socio-economic impact in the region. If the region develops as in the A1 scenario, global change will have a diverse impact on the region. Especially the natural areas are threatened, whereas the agricultural areas are negatively as well as positively affected depending on the region, and water bodies are mostly positively affected. The region is able to cope with these changes; only extreme events are expected to have a significant negative impact in the region. In the B2 scenario the environmental awareness is higher and this is also reflected in the results. Changes are mostly positive and the stakeholders find these changes more acceptable than changes according to the A1 scenario.

Concerning East and West Germany, both parts of the region are affected by environmental as well as socio-economic changes.

Scenario A1

Under the A1 scenario for agriculture, which is the most important issue in this case study assessment, the most acceptable changes to the stakeholders seem to be those concerning food quality (4.8 average), living and recreation (4.2 average for Lüneburg and 4.0 average for Magdeburg). In contrast to agriculture, stakeholders seem to manifest less acceptability of changes in employment (2.2 average for both regions), farmer income (2.2 average for both regions), crop yield variability (2.3 average for both regions), food production (less for Lüneburg – 2.5, but more for Magdeburg, 3.8 average) and biodiversity of agro-ecosystems (less for Lüneburg – 2.5 and more for Magdeburg – 2.7 average). For nature stakeholders seem to manifest a slightly acceptable to neutral attitude to changes in ecosystem services than in the other categories for both regions, being more concerned about the biodiversity of terrestrial ecosystems in the Magdeburg region (1.8 average) (Table 7). Under the scenario for water the lowest acceptability to stakeholders of changes is manifested for water variability (2.0 average for both regions) and the highest for tourism (4.5 average for both regions).

Summing up, in the A1 scenario Lüneburg (3.1 average) is less vulnerable than Magdeburg (2.7 average), mainly due to higher socio-economic and technological development and its proximity to Hamburg. A large part of the agricultural area is no longer needed and adaptive capacity is higher. The agricultural sector in itself is vulnerable, but Lüneburg is able to shift towards other economic sectors, so these changes are acceptable for most of the stakeholders. Magdeburg will keep its high agricultural production due to the good soil quality, but as economic and technological development is not very strong, the agricultural sector will not profit from this very much.

Scenario B2

For agriculture the highest acceptability of changes for stakeholders is in food quality (4.8 average for both regions), biodiversity of agro-ecosystems (4.2 average for both regions) and living and recreation (4.2 average for both regions), while the lowest acceptability is manifested for employment (more for Lüneburg – 2.5 and less for Magdeburg – 2.2 average), farmer income (2.7 average for both regions), crop yield variability (2.8 average for both regions) and food production (2.8 average for both regions). As for nature, stakeholders display high acceptability for changes in tourism (4.0 average for both regions), energy production and landowner income (3.8 average for both regions) and carbon sequestration (3.3 average for both regions); and they are open to changes because they do not manifest low acceptability for anything. For water the situation is similar because stakeholders are also open to changes, more to some than the others, like water supply which seems to be very important for living and activity in both regions (4.7 average), water quality (4.5 average) and flood protection (4.3 average), while they have an acceptability of 3.8 average for biodiversity of water and tourism for both regions.

Summing up, in the B2 scenario there is no difference in vulnerability between the two regions (Lüneburg 3.8 average, Magdeburg 3.8 average). Development in both regions is similar and mostly affects the region positively, which is reflected in the high acceptability to the stakeholders of the changes.