



- ABSTRACT -

Regional appraisal of climate change and the development of climate protection and adaptation strategies in the Schaalsee Biosphere Reservation region



Biosphärenreservat
Schaalsee



This study was promoted by



Ministry
for Economics, Labour and Tourism.



IAG Our particular thanks to go to the Ihlenberg Waste Disposal Company. Thanks to their commitment it is possible for us to put into effect the management for the climate protection projects in the Schaalsee Biosphere Reservation.



HONDA is supporting the German UNESCO Biosphere Reservation on climate protection.

Publication details.

Publisher: Office for the Schaalsee Biosphere Reservation.

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Foreword

The "Madrid Action Plan" (MAP) agreed at the 3rd World Congress of UNESCO Biosphere Reserves held in Madrid in February 2008 describes the currently observable effects of climate change as the most serious and globally significant challenge for all mankind. That is why the MAP assigns the testing and applying of policies for adapting to and mitigating climate change as the most vital task of the UNESCO biosphere reserves in conjunction with other intergovernmental programmes. As a model region for sustainable regional development, the UNESCO Biosphere Reserve Schaalsee therefore wishes to make an active contribution to the task of the UNESCO programme "Man and the Biosphere" by testing sustainable land use and resource management forms for the region.

The aim of the biosphere reserve administration is to integrate the topic of climate protection in the region in all planning and administrative process and actions in the long term and to develop and implement appropriate projects for climate protection and adaptation to climate change.

The "Action Plan for Climate Change" for the regional government of Mecklenburg-West Pomerania was recently revised at state level. Further to that, since November 2007, the effects of climate change have been realised on behalf of the biosphere reserve administration, using the model region of the UNESCO Biosphere Reserve Schaalsee as an example. The initial efforts to develop basic regional principles regarding climate change form a good starting point for the concrete development and implementation of projects relating to climate protection and adaptation to climate change. In order to initiate and implement appropriate projects, financial support from the Federal Agency for Nature Conservation for the research project entitled "Biosphere reser-

ves as model regions for climate protection and adaptation to climate change" was applied for and granted.

The core points of this implementation project are the improvement of regional stakeholder empowerment by means of educational events, targeted expert advice and, if need be, essential round tables with representatives and decisionmakers as well as interest groups in order to carry out model project initiatives that contribute towards climate protection or adaptation to climate change. Together with the already existing regional networks of stakeholders from the economy, agriculture and forestry and interested inhabitants from the region as well as with the involvement of local authorities and in cooperation with educational institutions, the intention is to develop and put to the test concrete private and public projects relating to climate protection or adaptation to climate change. Special attention is also paid to the cooperation, coordination, and optimisation of already existing climaterelvant initiatives and measures. The sphere of activities of the projects focus on the fields of action that are expected to be particularly affected by climate change or which display particularly large potential with regard to climate protection and adaptation to climate change in the region. This includes nature and landscape conservation, farming, the marketing of regional products, innovative projects using alternative uses of energy as well as transport and individual households.

At the same time, the projects for climate protection and adaptation to climate change are linked together in a long-term socioeconomic research project of the University of Greifswald to ascertain social and institutional demands made by adaptation to climate change. These activities are also supported by the business sector. Thus the UNESCO Biosphere Reserve Schaalsee has for several years



Klaus Jarmatz

now been cooperating with Honda Motor Europe (North) GmbH, Fruchtquell Dodow (a fruit juice manufacturer), the Ihlenberger Abfallentsorgungs GmbH (a waste-disposal company) and the German Association for Small and Mediumsized Businesses with regard to this issue. Only rapid and committed action will help us secure our global future and maintain our own means of livelihood in the long run.

Klaus Jarmatz
Director of the Biosphere Reserve
Administration

Introduction

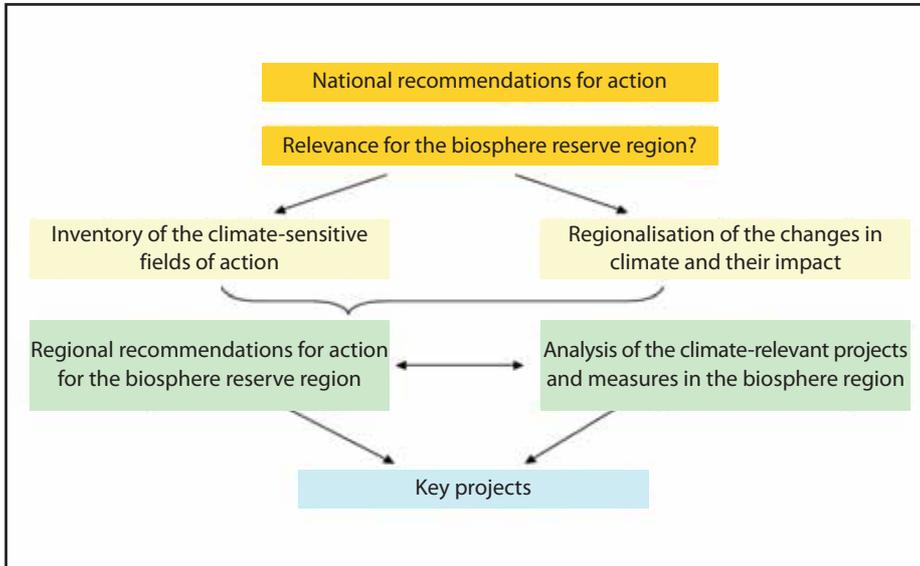
The paper at hand is the summary of a comprehensive study on the "Regional evaluation of climate change and the development of strategies for climate protection and adaptation to climate change in the Biosphere Reserve Schaalsee". This study builds on one carried out at federal state level in which the current climate analyses and climate-relevant recommendations for action were developed¹.

The unedited version of the study is structured as follows:

Thematic block	Basic contents
Audit and appraisal of the situation	Audit regarding the most important climate-sensitive spheres of action <ul style="list-style-type: none"> - Water management - Nature conservation/biodiversity - Development, settlement and energy - Health - Transport/mobility - Forestry - Agriculture - Fishing industry - Tourism
	Regional analysis and evaluation of the climate situation on the basis of existing climate data and Regional Analysis and Evaluation of the Climate Situation and Future Climate Trends for the Biosphere Reserve Region based on the dynamic regional model REMO (MPI of Meteorology, Hamburg) and the statistical model WETTREG (CEC Potsdam GmbH)
Effect of climate change in the biosphere reserve region	Detailed definition of the effects forecast in the countrywide study on the above-mentioned climate-sensitive spheres of action against the background of regional climate change and technical model results.
Regional recommendations for action	Systematic analysis of the nationwide recommendations for action with regard to their relevance for the Schaalsee biosphere reserve region and derivation of Regional recommendations for action for the above-mentioned climate-sensitive spheres of action
	Analysis of the projects and measures in the biosphere reserve region already performed, being implemented and planned with regard to the extent they contribute towards the implementation of the Regional recommendations for action
Identification of key projects	Derivation of key projects on the basis of the Regional recommendations for action for the biosphere reserve region with the <ul style="list-style-type: none"> - integration of already planned measures and project ideas as well as - the development of new project ideas
	Detailed illustration of five selected key projects whose implementation is of paramount importance

¹ Ministry for the Economy, Labour and Tourism (2008) Study based on the state parliament decision of 29.03.2007 ("Climate protection and the consequences of climate change in Mecklenburg-West Pomerania", Drs. 5/352), Schwerin.

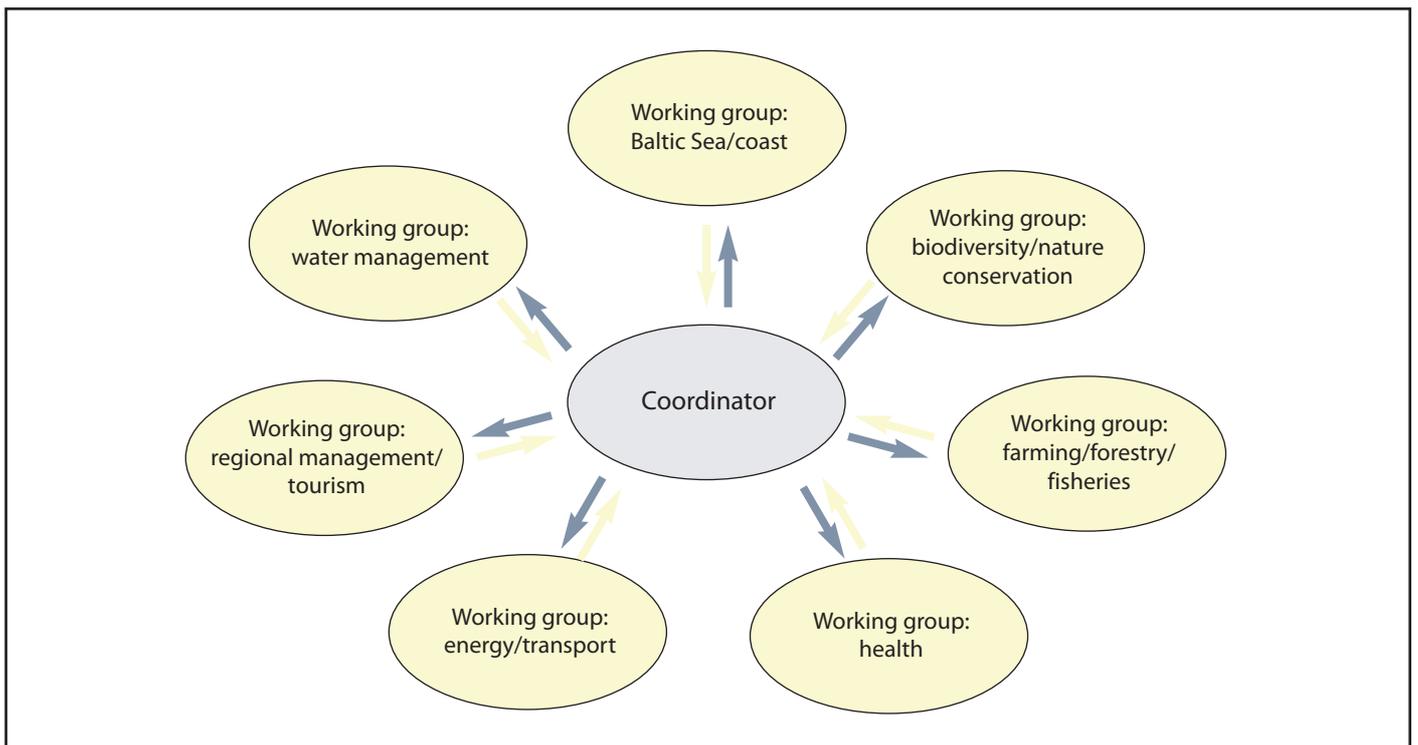
The following diagram illustrates the study's methodological approach.



Methodological approach of the study entitled "Regional Evaluation of Climate Change and the Development of Strategies Relating to Climate Protection and Adaptation to Climate Change in the Schaalsee Biosphere Reserve Region"
 The complete study can be viewed online at: www.schaalsee.de.

Organisational structure of the countrywide project "Climate Protection and the Consequences of Climate Change in Mecklenburg-West Pomerania"

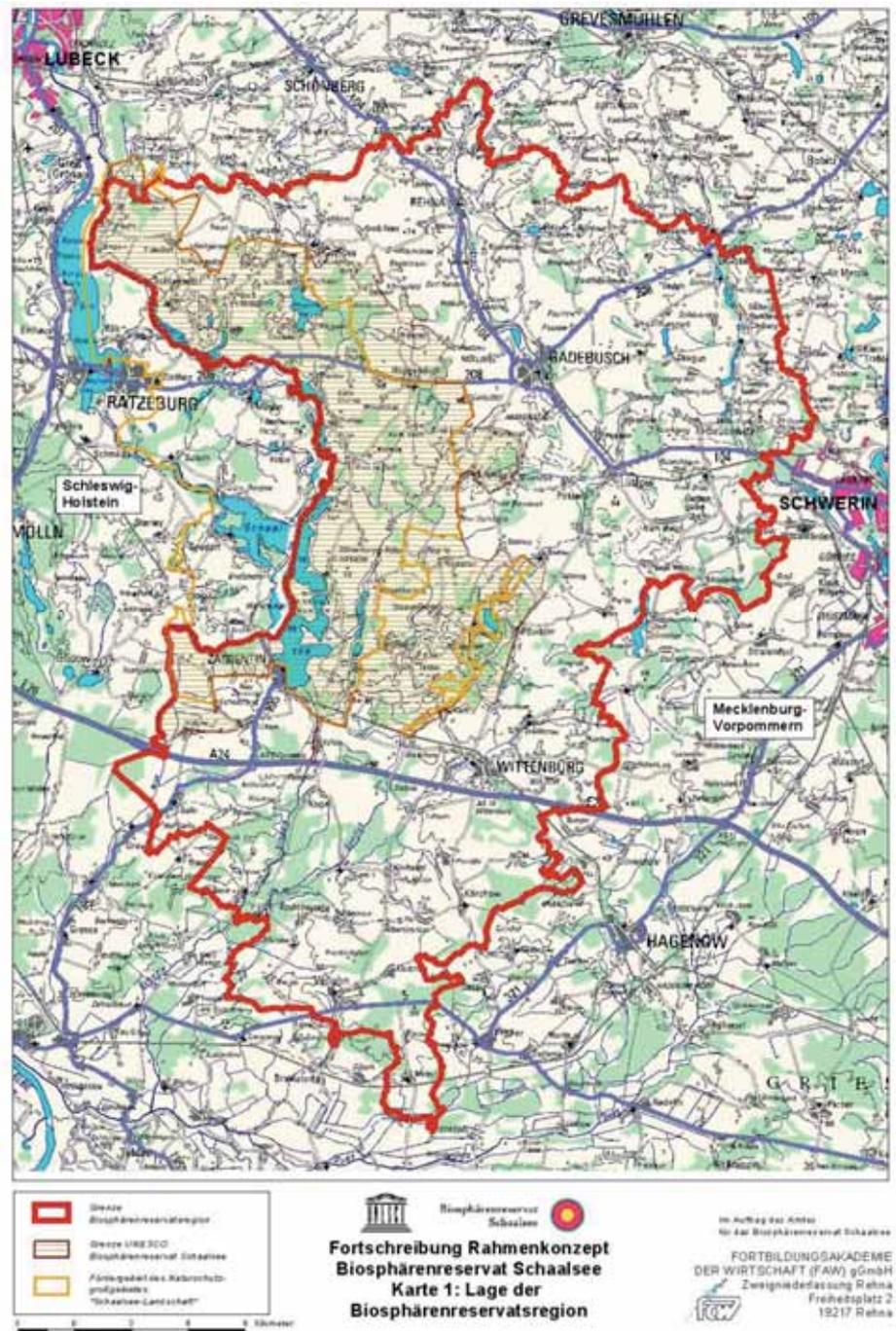
The study can be viewed online at: www.regierung-mv.de



Regional effects of climate change in the Schaalsee biosphere reserve region on climate-sensitive spheres of action

Area subject to investigation

The area subject to investigation in the study is the Schaalsee biosphere reserve region around the part of the Schaalsee Lake situated in Mecklenburg. The UNESCO Biosphere Reserve Schaalsee is a central component of this region. The boundaries of the biosphere reserve region equate to the development region within the scope of the LEADER+ community initiative, apart from the associated area of Lübstorf, and the biosphere reserve region covers a surface area of approx. 1,000 km².



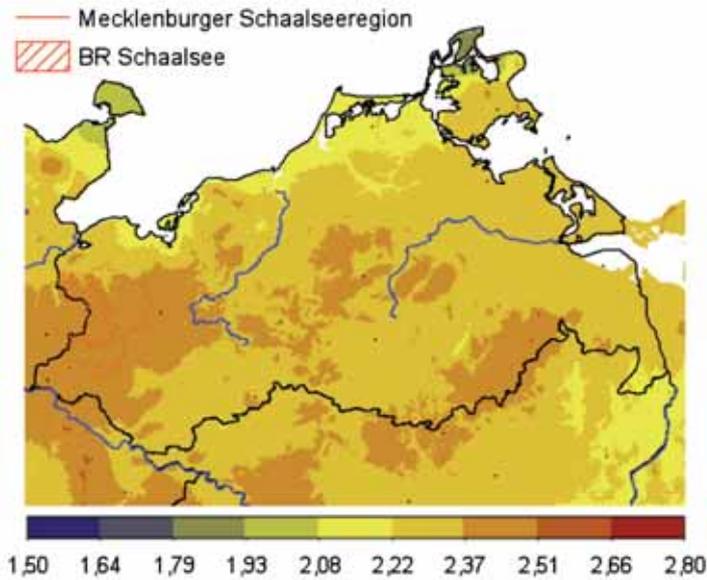
Schaalsee biosphere reserve region

Climate projections

Observations and measurements taken as part of international climate research confirm that climate change is advancing and accelerating. There is a high probability that the greenhouse gases caused by human activity are to blame for the major

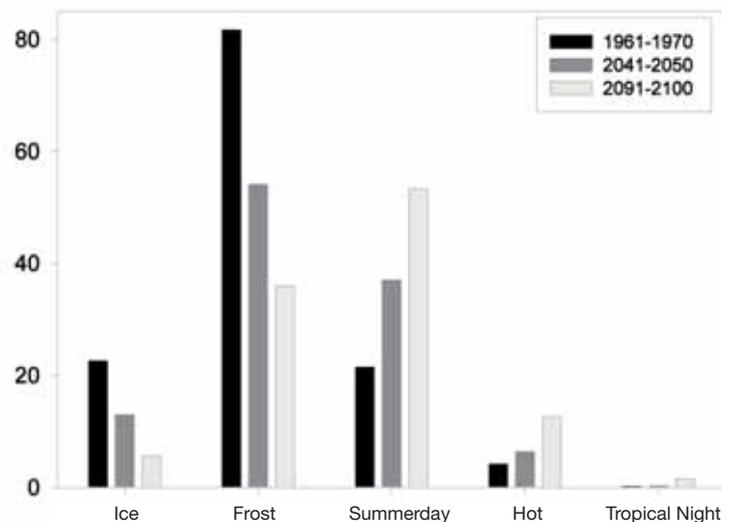
part of the climate change observed. The consequences of climate change are already detectible. According to climate projections², by the year 2100, an above-average increase in the daily mean temperature of 2.37 - 2.51 °C will occur in the

biosphere reserve region. The annual mean temperature will, according to these projections, rise to more than 10°C.



Change in average mean temperature [°C] for the period 2071-2100 compared to the control period 1961-1990 (WETTREG, scenario A1B)

Furthermore, by the year 2100, a decrease in the number of days with ice or frost and a rise in the number of days of summer and heat can be assumed.

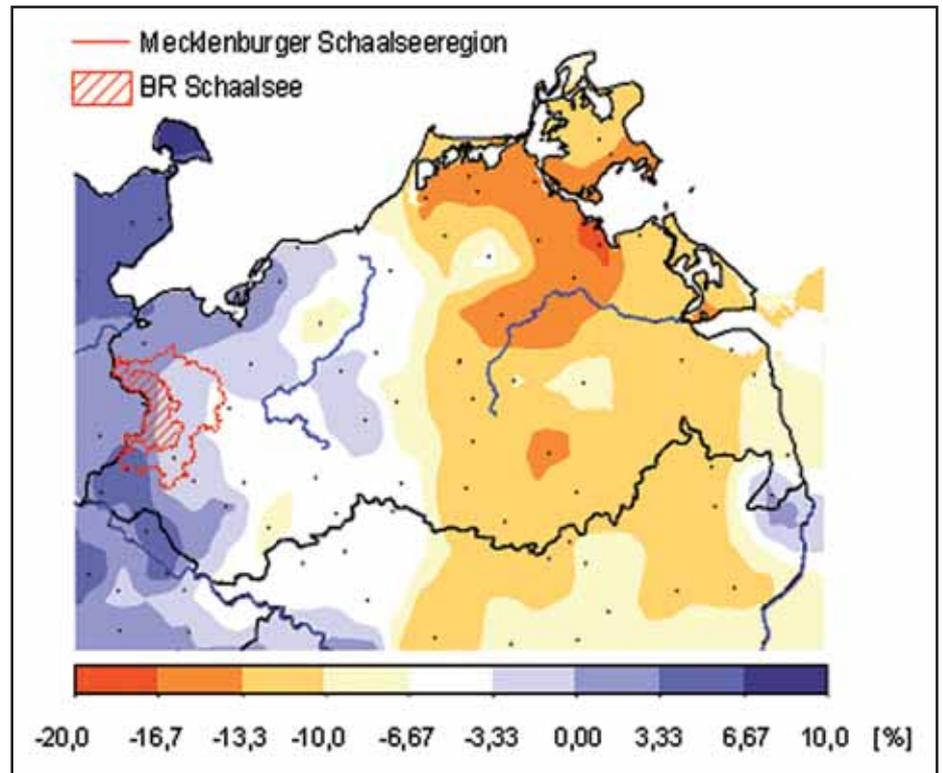


Number of threshold days for the Boizenburg climate station (WETTREG, Scenario A1B).

² For more detailed descriptions of the underlying projections and scenarios cf. Chap. 2.3.2 of the unedited version of the study at www.schaalsee.de

By the end of the century, the annual rainfall amounts in Mecklenburg-West Pomerania will probably only experience slight change (-15% to +10%). The western area of Mecklenburg-West Pomerania — and thus the biosphere reserve region — represents a quite special situation.

Whereas in the major part of the state, and especially in the east of Mecklenburg-West Pomerania, total annual precipitation will wane, the circumstances in the west will only change slightly. In the area subject to investigation, a gradient can be observed according to which an increase in the total annual rainfall of up to 5% in the west and a decrease of up to 5% of the same in the east can be expected. Basically, precipitation in the summer will decrease while an increase in precipitation in the winter is to be expected. A rise in precipitation of more than 5% may occur in the biosphere reserve region.



Change of annual rainfall amounts for the period 2071-2100 compared to the control period 1961-1990 (WETTREG, Scenario A1B)

Reduced rainfall levels in the vegetation period are associated to the reduction in summer rainfall. The West Mecklenburg region (Schwerin climate station) can probably expect a decline not only in the first vegetation period (April, May, June) but also in the second (July, August, September).

As regards the second half of the 21st century, it can be assumed that there will be an increase in characteristic measurement values for heavy rain of 50% for the model region of Schwerin. Thus the biosphere reserve region will be greatly

affected compared to the national average (rise of 15-30%).

For the second half of the 21st century, it can be assumed that there will be 50% increase in the amount of heavy rain measured in the model area of Schwerin. This means that the biosphere reserve region will be affected by more than the national average (increase of 15-30%).

The current situation of most significant climate-sensitive spheres requiring action will be summarised and the fundamental regional effects³ of climate change illustrated below.

³ The data and model results regarding the effects of climate change were taken from various working group reports compiled within the scope of the country study on climate impact research in Mecklenburg-West Pomerania. Against the background of regional climate changes and technical model results, the effects were specified in more detail as far as was possible. Possible impacts are predominantly based on WETTREG projections, which also formed the basis of the major part of the working groups (cf. detailed account in the unedited version of the study, available online at www.schaalsee.de).

Water management

The Schaalsee region is characterised by a multitude of lakes and watercourses. At its heart is the Schaalsee Lake which gives the biosphere reserve its name.

In the past, extensive drainage measures were carried out in the biosphere reserve region to improve the use of agricultural areas. This modified and transformed the water balance. One effect is a rapid acceleration in water runoff in the landscape. The water storage capacity in the landscape is also declining, just like the groundwater recharge and the self-cleaning properties of watercourses.

The construction of the power plant in Farchau has greatly affected the water balance of the Schaalsee. Besides the continuous use of the water in the Schaalsee between October and April, there are annual reductions in the level of the water in the lake by up to 30 cm caused by the water being used for the purpose of energy generation in spring. This has led to a stark decline in wetland areas and to a progressive change in vegetation linked with turf mineralization and nutrient contamination in the Schaalsee Lake. Numerous renaturation projects have been planned or already carried out in the biosphere reserve region in the area of bogs and watercourses in the last few years.



Aerial photograph of the Schaalsee, at the heart of the biosphere reserve and its region

Regional impacts of climate change:

The highest amount of evaporation will take place in the month of May, due to the increase of temperature, instead of in the months of June or July as before. Mean evaporation will increase in the months of March to May from approx. 170 mm to 185 mm (1951-2002 compared to 2051-2100). In the summer months of June to August, evaporation will fall from approx. 240 mm to approx. 175 mm (reduction in summer rainfall). This dominating effect will lead to a reduction in the annual amount of evaporation by 7% to 11% by the year 2050 and by 11% to 20% by the year 2100.

The low summer precipitation amounts and the higher temperatures in autumn will bring about a reduction in mean soil moisture (up to a depth of 90 cm) especially from the summer to the winter months. Only the higher winter precipitation will recharge the groundwater reservoir.

Due to the lack of summer precipitation, one can expect an increase in extreme low water events affecting watercourses and lakes. There will be a risk of extremely low water levels in lakes. Important habitats such as silting up areas and bogs could fall dry in summer and autumn. The ecological run-off may fall short, which could have a negative impact on wetlands near rivers and fed by groundwater.

Furthermore, problems with meeting the water demands caused by farming may arise. Due to the increase in heavy rainfall, especially in the second half of the 21st century, an increased risk of extreme high water is to be expected. This will affect the number of occurrences as well as the duration of these events.

Nature conservation and biodiversity

Due to the structural diversity and coherent state of the Schaalsee landscape and its many lakes, there is a whole host of high-quality varieties of biotopes and habitats. Thus the region has near-natural forests with a high proportion of old growth, intact bogs, undisturbed lakes of various trophic levels, small bodies of water, watercourses, dry habitats, damp lowlands, extensively used grassland areas as well as various stages of succession. The lakes and their lowland areas are embedded in a hilly terminal and ground moraine landscape that crosses over into level sands in the southern part of the biosphere reserve. The moraine landscape exhibits a huge wealth of small-scale landscape structures that are scattered throughout the agricultural landscape and that represent, in part, notable evidence of a cultural landscape shaped by agriculture, e.g. hedgerow systems (hedge banks and lanes), lots of field shrubbery, old individual trees, tree rows and avenues as well as orchards and so-called "Bauernwälder", which were forests used by farmers. Thanks to the high water quality and water depth of the Schaalsee Lake, the macroclimate transitional zone (overlap-

ping area of continental and Atlantic climatic influences) and the fact that the former border region remained undisturbed for decades, a valuable species-rich fauna and flora was successfully preserved. In the Schaalsee Lake, the only autochthonous occurrence is the common whitefish (*Coregonus lavaretus*), which, just like the vendace (*Coregonus albula*) and the relict amphipod *Pallasea quadrispinosa*, is regarded as a glacial relict. The presence of otters and beavers has also been proven. Locally, there are large stocks of tree frogs and fire-bellied toads. Endangered reptiles present in the area include grass snakes and adders. The Schaalsee area is of special significance as a breeding, moulting and resting ground for water birds. Due to its great significance to bird life, the major part of the area has been designated an EU bird sanctuary.

The conservation of near-natural bogs and the renaturation of bogs often affected by drainage or peat extraction have great significance in the bog-rich biosphere reserve region. This is where one centre of the spread of bog in Mecklenburg-West Pomerania is.



Typical avenue



Ruddy darter



Sundew, a botanical rarity, a typical bogland plant on the renaturised Neuendorfer bog

Regional impacts of climate change:

The direct impacts of climate change (rise in temperature, change in rainfall etc.) will generate quite significant pressure on species and ecosystems to adapt to them. The rise in temperature may lead to a shift in climatic zones ranging between 200-1200 km by the year 2100. Many species will not be able to respond appropriately to migration velocities of 20-200 km per 100 years.

The latest model calculations assume a species loss due to climate change of about 10-30 % of the current species population in Central Europe. Species with a narrow ecological tolerance range will be particularly affected by this. Moisture-loving species will also be affected. Due to the migration of fauna and flora from south to north, new biological communities may be formed. Even so-called neobiota may be fostered in the course of climate change. Furthermore, changes in the bird migration may be assumed.

Reduced summer precipitation will, among other things, negatively impact on the hydrological balance of the boglands. Besides the water stress suffered by aquatic animals, a fall in the groundwater level will also lead to the mineralization of the body of peat. This could lead to bogs increasingly becoming CO₂ - und N₂O emission sources. There will be a positive feedback reaction, i.e. the emissions will in turn increase the climatic impacts.

Increased temperatures and more frequent extreme weather events (e.g. long periods of drought) would reduce water availability in the kettle holes and drastically change the water management cycles experienced throughout the year to date. Besides the potential species loss of specialised aquatic creatures, there may be a functional loss of the kettle holes as "stepping stone biotopes".

Development, settlement and energy



The solar pyramid at the PAHLHUUS feeds solar energy into the grid and is used for environmental educational events.

With a population density of 47 inhabitants/km², the biosphere reserve region has one of the lowest population densities in the West Mecklenburg region.

The reasons for a continuing decline in population today are, above all, the low birth rate and the increasing percentage of old people in the region.

There are several biogas plants in the biosphere reserve region. Furthermore,

there are numerous solar thermal and photovoltaic plants. There are a few larger photovoltaic plants on private (agricultural) or public roofs. The Regional School of Rehna is a model example. The biosphere reserve itself is a wind power exclusion zone. The wind power plants in Löwitz, Köchelstorf, Klein Welzin, Gottmannsförde and Groß Trebbow are in the biosphere reserve region.

Regional impacts of climate change:

Climate change will lead to a decline in heating demand due to rising temperatures. At the same time, there will be a rising need for more air-conditioning in the summer. This could mean an overall rise in energy consumption. Air-conditioning will cause additional costs due to increased energy consumption (and against the background of the trend in rising energy prices).

In the solar thermal area, the main focal point could shift from heating and hot water generation to hot water generation due to the trend of a fall in the demand for heating. The power output demand of heating technology that will fall as temperatures rise could mean an opportunity for making more use of solar heat. With regard to statements on the change in future energy provision of solar thermal plants, global radiation has to be seen as the most significant climate variable. Particularly in the summer months of June, July and August, an extended period of sunshine may be possible (higher temperatures, less rainfall, less cloud cover). This will offer additional opportunities for the use of solar thermal plants. The temperature rise in the summer of up to 3°C by 2100 (meteorolog. summer) and the increased frequency of extreme weather events will lead to the need for buildings to adapt to such changes (among other things the demands regarding building materials and protection against the sun).

Increased temperatures and the extended vegetation period will principally favour the growth of biomass and thus energy production from renewable resources. This, however, will be opposed by the reduced amount of precipitation during the vegetation period. Farming on sandy soils with a low water storage capacity will be particularly affected by this.

Forestry

The composition of tree species in the districts of the biosphere reserve region varies greatly. On the whole, at 63 %, the proportion of deciduous trees is significantly higher than that of coniferous trees at 37 %.

In all districts, the predominant part (80-90%) of the forest can be allocated to age categories I to IV (0-80 years old). What is particularly noticeable is the high proportion of trees over 100 years old in the district of Voitendorf (about 20%).

Within the existing, in part large-scale, forest areas, extended forest mires with their typical formation are an outstanding characteristic. The former internal border restricted forest use, especially in the Mecklenburg part, so that structures similar to primeval forests were, in part, allowed to develop in the area of the former East-West German border. The forest vegetation of the biosphere reserve features numerous notable stocks worthy of conservation. The forests directly bordering the banks of the lakes in particular



Near-natural forests covering a steep slope on Kampenwerder Island: when forests are allowed to mature, they become valuable CO₂ sinks

are, in many cases, characterised by being in a very near-natural state. The lakeside forests of the Schaalsee remained untouched for a long time thanks to their location so close to the border. One example

are the moss-rich forests covering steep slopes on the west-facing escarpments on Kampenwerder island that display multi-trunked beech trees that were several hundred years old.

Regional impacts of climate change:

With the rise in temperature, the vegetation period, and thus also the growth phase, will be extended. Trees will principally react to that with increased biomass growth. In the event of less precipitation during the vegetation period, the rise in temperature may, however, lead to growth inhibition as well as localised drought damage. Due to the extended vegetation period, the risk of damage from early and late frosts will also increase.

Higher temperatures will increase the mineralization of organic substances in the soil. In certain location- and stock-specific circumstances, the leaching of nitrate via the soil seepage water is to be expected (groundwater contamination). This goes hand in hand with acidification pulses and the loss of nutrients.

Many harmful insects are thermophilic and will benefit from the rise in temperature, along with bacteria and fungi. There will also be an additional risk of new harmful insects migrating to the area from the south. This will increase the risk of calamities, especially with regard to the trees already under stress from the drought (reduction of summer precipitation).

The summer drought will lead to an increased drying out of the forest soil and mulch. This will cause, among other things, an increased risk of forest fires. Summer droughts will also lead to growth inhibition and reduce the vitality and thus the resistance of the trees to a multitude of harmful factors. Several consecutive years of drought will have a particularly adverse effect.

With the rise in extreme weather events, an increased risk of windfall (blowdown) can be assumed. Shallow-rooted trees in particular (e.g. spruces), sited near groundwater, are at risk if long-lasting flooding occurs due to the increase in winter precipitation. Storm damage often brings with it insect calamities (e.g. bark beetle infestations).

A shift in the range of species to xerophilic or thermophilic ones is likely (species of oak, pine, rowan etc.).

Agriculture



The cultural landscape in the biosphere reserve region has been marked by agricultural use.

In the biosphere reserve region, agriculture covers 72 % of the surface. Due to the mainly high quality of the soil (soil quality > 50 in the area of the terminal moraine), the region has large agricultural potential for the cultivation of high-quality food and fodder as well as for the growing of biofuel plants.

A total of 88 farmers work in the biosphere reserve region; for 21 of them it is their regular source of income and for 35 of them it is a second source of income. The number of agricultural enter-

prises has declined in the last few years. Individual agricultural enterprises in the form of family-run farming operations have been particularly affected. The agricultural structure is dominated by major agricultural operations with an area of more than 500 hectares.

The contractually set-aside areas in the Schaalsee biosphere reserve cover a total of 1,164.42 hectares (71 contracts). Eight enterprises covering about 6% of the area are run according to ecological criteria.

Regional impacts of climate change:

Increasing temperatures and atmospheric CO₂ concentrations will have, as a rule, conflicting impacts on crop yields. In combination, the two factors will, therefore, have relatively little influence. In the eastern area of the area subject to investigation⁴, where the highest decline in summer rainfall (up to 30 %) is to be expected, falls in crop yields are to be expected. On areas in the biosphere reserve region with well-watered soils as well as in the western area subject to investigation with its low declines in summer precipitation, on the other hand, increases in cereal crop yields in the next 2-3 decades will be possible. Yield stability, however, cannot be guaranteed in the long term due to the increased incidence of extreme weather events (droughts, storms). Yield variability will, in general, increase.

Due to the temperature rise, there will be a prolongation of the vegetation period. On the one hand, combined with the favourable water supply at the beginning of the vegetation period, this will represent an opportunity. On the other hand, there will be an increased risk of late frosts. The shifting of the agricultural zones by 200-300 km for every degree Celsius of warming will offer opportunities in market gardening. It might be worth planting thermophilic plant species make efficient use of water such as soy, millet, sunflowers, maize and durum wheat.

The increase in winter precipitation will lead to an increased risk of puddling and soil compaction. In the eastern part of the area subject to investigation, increased expenditure of materials and energy to work the soil in the summer is to be expected. The risk of soil erosion will increase in the future. On the one hand, this will be due to drier soils in the summer and, on the other, to increasing rainfall in winter and the more frequent heavy rainfall events. Linked to this, is a loss of humus and nutrients (displacement or leaching of macro-nutrients, entry into sensitive ecosystems).

With regard to grassland management, increasing winter rainfall and a rise in temperature could increase yields and quality on mineral-rich sites. In contrast, the possible risk of drought in the summer will represent a risk to crop yields. The fen sites subject to water regulation will be one exception to this. Long-lasting groundwater deficit will lead to an increased release of CO₂ and to subsidence in marshy ground.

⁴ The division of the area subject to investigation into an eastern and western part is just a rough indication. More precise spatial delimitation is not possible as the climate changes are a matter of gradients.

Fishing industry

The lakes in the Schaalsee biosphere reserve are managed by a total of six professional fisheries. Furthermore, there are angling clubs in Schlagsdorf, Groß Thuro, Dutzow/Kneese, Zarrentin and Neuenkirchen. Leisure anglers predominantly use the bodies of water between May and September and mainly at the weekends. The most popular fish species for anglers are the eel, pike and perch. Seen from an economic viewpoint, five species (the eel, vendace, pike, European

perch and broad whitefish) make up 95% of the total revenue generated. According to the reports on catches by the Schaalsee anglers in Mecklenburg, catches in the years from 1994-2001 are down by about 50% compared to those of the 1980s. The fall in catches is particularly pronounced with eels (approx. 2/3) and pike (approx. 20%). Declines in catches have also been recorded with the broad whitefish and, less markedly, with the European perch.



Fisherman at Schaalsee lake

Regional impacts of climate change:

Psychrophilic species such as brown trout that are dependent on cool, oxygen-rich and flowing water as well as gravely to sandy spawning grounds may be negatively impacted by climate change due to the higher water temperatures and the associated drop in oxygen content of flowing bodies of water. Trout areas in the lowlands will be particularly adversely affected by climate change as the fish will not be able to switch to higher and thus cooler regions.

The various fish species of the perch regions, on the other hand, will also be able to tolerate higher water temperatures and lower oxygen content levels. Climate-related rises in temperature of up to the region of 22-28 °C will accelerate the development of the various food organisms and fish growth. The immigration of new species of fish as well as other species of plants and animals will be very likely in these regions. Long periods of heat will, however, also lead to anoxia in these watercourses and will foster fish diseases and fish mortality. Eels will be particularly affected. Higher temperatures in the winter months will probably also prevent bodies of flowing waters cooling off and being covered by ice. Predators will thus have year-round access to the fish population.

The water in shallow lakes is continually being mixed and thus replenished with oxygen. Warming will increase water productivity. The growth in fish stocks will increase as long as water temperatures do not exceed 30 °C over a long period of time. In deep lakes, such as the Schaalsee, a stable layering dominates in the summer months, in which the upper epilimnion, the central metalimnion (also known as the thermocline) and the lower hypolimnion along with their typical temperature and oxygen characteristics can be discerned. Anoxia will prevail beneath the thermocline. If the temperature of the epilimnion will no longer fall below 8°C due to rising temperatures caused by climate change, the complete intermixing of the water in the lakes will be limited. Thus less oxygen will penetrate the deeper layers that are already oxygen-depleted. In addition, the transport of nutrients (caused by the decomposition of sunken biomass) from the deep waters to above will no longer be possible. According to this, too much limnological change in the deep lakes with impacts on the chemism may result. The whitefish in the oligotrophic to mesotrophic lakes would probably be particularly affected by this. It can be assumed that burbot would also be negatively impacted. Due to a lack of ice cover in winter, predators would also have year-round access to the fish population.

However, positive developments can also be expected as the rise in temperature will increase primary plant production as well as secondary (animal) production and also the final production of fish within the food pyramid. The temperature rise will probably lead to increased productivity in shallow as well as deep lakes. Populations of individual thermophilic freshwater species such as carp and catfish may be boosted by the rise in temperature. Only a few fish species, such as burbot and whitefish, will lose the conditions they require to reproduce.

Tourism

The scenic characteristics of the biosphere reserve region attract a lot of tourists and offer such tourists a very diverse landscape. Furthermore, the region is characterised by unique views that cannot be found elsewhere.

The various tourist information facilities in the region constitute an important element of the visitor guidance and control system. This includes the PAHLHUUS (information and administrative centre in the biosphere reserve) in Zarrentin and the GRENZHUS (museum on life at the inner-German border) in Schlagsdorf, which, as central venues, perform an important distribution function. Besides them, there are other tourist information offices with various emphases. There is a lot of regional as well as specific, topic-related information material for the biosphere region (maps, leaflets, brochures, flyers, etc.).



Biosphere reserves aspire to develop ecologically sound tourism.

Regional impacts of climate change:

Due to higher summer temperatures, lower summer rainfall levels, higher air and water temperatures, water-rich areas such as the biosphere reserve region will become more attractive for tourists. Because of climate-related temperature rises in the southern European holiday regions, summer holiday destinations may shift towards northern, cooler and water-rich areas (e.g. biosphere reserve region).

However, due to water levels falling shorter than usual as a result of increased occurrences of low water events, tourism (water sports) may be negatively impacted. Deterioration in water quality would also have negative consequences for water-bound leisure activities, especially because of a possible increase in micro-organisms (e.g. blue algae) in the summer.

A further possible and negative impact will be the increase of extreme weather events. Besides restricting leisure activities, this could lead to temporary slumps in the tourism industry.

The extent to which climate-related changes in the landscape will affect tourism is speculative. The loss of avenues typical of the region (drought events) or an increased incidence of neophytes (monodominant stocks) could also have a negative impact in the long term. Likewise, in the course of climate change, altering growing practices in agriculture and forestry could affect the landscape.

Due to the increased cooling requirement in the summer (air-conditioning) in facilities used by the public or tourists, one can expect energy demand to rise. This could result in higher accommodation prices.

Transport/mobility

The region can be accessed nationwide via motorways A 20 and A 24 and the main roads B 104, B 208 and B 5.

However, the region is not well served by rail. It is currently not possible to reactivate the Zarrentin-Ratzeburg track as a few sections have already been disused or dismantled for more than 30 years. Trains stop in Boizenburg, Büchen, Mölln, Ratzeburg, Rehna, Gadebusch, Lützwitz, and Hagenow. Some of these train stations are linked to the bus network.

Local public transport is mainly geared towards school and commuter traffic. The bus and rail connections on offer are not

very suitable for tourists as a journey to the biosphere reserve region can only be done with lots of changes and long travel times.

The Hagenow-Zarrentin railway section ("old emperor's section") was brought back to life with the "Schaalsee Express" in April 2008. A historical railbus from the Westmecklenburgische Eisenbahngesellschaft (West Mecklenburg railway company - Wemeg) dating back to 1960 runs on the section between April and November, thus adding to the tourist attractions on offer.

The proximity to the metropolitan area of

Hamburg and Lübeck results in daily commuter traffic between the region and Schleswig-Holstein, Hamburg and Lower Saxony.



The Schaalsee Express is endeavouring to revitalise the old emperor's stretch of track between Hagenow and Zarrentin on the banks of the Schaalsee Lake. Against the background of the efforts relating to climate protection, public transport will once more gain in importance.

Regional impacts of climate change:

The change in transport structure and service will greatly depend on the availability and price of crude oil. The development of alternative fuels (e.g. biogas) and technologies (e.g. fuel cells) will gain in importance, reduce dependence on crude oil in the long term and thus influence the transport structure and service. The trend cannot be predicted at present.

Due to the projected increase in extreme weather events, negative impacts on the flow of traffic and traffic safety can be expected, e.g. due to storm damage to streets and rails.

On the other hand, winter restrictions due to frost and ice will decrease in the future.

Regional recommendations for action

The climate-relevant recommendations for action⁵ developed at Federal state level have been systematically checked with regard to their relevance for the biosphere reserve region and then applied to it. For this purpose, the state-wide recommendations for action have been reviewed in a two-phase process. In the first phase, all recommendations for action that are out of the question due to the geographical situation of the area subject to investigation were filtered out (e.g. coastal

protection). In parts, amendments were made resulting from the regional considerations and peculiarities. In a second phase, every recommendation for action was assessed with regard to its relevance for the biosphere reserve region. Furthermore, projects and measures that have already been carried out, are in the process of being implemented or are planned were analysed to see to what extent they contribute towards the implementation of the regional recommendations for action.

The underlying methodology and comprehensive presentation of the recommendations for action is contained in detail in Chapter 4 of the unedited version of this study (available online at www.schaalsee.de).

As an example, in the following, up to three recommendations for action will be briefly outlined for every sphere of action for which an urgent need for action in the Schaalsee biosphere reserve region has been determined.

Water management

Increase in water use efficiency in the agricultural sector

Rationale

In irrigation management, a rise in additional water demand of a magnitude of 40l/m² must be assumed. With 72% of the land in the biosphere reserve region being used for farming, a huge demand for water will arise. Using aquifers or surface water to satisfy the water demand would have extremely adverse effects on the numerous wetlands, bogs, lakes and rivers in the biosphere reserve region. The development and use of novel, water-saving technology is, therefore, of central significance to the region.

Regional recommendations for action

- Selection of suitable agricultural enterprises for trials
 - of novel, water-saving technology (soil cultivation, nutrient application, on-surface and sub-surface drip irrigation systems)
 - of cultivated fruit varieties with high water use efficiency.
- Expansion of changing from drinking water to industrial water supply in allotments

Stakeholders

Farmers, research institutes, faculties of agronomy, State Research Centre for Agriculture and Fishery (LFA), allotment associations

⁵ Ministry for the Economy, Labour and Tourism (2008) "Das Klima bewegt uns" ("The Climate Affects Us"). Climate change in Mecklenburg-West Pomerania - initial analyses and recommendations for action. Unpublished report, dated 06.05.08, Schwerin.

Further and more in-depth investigations regarding the individual water supply elements

Rationale

On the basis of existing modelling results, statements regarding the biosphere reserve region can only be made to a limited extent. Furthermore, in-depth analyses regarding the various water regime elements such as evaporation, soil moisture, groundwater recharge, the development of run-offs etc. will be carried out in order to get concrete insights into the situation in the drainage area of the biosphere reserve region.

Regional recommendations for action

Performance of more in-depth studies regarding the regional water regime e.g. as part of degree dissertations and doctoral theses (among them the universities of Rostock and Greifswald).

Stakeholders

Research institutes, AfBR Schaalsee (Office for the Schaalsee Biosphere Reserve), StAUN Schwerin (State Office for the Environment and Nature, Schwerin)

Improvement of landscape water supply/restoration of bogs

Rationale

Due to water management drainage measures in the past, up to the present day, there has been development potential to improve the landscape water regime. Owing to the geographic circumstances and the expected fall in summer precipitation of up to 30%, implementation of these recommendations for action takes on huge significance.

The safeguarding and restoration of natural water conditions in bog areas in particular should be a primary objective due to the special significance of natural, waterlogged bogs to the landscape water regime, water protection, species and biotope conservation and climate protection. By restoring natural or near-natural water conditions and restoring the function of bog areas as natural CO₂ sinks in the long term, a contribution towards a marked reduction in the emissions of climate-relevant gases from drained bogs can be achieved.

Regional recommendations for action

- Continuous improvement of the landscape water regime in areas affected by drainage, preferably in highly drained, degraded bogs, and safeguarding retention areas in wet lowlands (run-off delay by renaturing water courses)
- Implementation of planned renaturation and bog restoration measures as part of the "Lebensader Schilde" project ("River Schilde Lifeline") as well as the LIFE project "Feuchtlebensraummanagement" ("Wetland Habitat Management")

Stakeholders

AfBR Schaalsee, subordinate nature conservation authorities, "Schaalsee-Landschaft" ("Schaalsee Landscape") special purpose association

Renaturation of the Neuendorf bog. Degenerated bogs change from being CO₂ sinks to "CO₂ emitters". Renaturation can reverse this process.



A bog has to be "wet": excursion to the renaturalised Neuendorf bog

Nature conservation and biodiversity



Environmental education and PR work are already writ large at the Schaalsee site

The "stream sponsors" of the river Schilde planting trees along "their" river.

Mainstreaming, PR work and educating schoolchildren on the topic of climate protection

Rationale

Climate protection and nature conservation issues are increasingly being taken up in political discussions, particularly at regional and community level. Climate concerns can thus be anchored in an interdisciplinary manner and actually be taken into consideration in future decision-making and planning processes.

Regional recommendations for action

- Organisation and implementation of events in order to explain the changes in climate and their associated effects to regional and local politicians. Such events should also be used to pass on to regional and local politicians experience and know-how with regard to climate protection and adaptation strategies.
- "Climate change" as an issue and subject of discussion at meetings of the regional advisory council (board of trustees of the Schaalsee biosphere reserve)
- Promotion of climate-relevant environmental education by creation of specific activities
- As part of the excursions offered, visitors to the biosphere reserve should be sensitised with regard to the issue of climate. The aim would be to point out to them the measures already carried out and planned in the biosphere reserve region and to increase their understanding of the process.

Stakeholders

Board of trustees for the Schaalsee biosphere reserve, rangers and environmental educationalists of the AfBR Schaalsee, schools in the region, regional nature conservation bodies

In future, activities will be more strongly directed toward sensitising people with regard to the topic of climate protection and adaptation to the consequences of climate change.

Schoolchildren in the Zarrentin calcareous fen



Balance of minimisation and adaptation strategies

Rationale

The regional balance of greenhouse gas emissions plays a significant role in recording ecosystem-based sink and storage functions e.g. of bogs and forests. By means of this quantification, the contribution towards climate protection can be clarified using an objective criterion.

Regional recommendations for action

Balance of regional greenhouse gas emissions

Stakeholders

Institut für Dauerhaft Umweltgerechte Entwicklung von Naturräumen der Erde (DUENE e.V). (scientific non-profit, non-governmental organization institute for the sustainable development of landscapes of the earth), University of Greifswald

Creation and interlinking of migration and/or dispersal corridors

Rationale

With its large structural diversity, coherent landscape and numerous near-natural watercourses (e.g. Schaale), the biosphere reserve region has a lot of migration and/or dispersal corridors for populations and species. In particular, it is the fact that for decades the area was not fragmented by, for example, roads owing to its former border location that has had such a decisive influence ("green belt" as a wildlife corridor of national importance). Thus one important prerequisite for increased south-north migration of animal and plant species in the future is already in place.

The Schaalsee Lake and the north-south flowing watercourses in the biosphere reserve region in particular are important biotope corridors. They are partly a matter of interconnected spaces of European-wide significance (including Schaalsee Lake and the rivers Schaale, Schilde, Maurine and Radegast).

Regional recommendations for action

The creation and interlinking of migration and dispersal corridors must be pursued as a priority in the biosphere reserve region. Measures that serve to maintain or improve the biotope-linking structures running from north to south should be implemented as a matter of preference. In particular, they are

- the Wakenitz lowlands
- the lakes, forest and bogs north of the Schaalsee up to the eastern bank of the Great Ratzeburger Lake
- the Stepenitz, Radegast and Maurine valley
- the Schaalsee with surrounding forests and bogs
- the Boize, Schaale and Schilde rivers
- the "bogland gutter from Klein Salitz to Neunekirchener Lake"
- the former strips of the border region

Stakeholders

Regional nature conservation authorities, "Schaalsee-Landschaft" (Schaalsee landscape) special purpose association

The otter is a typical migratory species. The Schaale is currently the westernmost water-course in Mecklenburg-West Pomerania that is in constant use by otters.



The connectivity of watercourses for lampreys and invertebrates is an important prerequisite to create natural exploratory and dispersal corridors: new fish ladder on the Schilde river near Woez.

Development, settlement, energy

There are already numerous photovoltaic systems on private houses in the region.

Energy-efficient development of building designs and building services engineering/ financial support of PR work and education

Rationale

The temperature rise in summer and the increased frequency of extreme weather events will lead to buildings having to adapt to such circumstances. By means of improved building design and building services engineering, energy demand and the associated CO₂ emissions can be greatly reduced.

Climate protection can also be quickly and efficiently implemented in the fields of domestic heating and the insulation of buildings. Many state funding schemes make the modernisation of heating systems and the improvement of energy efficiency in the building sector additionally attractive.

Additionally, in the tourist sector, there are huge potentials when it comes to satisfying energy demand by means of regenerative energy sources. As the main tourist season falls in the summer months, a significant part of the hot water demand could, for example, be met by using solar thermal systems.

The lack of the use of novel building designs and technology is usually due to the ignorance and uncertainty of the general public. Since the acceptance of such events has been very great in the past, PR work should be intensified.

Regional recommendations for action

- Organisation of information events for building owners to adapt existing building stock to the future ambient conditions (e.g. more protection against the sun, heating, cooling and ventilation systems).
- Organisation of information events for building owners to promote demand for existing innovative technology and designs. This includes:
 - The use of regenerative energy sources (photovoltaic modules, solar heat, geothermal energy, heat pumps, wood-chip-fired or pellet-fired heating systems, etc.).
 - Construction of passive houses, low-energy houses
 - Possible funding to use regenerative energy resources
 - Energy-saving opportunities in the home
- Creation of specific facilities for a permanent information display on the above-mentioned topics.
- Announcement of energy-saving competition for schools
- Development of modified street lighting designs for saving energy

Stakeholders

Solarzentrum M-V Wietow (Mecklenburg-West Pomerania solar centre), municipalities, Energie-Umwelt-Beratung e.V. (Energy-Environment-Advice), AfBR Schaalsee

It need not always be maize!

A diversified cropping structure is a decisive criterion for the sustainable production of energy plants.



Development of the sustainable energy use of biomass

Rationale

The implementation of these recommendations for action is of central significance for a successful move towards obtaining a sustainable energy supply.

The eleven biogas plants in the region already make a contribution towards this.

Regional recommendations for action

- Organisation of information events for the citizens of the region, e.g.
 - regarding funding possibilities in the field of regenerative energy sources
 - Development of a regional energy network
 - Development of value-added chains/product lines
- Financial support of the re-use of waste heat from biogas plants in the region, combined heat and power
- Regional energy concept, biomass production according to sustainability criteria (priority areas and exclusion zones for biomass production), development of interlinking structures
- Networking with other energy regions to benefit from an exchange of experiences

Stakeholders

Local authorities, Energie-Umwelt-Beratung e.V., Solarzentrum M-V Wietow , regional planning departments of the administrative districts

Forestry

Forest transformation
<p>Rationale</p> <p>Forest transformation towards stocks with a high level of genetic and species diversity is a central adaptation strategy in the field of forestry since at present only inadequate estimates can be made as to how individual tree species will respond to climate change. Furthermore, stable and complexly structured mixed stands possess the highest amount of resistance towards the climate change expected.</p>
<p>Regional recommendations for action</p> <ul style="list-style-type: none"> – Promotion of complexly structured and species-rich mixed stands through forest transformation – At least small-site interruption of large-scale pure pine stands – Organisation of information events for owners of private forests: <ul style="list-style-type: none"> - Explanation of the dangers of planting lots of fast-growing coniferous trees - Explanation of the benefits of promoting complexly structured and species-rich mixed stands - Explanation of funding possibilities
<p>Stakeholders</p> <p>District foresters, owners of private forests</p>

Management of wet forests
<p>Rationale</p> <p>Due to increasing winter temperatures (rise in monthly mean temperature in January and February of about 4°C by 2100), the waterlogged soil substrate will freeze less frequently. This will hinder or prevent standard wet forest management procedures as vehicles will no longer be able to drive over soil substrate as an essential part of carrying out management work. That is why alternative management methods have to be developed in good time.</p>
<p>Regional recommendations for action</p> <ul style="list-style-type: none"> – Selection of suitable wet forests to trial new strategies – Contacting the Forstamt Friedrichsmoor (Friedrichsmoor Forestry Office) for an exchange of experiences with regard to new cable crane procedures
<p>Stakeholders</p> <p>State forest institute, Forstamt Friedrichsmoor (Friedrichsmoor Forestry Office), Eberswalde University of Applied Sciences, district foresters</p>



The promotion of stable and complexly structured mixed stands as well as natural rejuvenation is increasingly gaining in significance thanks to climate change.

Agriculture

Crop rotation, soil cultivation, soil and erosion protection

Rationale

As farming takes up the largest amount of area in the biosphere reserve region (72%) and drastic climate changes can be expected in the region (reduction in summer precipitation, risk of erosion due to heavy rainfall events, increase in winter precipitation and thus flooding), adaptation strategies are indispensable. Particular attention has to be paid to erosion protection as the soils in the biosphere reserve region are particularly at risk due to their geological formation and the topographic features.

Regional recommendations for action

- Organisation and the carrying out of information events for farmers in the region on topics such as altered crop rotation, risks of late frosts, use of water-saving and erosion-reducing soil cultivation methods, erosion protection and altered fertilisation times
- Ascertainment of fields at particular risk from erosion by superimposing soil erosion maps over current agricultural land use in the region
- Selection of suitable farming operations to trial novel strategies
 - Farming operations with fields near sensitive ecosystems (e.g. bodies of water, wetland habitats) and at high risk of erosion should give trials of soil protection measures top priority.
 - Farming operations with fields on outwash plain areas in the biosphere reserve region should give top priority to testing novel fertilisation systems and deadlines.
 - Selected farming operations could use strategies to safeguard crops, bring forward harvests as well as reduce the risks posed by late frosts.
 - Trial of water-saving and erosion-reducing soil cultivation
- Contacting forestry facilities and institutions for scientific advice and support when trying out novel farming strategies

Stakeholders

Farmers, farmers' association, Amt für Landwirtschaft (Office for Farming), Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz M-V (Ministry for Farming, the Environment and Consumer Protection in Mecklenburg-West Pomerania), agronomic research facilities and institutes (e.g. agronomic faculties, Landesforschungsanstalt für Landwirtschaft und Fischerei M-V (State research institute for farming and fishery in Mecklenburg-West Pomerania))

Intensive farming increases the risk of soil erosion



On the other hand, extensive, site-specific use promotes the habitat quality of agricultural areas: meadow use on the Zarrentin calcareous fen



Adjustment of the crop species range to summer drought and heat

Rationale

A fall in summer precipitation of up to 30% can be expected in the biosphere reserve region. Due to the predominantly good soils in the region (soil quality figures of between 40 and > 50), agricultural production will continue to play a significant role in the future. The implementation of the recommendations for action will become more important in ensuring long-term yield stability.

Regional recommendations for action

Selection of suitable agricultural operations

- to trial novel crop species. Crop species (even new varieties) that are drought and heat resistant, hardy (late frost) and very pathogen-resistant should be used
- to examine the effect of winter (frost) on crop species such as winter cereals
- for studies of the changes in the quality of crop fruits subject to climate change

Contacting forestry facilities and institutions for scientific advice and support when trying out novel farming strategies

Stakeholders

Farmers, agronomic research facilities and institutions

Expansion of fruit and vegetable cultivation

Rationale

Especially in the field of market gardening, the projected temperature rise and the predominantly good soils in the region offer huge cultivation potential. The current large-scale growing areas (Brandenburg, Pfalz, Bavaria) will increasingly struggle with summer precipitation deficits and that is why shifting vegetable cultivation to regions with stable precipitation levels or sufficient irrigation water, such as in the biosphere reserve region, is a possibility. With regard to fruit-farming, one can assume increases in yield in the biosphere reserve region given sufficient irrigation. The available groundwater could be one limiting factor here as the use of groundwater for irrigation purposes competes with the need for groundwater to recharge the Schaalsee Lake.

Regional recommendations for action

- Organisation and implementation of information events for fruit growers in the region to discuss opportunities and potential risks as well as possible preventive measures
- Expansion of the extensive orchard meadows in view of positive nature conservation effects
- Creation/strengthening of sales structures in the metropolitan area of Hamburg
- Selection of suitable agricultural operations to trial the cultivation of different vegetable varieties

Research work in the field of variety selection (historical varieties versus new varieties) must be pushed forward. For this purpose, the appropriate research institutions must be contacted.

Stakeholders

Farmers, Amt für Landwirtschaft (Office of Agriculture), farmers' association, Fruchtquell Getränkeindustrie & Co.KG (Wesergold) (fruit juice manufacturer)

Tourism

Flexibilisation of tourist attractions

Rationale

As tourism in the biosphere reserve region has to date mainly been limited to summer tourism, but the impacts in this area are complex and not easy to foresee, it is difficult to formulate specific adaptation strategies. That is why it is important to be able to react flexibly to any change in the tourist sector.

Regional recommendations for action

- Diversification of what is on offer to tourists in order to promote flexible responses towards changes
- Creation of more year-round activities/attractions that are not weather-dependent (indoor events, exhibitions, etc.)
- Ensuring an attractive local experience (accommodation, gastronomy, leisure facilities, attractions, creation of spaces with pleasant atmospheres for tourists to while away time in)
- Accentuation of regional features (cultural history, culinary specialities)
- Expansion of educational and cultural activities on offer (e.g. lectures, concerts)

Stakeholders

Enterprises targeted towards tourists, tourism associations, local authorities, cultural funding bodies and clubs



Activities and attractions that do not depend on the weather contribute towards the flexibilisation of tourist attractions. Against the background of climate change, this is gaining increasing importance (here: an exhibition in the PAHLHUUS).



The large cultural and historical capital of the region also offers huge potential with regard to this (here: the Roggendorf estate)



Internationalisation of tourist attractions

Rationale

Due to the classic bathing resorts in the Mediterranean becoming less attractive because of summer temperatures of, in part, more than 40°C, there is a possibility that summer tourism will shift to, among other places, the northern regions of Germany, such as the biosphere reserve region. That is why it is important to create an interesting and intelligible range of attractions and activities to attract foreign tourists.

Regional recommendations for action

The range of things on offer in the tourist sector should also be written in English. This includes, among other things, topographical maps, signposts (for cycle paths and hiking trails), information boards, information leaflets and brochures about sights and attractions, menus in restaurants and cafes, information in the PAHLHUUS and GRENZHUUS, etc.

Stakeholders

Regional tourist associations, Landestourismusverband M-V (state tourist association of Mecklenburg-West Pomerania), AfBR Schaalsee

Transport

Reduction or avoidance of motorised transport/promotion of public transport

Rationale

The biosphere reserve region exhibits great potential when it comes to putting these recommendations for action into practice. It is of great importance as, on the one hand, the promotion of regional net value added is an essential objective whereby transport routes and CO₂ emissions could be reduced. On the other hand, the region is also characterised by a large amount of commuter traffic (top-class residential estate in the biosphere reserve region, jobs in the surrounding metropolitan area).

Local public transport is mainly geared towards school and commuter traffic. The bus and rail connections on offer are not very suitable for tourists.

Regional recommendations for action

- Establishment of a commuter portal to form car pools
- Expansion of the regional brand network "Für Leib und Seele" (For body and soul)
- Support of the direct marketing of agricultural and artisan products
- Carrying out of CO₂-neutral events in the biosphere reserve region (e.g. in PAHLHUUS)
- Support of central bike hire facilities (e.g. PAHLHUUS and GRENZHUS)
- Improvement of the public transport system (development of coordinated and balanced public transport system, promotion of park-and-ride offers, etc.)

Stakeholders

Cultural funding bodies and clubs, ADFC (General German cycling club) Ludwigsluster Verkehrsgesellschaft mbH (coach company), DB Netz AG (German rail company), SGS Bus & Reisen GmbH (coach company), providers of tourist services, AfBR Schaalsee



Regional brand "Für Leib und Seele" (For body and soul) and biosphere market: regional products sold here.
- This helps cut down the carbon footprint of long transport routes, contributing towards combating climate change.



The importance of cycling tourism will continue to increase and should be aided more by an appropriate infrastructure.

Key projects

In order to implement the Regional spheres of action, a selection of key projects that are as effective as possible was made; they are introduced in the following. The selection of key projects was based on the following criteria in a graduated procedure⁶ :

- The key projects are intended to meet the recommendations for action for which planning deficits have as yet existed.
- Furthermore, selected key projects should exploit high synergy effects if possible.
- The selected projects should have a good PR effect.
- The feasibility of the projects must be ensured.

S1: Regional greenhouse gas balance sheet for the biosphere reserve region

Brief description and rationale

In order to determine to what extent regional greenhouse gas emissions correspond to higher-level (national, European) reduction targets, a regional greenhouse gas balance sheet should be drawn up.

Regional greenhouse gas balance sheets are, as a rule, made by drawing up a balance sheet of the energy consumption and converting it into CO₂ equivalents. This simplified approach does not do justice to the circumstances of the biosphere reserve region as, for example, measures to protect species and biotopes (restoration of degraded bogs) and forest and grassland areas that have a positive effect on the greenhouse gas balance are not taken into consideration. Further factors that should be included in the regional greenhouse gas balance sheet are the use of regenerative sources of energy as well as the holding of CO₂-neutral events and the development of CO₂-neutral attractions and activities for tourists.

In order to find out what amounts of CO₂ equivalents are achieved by climate-relevant measures in the biosphere reserve region, this should be summed up separately.

Measures

- Drawing up an expert report to record all CO₂ sources and sinks in the biosphere reserve region
- Presentation of the results in a way that has a good publicity effect and which imparts to the Schaalsee visitors that the regional greenhouse gas balance can be positively influenced by appropriate planning of their holiday in the biosphere reserve region.

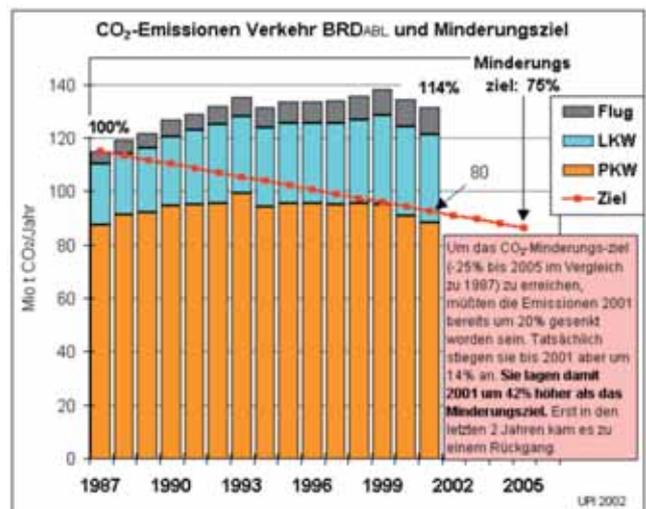


Figure taken from: UPI Report 33, CO₂ balance of the Federal Republic of Germany, available online at www.upi-institut.de/upi33.htm

⁶ For detailed descriptions see Chap. 5 of the unedited version of the study, available online at www.schaalsee.de

S2: Research project on the Schaalsee water supply

Brief description and rationale

The Schaalsee water supply is, among other things, subject to strong anthropogenic influence due to the operation of the power plant built in Farchau in 1923. Due to the continuous use of the water from the Schaalsee between October and April for the purpose of energy generation, the water level of the lake falls by up to 30 cm every spring. The consequences are a sharp decline in wetland areas and the biodiversity, peat mineralization and the associated CO₂ emissions as well as nutrient contamination in the Schaalsee.

According to current climate projections (Chap. 2.3.3), there is a risk of extremely low water events due to reduced summer precipitation (up to 30% by 2100). At the same time, increased evaporation in the summer is to be expected. Together with the changes in the groundwater supply, this will result in huge impacts on the water level of the Schaalsee Lake, which is mainly fed by groundwater.

There is thus an urgent need to undertake research in the field of the water balance (exact logging of inflows and outflows) and the development of the Schaalsee water supply as a scientific basis for the derivation of necessary measures. Adaptation strategies are, for example, in the field of the defined summer and winter lake levels of the Schaalsee necessary since the winter precipitation is to be used in future to compensate for the summer deficits. As the Schaalsee is mainly fed by groundwater, changes in the groundwater supply affect the water level of the lake. In order to be able to adequately assess the future development of the water supply, a further focus of future research should, therefore, lie on the development of the water regime elements (evaporation, soil moisture, groundwater recharge, development of outflows, etc.).

Measures

- Research, collection and evaluation of the existing data in Mecklenburg-West Pomerania and Schleswig-Holstein regarding the quality and water regime of the Schaalsee
- Scientific studies on the development of the water regime elements incl. precipitation and outflow modelling (call for dissertations/ doctoral theses on the above-mentioned topics in cooperation with hydrological faculties at the universities in Mecklenburg-West Pomerania)
- Studies on the development of fish stocks in the Schaalsee taking climate change into consideration
- Charging a qualified engineering company with drawing up a central, target-oriented survey to integrate the results of the individual surveys and research results
- Derivation of suitable management recommendations targeted towards the various stakeholders



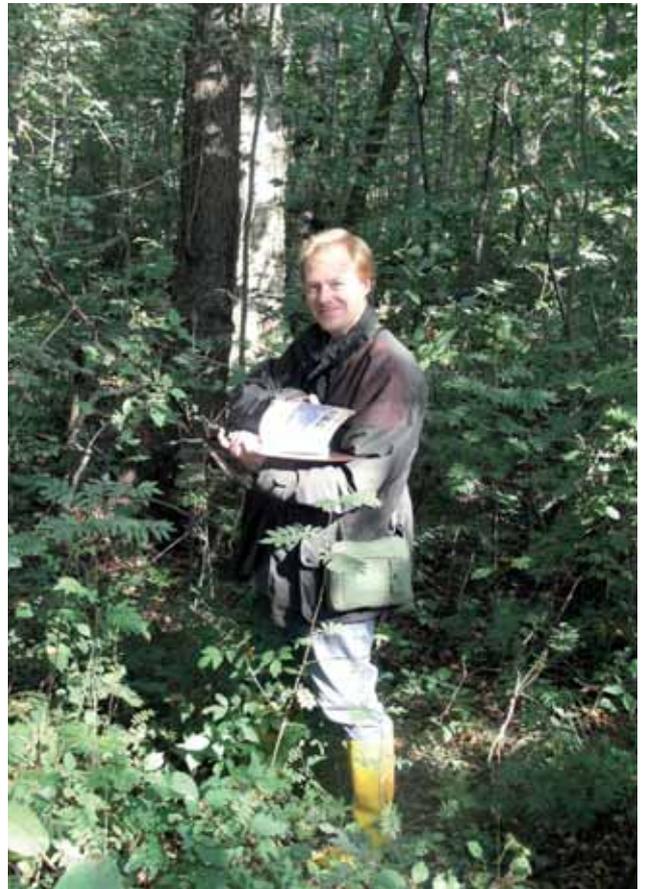
S3: Main research point: forestry

Brief description and rationale

- a) Due to climate change, tree species and ecotypes that have not yet been planted in the area could turn out to be important additions to it. A random use of species and ecotypes that have not yet been scientifically proven does, however, harbour a high risk as there are deficits in knowledge regarding their hardiness and resistance to frost. This is why carrying out trials with alien tree species or alien ecotypes is a point that research should focus on.
- b) Due to the rising winter temperatures (rise in monthly mean temperature in January and February of approx. 4°C by 2100), the water-logged soil substrate will freeze less frequently. This will hinder or prevent standard wet forest management procedures as vehicles will no longer be able to drive over soil substrate as an essential part of carrying out management work. That is why alternative management methods have to be developed in good time in order to ensure sustainable forestry management of wet forests in the future, too.
- c) Expansion of the site mapping: The inclusion alone of the groundwater level carried out as part of the current local assessment (SEA 95) will no longer do justice to the coming demands for a site investigation procedure. The inclusion of dynamic developments as well as field water capacity should be integrated into the procedure.

Measures

- a) - Selection of suitable growing areas in cooperation with the forest districts and the state forestry administration
 - Selection of suitable alien species and ecotypes in cooperation with the forest districts and the state forestry administration
 - Call for dissertations/doctoral theses (e.g. Eberswalde University of Applied Sciences) for the scientific support of sample areas
- b) - Charging companies with testing cable crane technology in the biosphere reserve region
- c) - Integration of water availability and variability (field capacity/water storage ability of the substrate/water balance levels) in the site investigation procedure
 - Addressing of water balance levels
 - Mapping of areas that have not previously been mapped due to their former position at the border
 - Deduction of stocking objective varieties arising from the amended site reconnaissance procedure



S4: Climate protection competition in schools

Spheres of action

Energy, PR work and education

Brief description and rationale

Young people who shape the future through their actions in particular should be sensitised towards the problems of climate change and be familiarised with the possibilities of climate protection and saving energy. That is why the idea of climate protection should be anchored in the educational mandate and curricula. Considerable savings are possible - particularly in the building sector - just by changing personal consumption patterns. By committing themselves to this topic, schoolchildren will grapple with the subject and make an active contribution towards climate protection.

Measures

- Event for representatives of schools to present the project idea
- Events for training teachers as ambassadors of the issue who will then pass on the information they have learnt to others
- Integration of the GLOBE project (Global Learning and Observations to Benefit the Environment) into regular classes
- Charging a student-run company
 - with the preparation of an energy-saving competition project with the aim of achieving maximum reduction in energy consumption
 - design of a climate survey to determine the CO₂ mass equivalents saved within a certain time frame due to altered consumer conduct (renouncing cars, turning the heating down, switching appliances off instead of leaving them on stand-by, etc.)
- Cooperation with schools from the town of Hamburg that have already taken part in climate protection competitions (e.g. Emil Krause Gymnasium (grammar school) in Hamburg)



S5: Series of events: "Klimastammtisch" (Climate Round Table Meeting)

Brief description and rationale

Since a broad spectrum of spheres of action is affected by the effects of climate change, various target groups will have to be addressed. This is why the development of a series of events is a possibility. The stakeholders concerned are farmers, fruit growers, the owners of private forests, citizens living in the biosphere reserve region, regional and local politicians as well as visitors to the Schaalsee region. They should be sensitised towards the nature of climate problems and given information regarding the necessary adaptation strategies and possible preventative measures.

Measures

- Carrying out of regular events in the PAHLHUUS on various climate-related topics
- Inviting expert speakers to talk to target groups
- Repeating series of events at regular intervals

All events should be carried out to be as CO₂-neutral as possible (possibly setting up special bus routes, etc.)



Based on this study numerous measures and projects are already being implemented or are in course of preparation in the individual for fields of activity and commensurate with the regionalised recommended actions in the Biosphere Reserve Schaalsee .

The long version of this study and also further information on the UNESCO Schaalsee Biosphere Reserve can be found under www.schaalsee.de.



Growing bogs and natural forests store carbon dioxide in considerable quantities.

