Stock, M. & W. Lahmer (2007): Brandenburg: A region in Germany suffering from water deficit - In spite of its numerous lakes. In: Lozán, J. L., H. Grassl, P. Hupfer, L. Menzel & C.-D. Schönwiese. Global Change: Enough water for all? Wissenschaftliche Auswertungen, Hamburg. 384 S. Online: www.klima-warnsignale.uni-hamburg.de

3.1.10 Brandenburg: A region in Germany suffering from water deficit – In spite of its numerous lakes

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SUMMARY: *East Germany's attractive landscapes with their lakes, rolling hills and moors were formed by ice age processes and are now endangered by climate change. The abundance of water stands in contrast to the low precipitation as compared with other regions. This chapter presents results assessing the impacts of regional climate change for Berlin and Brandenburg. The significant decline of precipitation and groundwater refill observed in the past decades has already raised water deficit problems. The projected climatic trends up to the middle of the century show a further decline in precipitation, especially in summer, accompanied by an increase in evaporation. This will presumably lead to intensified problems in water supply and quality. Adaptation measures are suggested to reduce potential damage to the economy and to the natural environment.*

With respect to climate change, the future availability of water must certainly be considered to be a problem of global dimension. However, with regards to water resources, precipitation and other climate parameters, regional conditions vary considerably. The same is true for the already evident impacts of climate change on the water cycle, vegetation and the economy and for the changes still to come. In this chapter, methods and results of a climate impact study for a region in Central Europe will be discussed.

Like Poland and Hungary, the eastern part of Germany and especially the region of Berlin-Brandenburg is likely to suffer from future water problems as a result of climate change. For this reason, this part of Germany was selected for a regional impact study performed by the Potsdam Institute for Climate Impact Research (PIK). Brandenburg's attractive landscape with its numerous lakes, rolling hills and moors was formed by the ice age some 120,000 to 10,000 years ago. The abundance of water reflected by numerous lakes, however, stands in contrast to the low precipitation – compared with other regions in Germany – of about 600 mm/year.

The significant decline of precipitation and groundwater refill observed in recent decades has already caused problems related to water deficit. The main question is therefore whether this development will increase in future decades. The regional climate scenarios developed in the study are based on global scenarios for the increase of temperature and CO_2 (IPCC 2001). However, it is not possible to use GCM results directly for regional hydrological assessment studies, since although they supply mean temperature trends the global climate models still do not provide precipitation, sunshine duration and other meteorological parameters with sufficient spatial resolution.

Out of the three available regionalisation methods (statistical downscaling, regional climate models, statistical models) the third approach was used in the present case. The statistical scenario model STAR (WERNER & GERSTENGARBE 1997) combines reliable GCM trends (e.g. for temperature) with statistical analyses of observed regional climate data and provides scenario time series usable for regional impact studies. For the Brandenburg study (GERSTENGARBE et al. 2003) the global scenario A1B was chosen, with a moderate regional temperature increase of 1.4 K over the period 2001 to 2055. Besides this temperature increase, the decline in precipitation up to the middle of the century, especially during summer, accompanied by an increase in evaporation, will be the most important hydrological impact. The decline in precipitation up to the middle of this century given in *Fig. 3.1.10-1* shows that the impacts are more severe southwest of the capital Berlin than in the east of Brandenburg.

To study the potential impacts of climate change on the hydrological cycle of the study region, water balance calculations were performed for the reference (1951–2000) and the 1.4 K climate change scenario (2001–2055), using the hydrological modelling system ArcEGMO™. According to these calculations, mean daily temperatures will increase not only in summer but also in winter. The mean annual precipitation in the Berlin- Brandenburg region will decrease by about 50 mm/year, especially during winter. The climatic water balance (difference between precipitation and potential evapotranspiration) will decrease further from already negative values (-25 mm/year) in the reference period to just -124 mm/year in the scenario period. Evaporation will decrease by 20 mm/year during summer and increase by about the same amount during winter. Groundwater recharge turns out to be the most sensitive water balance component under climate change. It decreases considerably from 80 mm/year (reference period) to 34 mm/year (scenario period), i.e. by about 46 mm/y or 57%. This decline induces a considerable perturbation of the regional water cycle, influencing various water bodies and the groundwater level. The decline is more pronounced in the winter period, while the reduction in summer (-12 mm) is rather moderate, due to the reduced precipitation. A comparable

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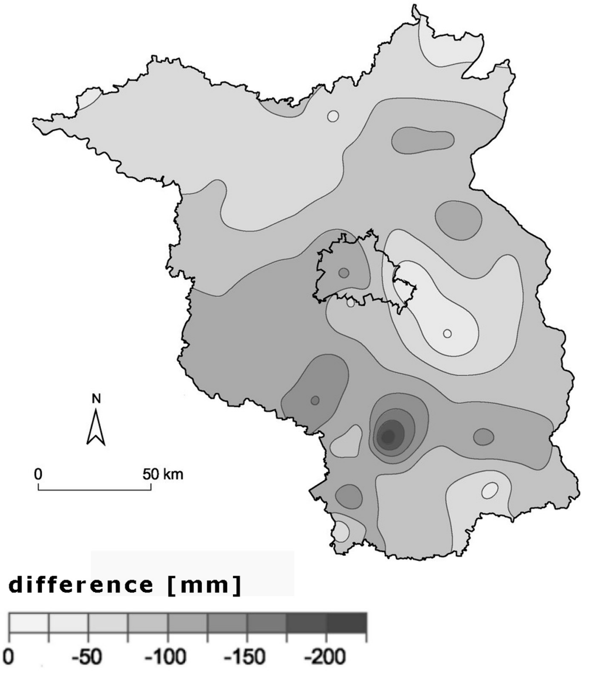

Fig. 3.1.10-1: Map of Brandenburg and Berlin (in the centre) illustrating the spatial differences of the simulated future decline of precipitation. It shows the difference between the mean annual precipitation in the decade 2055/2046 as compared to the mean in the period 2000/1951.

reduction is found for the total runoff, which declines from 101 mm/year to about 57 mm/year under climate change (-43%). Once again, reduced precipitation and increased evapotranspiration are the reasons for this.

In summary, the climate change study performed in the Berlin-Brandenburg region reveals considerable problems related to water availability, supply and quality. The results describe the potential impacts of climatic changes on the actual conditions of the region. They do not represent a prediction, but a scientific basis to identify adaptation and mitigation measures which might help to reduce future climate-related implications.

Under an already tight hydrologic situation with groundwater tables already dropping, the results of the study show that by the year 2055 some important parameters influencing landscape water balance will change significantly for the worse. Even relatively small changes of temperature and precipitation as chosen in the climate scenario, can have a quite significant influence on evaporation, percolation and discharge. A further decline of precipitation in summer with a simultaneously rising evaporation rate will have dramatic consequences, especially during summer. Intensifying losses through evaporation over open water bodies and in wetlands will lead to a percolation of less than half that of today in the year 2055. This development will be exacerbated by the increasing tendency towards extreme droughts and floods. The overall reduction of percolation and discharge might cause a severe drop of groundwater tables, water tables in lakes and rivers as well as a steep decline in water quality (fish kill) especially in the summer months. Rivers and wetlands might fall dry in summer and the extensive lowlands and boggy areas in their multifunctional character and as habitats for endangered species could be lost. These are extremely sensitive natural areas with respect to climatic changes because of their high evaporation and low groundwater recharge rates.

The scenarios and the derived hydrological results underline the need for adequate actions to be taken in the future. With respect to the study region or similar regions in Europe or world-wide, one of the lessons learned is to reduce runoff and to increase water retention in water-sensitive areas such as wetlands. This often implies changes of the actual landuse (e.g. agriculture and forestry), in order to fit future climatic conditions. In addition, further adaptation strategies for natural landscapes and various economic branches will be necessary in order to reduce both direct and indirect damage induced by climate change.

In the long run, sophisticated adaptation measures for landuse, economic systems and infrastructure will pay off in promoting for the sustainable development of a region or country. This is especially true in view of the forecasted increase of climate variability and extreme events such as the 2002 Elbe flood or the extreme dry year 2003 in Europe. Though there are still research deficits concerning the future frequency of such events, the following seems to be clear: there is no alternative to (i) reducing greenhouse gas emissions world-wide and (ii) developing adaptation strategies, especially for water-sensitive regions♦