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This monograph shall inform you about up to date methodologies and recent results in landscape research. It is intended as a guide for researchers, teachers, students, decision makers, stakeholders interested in the topic of landscape science and related disciplines. It provides information basis for decision makers at various levels, from local up to international decision bodies, representing the top level of landscape science in a very short form.

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Chapter V/25: SIMULATING THE REGIONAL AGRICULTURAL IRRIGATION DEMAND IN A NORTH-WESTERN GERMAN LANDSCAPE

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ABSTRACT. Intensive agricultural production in the northwestern German region North Rhine-Westphalia demands water for irrigation. Future climate change is expected to impact the agricultural production conditions and to increase the regional irrigation demand. An integrated model framework addresses the simulation of the regional agricultural irrigation demand. It consists of climate models, crop-soils models and a ground-water model and it represents the regional heterogeneous climatic, geographic and agronomic conditions. A regional climate model simulates climate change expected for the mid-term future period from 2020 to 2050. A regional crop soil model allows for regions with increased irrigation demand to be identified and regions in which the increase in irrigation demand is less extreme. The results show, that for the mid-term future regional irrigation water demand will increase in regions with irrigation-intensive crop production or in regions with low available water capacities. These regions need to be particularly targeted by water management policies.

INTRODUCTION

Climate change is expected to impact agricultural production conditions by changes in temperature, precipitation, evapotranspiration, wind, soil moisture and to directly impact the irrigation demand in crop production. Thus, water management is an important topic for regional agricultural production and politicians particularly with respect to the development expected due to climate change. The expected impacts require adaptations to prevent water resource conflicts and ensuring the regional agricultural irrigation water demand. Also regions where water resource conflicts are less problematic

KEYWORDS: irrigation, water demand, agriculture, climate scenario

INTRODUCTION

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might face problems for agricultural production and other users in the future. Thus, politicians and stakeholder are challenged to design an efficient and sustainable allocation of water resources.

STUDY REGION
The northwestern German study region North Rhine-Westphalia is characterized by intensive agricultural production partially under irrigation. The dominating maritime climate is in general characterized by cool summers and mild winters. However, longer phases of continental high barometric pressure can move winds from the east to southeast resulting in warmer temperatures and a dry climate in the summer [1]. The irrigation water demand in the southeastern two-thirds of the area is a very small (< 1 mm), which results from extensive cereal production or dominating grassland farming in the mountainous regions. The western and northern regions show heterogenous production varying from root crop production (potatoes and sugar beets) with low irrigation demand (1 to 2 mm) to intensive horticultural production (vegetables and flowers) with medium and high irrigation demand.

THE INTEGRATED REGIONAL IRRIGATION DEMAND MODEL
Table 1 presents an overview of the integrated model for regional irrigation demand in North Rhine-Westphalia. The integrated model frame-work links different simulation models in a top down approach. The regional climate model WETTREG 2010 simulates the changes in temperature, precipitation and transpiration. The IPPC climate scenario SRES A1B serves as global climate scenario.

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A normative static crop soil model simulates the irrigation demand determined by different drivers of climate, soil and crop production. The model consists of a few selected basic soil physical models. However, the good quality of the high resolution regional data anticipates reliable model results.

The water balance model mGROWA by Herrmann et al. (2013) [2], simulates the groundwater recharge. The model mGROWA is a deterministic conceptual hydrologic model for the simulation of water balances of large areas (river catchments as well as entire states). The groundwater recharge is of interest for politicians and stakeholders, since expected impacts on irrigation water demand require adaptations to prevent water/groundwater resource conflicts, e.g., in the form of water management policies, systems and strategies). Ensuring a regionally sustainable groundwater availability requires that the irrigation water demand does not exceed the ground water recharge. For more details describing the integrated model see Kreins et al. (2015) [3].

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MODEL VALIDATION
The simulated average irrigation demand for the historical period 1961 to 1990 matches very well with the regional irrigation data of two years: 1999 and 2008. Special surveys provide regional data only for these two single historical years. The surveyed data represent the specific climatic variability in these years. The deviations between the absolute irrigation demand in the surveyed years and in the simulated average period are significant. Therefore, the application of a statistical validation method is not suitable to compare the simulated data with the available statistics. However, the comparison of the regional pattern (distribution and ranges of quantities) shows a very good fit between the simulated average irrigation demand and the statistical data. Thus, this ex-post comparison proves to have a remarkably good suitability to reproduce historical regional irrigation patterns, and permits one to assume a good forecasting quality of the model (see Kreins et al. (2015) [3]).

SCENARIO ASSUMPTIONS
To simulate the regional climate for the short and the mid-term, the IPPC climate scenario SRES A1B provides the required assumption for temperature, precipitation and transpiration.
The scenario SRES A1B represents the expected increasing temperatures and the redistribution of precipitation from summer to winter [6] and can be considered as a plausible future climate scenario of interest for policy-makers and water management decisions. The regional climate scenario represents an average climate. The scenario does not assume temporal climatic variability (e.g., extreme weather events).

SIMULATION RESULTS
The model framework developed simulates climate change and provides information on the impacts on irrigation water demand and groundwater recharge. In this article we focus the analysis of impacts on irrigation water demand.
The climate change impacts on irrigation water demand are expected to be regionally different. The simulation for the current to short-term future (period 1990 to 2020) (Figure 1 a) shows high irrigation water demand in the western part and in the northern part. In the western regions production of irrigation intensive horticultural crops cause a high water demand. In the northern region sandy soils provide only low available water capacities for the production of cereals.

In the mid-term future (period 2020 to 2050) (Figure 1 b) the western and northern regions increase the water demand and the number of regions with high irrigation water demand will increase. In the southeastern and southern regions the water demand remains low. The precipitation in mountainous regions here is higher, and agricultural production is dominated by less irrigation-intensive grassland farming.
CONCLUSIONS
1. The short-term and mid-term climate scenario will result in an increase in regional irrigation water demand in regions with irrigation-intensive production or in regions with low available water capacities. These regions need to be targeted by water management policies.
2. Mountainous regions with dominating grassland farming are less impacted in their water demand by the simulated climate change in mid-term future.
3. The developed integrated model approach is suitable for considering the regional climate, geographical and agronomic conditions, which are very heterogeneous in the study region NRW. Thus, the model might provide useful information for policy-makers and stakeholders.
4. The degree of integration and the selection of the models allows for an easy transfer to other German regions and to regions for which the required data is available.

REFERENCES

Chapter V/26: INSTRUMENTS OF THE INTEGRATED POLLUTANT / SEDIMENT MANAGEMENT IN THE ELBE CATCHMENT AREA

Глава V/26: Инструменты комплексного управления загрязнителями / осадками в районе водосбора Эльбы

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ABSTRACT. Investigations of the pollutant situation of the Elbe catchment area have shown that contaminated sediments of the Elbe and its tributaries represent a significant secondary source of pollutant emissions. This not only endangers the achievement of environmental goals set e.g. by European water policy, but also affects economic issues. The relocation of the sediments for the maintenance of navigable depth, unavoidable e.g. for the Hamburg Port Management, is constrained by a critical pollutant loading of the Elbe sediment. An improvement of the loading situation is achieved only through a holistic sediment management in the whole Elbe catchment area, promoting in particular measures which focus on the reduction of pollutants in the upstream river catchment area. This aim was met by launching the project “Remediation of contaminated Elbe sediments– ELSA” in 2010 as an innovative instrument to support an integrated sediment management in the Elbe catchment area.