CAM COASTAL AQUIFER MANAGEMENT

go-CAM Implementing strategic development goals in Coastal Aquifer Management

Eine Initiative des Bundesministeriums für Bildung und Forschung GRoW GLOBALE RESSOURCE WASSER

Integrated hydrosystem modelling as a key contribution to the UN-SDG 6 targets

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Introduction

Worldwide groundwater is the preferred source for drinking water due to its mostly outstanding natural quality. Therefore, groundwater reservoirs are of crucial importance in relation to the 'resource-oriented' SDG target 6 of the UN Sustainable Development Agenda for 2030 to achieve security of water supply. At present, however, groundwater is not adequately expressed with respect to resource sustainability and quality protection. Therefore, new physically based indicators are required in order to define the groundwater status, its risks and trends.

To address this need for suitable indicators it is essential to fill the gaps in scientific understanding of complex coastal aquifer systems using hydro(geo)logical models. A deep understanding of water flow and solute transport processes within and across this dynamic hydraulic transition zones is essential for an effective water resource management. The application of hydrosystem models enhances the understanding of these processes and allows for the quantification of the regional water balance – for the current state as well as for changing conditions in the future. In the project go-CAM integrated hydrosystem modelling also aims at identifying, quantifying and predicting the development of groundwater indicators for coastal management according to the UN-SDG 6 targets.

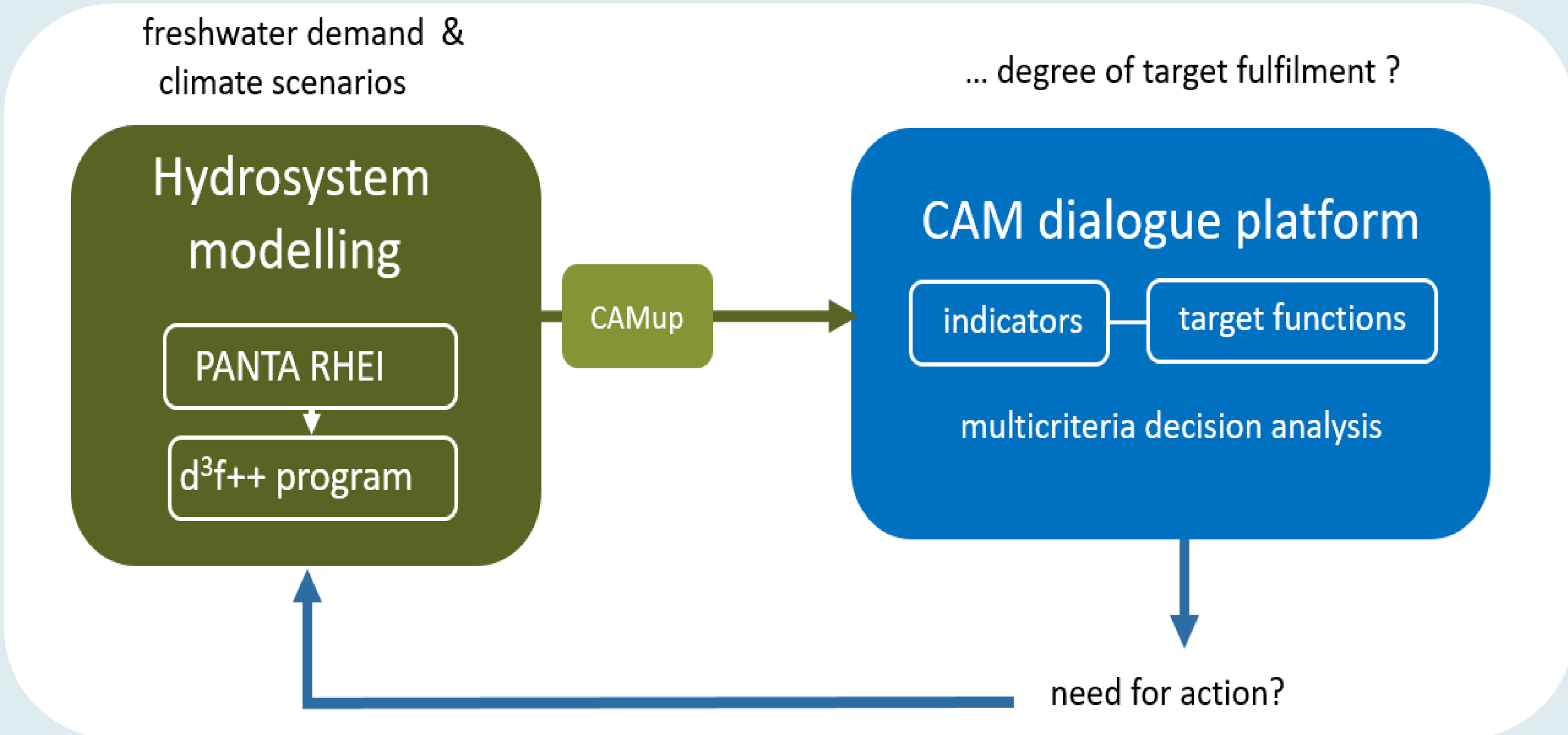

Figure 1: From modelling to decision making: Concept of the go-CAM-Project

Methods

The concept of the go-CAM project relies on the integration of hydrological and hydrogeological investigations based on watershed modelling, groundwater models, geophysical surveys and hydrogeological models (see fig. 3). The requirements and the focus of these modelling approaches will be indirectly determined by groundwater indicators that are defined by regional stakeholders. This part of analyzing the groundwater availability is highly influenced by water demand, climate conditions and the sea level (see figure 1). All model results will be transferred to the CAM-dialog platform (Coastal Aquifer Management).

Hydrological Modelling

For the quantification of the regional water balance in four international case study regions the deterministic, semi-distributed hydrological model system PANTA RHEI (LWI-HYWAG & IfW 2017) was used. For all four go-CAM case study regions a regional hydrological model was built up considering regional peculiarities such as dams and intermittent rivers. All regional models could be calibrated and validated well to very well according to the regional data situation and were then used for the calculation of an ensemble of each 17 RCP 8.5 and RCP 4.5 climate scenarios from the CORDEX project.

Modelling results, such as time series of discharge, evapotranspiration and groundwater recharge on the one hand represent either a preliminary stage or serve directly as water status indicators and evaluation parameters in the newly developed CAM tool. On the other hand the hydrological modelling results were subjected to a detailed evaluation to investigate the relevance of changes in climate for the regional water cycle, water resources, groundwater recharge and water availability. The spatially and temporally differentiated calculated groundwater recharge serves as a coupling variable between the hydrological model and the numerical groundwater models that were built up using the code d^{3}f++ (see figs. 2 and 3).

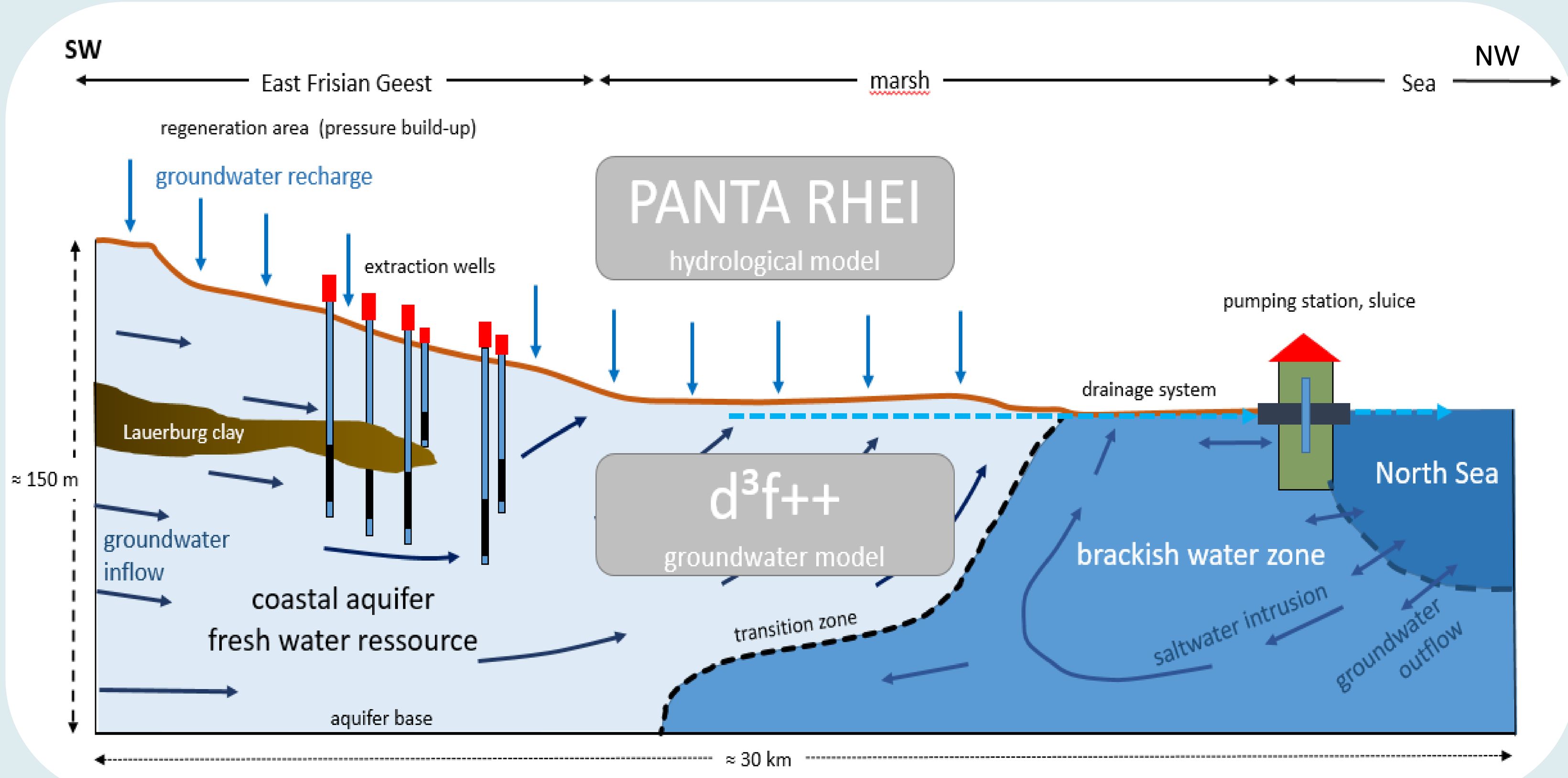

Figure 2: Principal settings of saltwater intrusion modeling

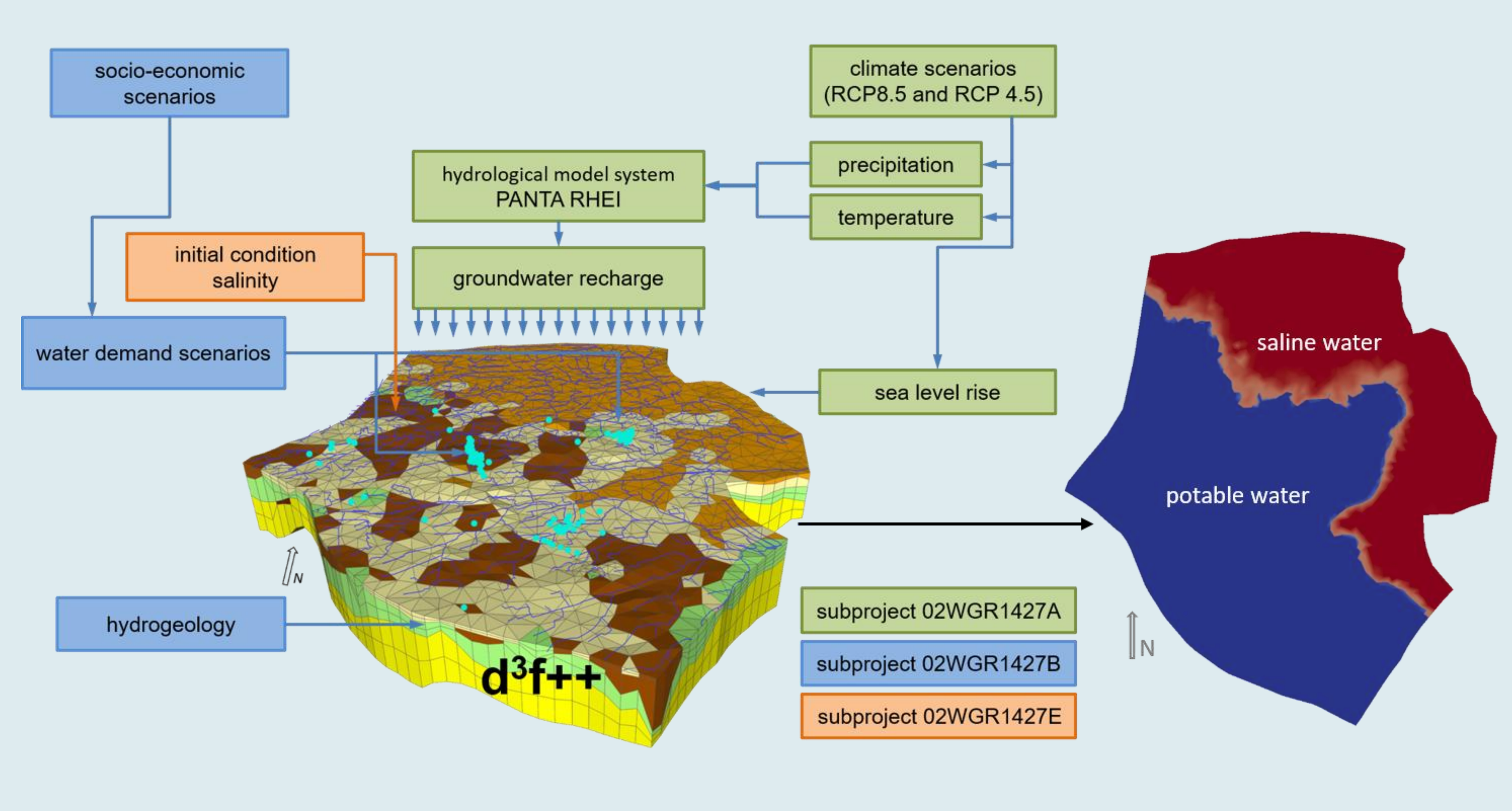

Figure 3: Linking hydrological, geophysical and hydrogeological approaches in go-CAM

Hydrogeological Modelling

The objective of this works was forecasting the impact of different climatic and demographic scenarios on the freshwater availability.

Density-driven groundwater flow modelling at a regional scale over long time periods involves a powerful tool like the code d^{3}f++ (Schneider 2016) that deploys cutting-edge numerical methods and parallelization. Two regional 3d density-driven groundwater flow models and a nitrate transport model have been set up, based on detailed geological and geochemical data and including groundwater recharge, river discharge as well as pumping wells (see fig. 2). The climate scenarios are based on the time-dependent recharge data provided by PANTA RHEI.

In the coastal regions works are focused on the influence of saltwater intrusion from the sea. A major challenge was to define the initial state for the salt concentration. In North Germany this data was derived by combination of aeroelectromagnetic data (Federal Institute for Geoscience and Natural Resources) with lithology information from boreholes. A transfer function was developed to transform the 3d resistivity data into a salt fraction (Leibniz Institute for Applied Geophysics). Fig. 3 illustrates the interdisciplinarity of go-CAM. The simulated salt or nitrate concentrations and groundwater heads are visualized, analysed and interpreted by the CAM tool.

References

LWI-HYWAG & IFW (2017): PANTA RHEI Benutzerhandbuch - Programmdokumentation zur hydrologischen Modellsoftware (unveröffentlicht), Braunschweig

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