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Managing coastal aquifers in climate and socio-economic change: An indicator-based multi-criteria decision system approach

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Worldwide, climate change as well as socio-economic changes are increasing pressure on water supply in coastal regions and lead to major changes in groundwater recharge as well as the regional water balance as parts of the hydrosystem. These changes are threatening water security and, thereby, impede the fulfillment of the SDG 6 targets, esp. SDG targets 6.2., 6.4. and 6.6 of the UN 2030 Agenda for Sustainable Development. Thus, a modern water management demands innovative and profound methods and tools that comprehensively cover these complex changes. To address this challenge, in the BMBF project "go-CAM" (Implementing strategic development goals in Coastal Aquifer Management) we took the methodological approach of developing new groundwater status indicators (e.g. chloride concentration in groundwater, position of saltwater/freshwater interface, freshwater volume) and corresponding target functions implemented in a new online-based management and evaluation tool called "CAM" (Coastal Aquifer Management). Both the physically based indicators as well as the target functions tackle economic as well as ecological issues. The groundwater status indicators are directly derived from the results of high-resolution, process-based (hydrological and hydrogeological) modeling of coastal hydrosystems. Due to their physical nature, the indicators are only applicable with appropriately designed climate and socio-economic scenarios for coastal water management if they are generated with models that also capture the system-relevant processes: Groundwater recharge, groundwater abstraction, discharge dynamics through drainage systems, sea level rise and groundwater discharge to the sea and saltwater intrusion.

The CAM platform is a tool that provides a way to make the results of the complex and extensive numerical modeling usable for a wider community and thus allow for a more efficient result exploitation. Building on the indicators and the selection of target functions and weighting factors the CAM tool uses Multi-Criteria Decision Analysis techniques (MCDA) to strengthen transparency and objectivity in decision-making processes and encourage communication between decision-makers in the water sector of coastal regions. In this way, the application of the CAM tool contributes to the establishment of an integrated water resources management and to derive and discuss future water management strategies as well as concrete measures.

Our methodological approach as well as the results are presented applied to a regional coastal

groundwater study area in the northwestern part of Germany, the Sandelermöns region, which covers an area of about 1,000 km².