



Long-term fluctuations of water resources availability and its implications for a sustainable management of arid agricultural coastal regions

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Freshwater scarcity and ongoing population growth associated with increasing water demands are major challenges for water management in coastal arid regions. Excessive use of groundwater for irrigation in agriculture puts those regions at risk of saltwater intrusion which limits agricultural opportunities. Additionally, some arid regions are characterised by a cyclic climate in which longer periods of dry years are followed by longer periods of wet years. This results also in long-term fluctuations of groundwater replenishment rates and water resources availability which may reach the same order of magnitude like long-term average values. Therefore, these long-term fluctuations should be considered for water resources management planning and operation. In order to evaluate their impact a simulation-based integrated water management system for coastal arid regions is used. The management system couples a groundwater module, assessing the water resources availability, and an agricultural module, controlling irrigation and cultivation within an optimisation module which allow for multi-objective optimisation of the water management regarding profitable and sustainable water resources and agricultural management on farm and regional scale. To achieve a fast and robust operation of the water management system, surrogate models are used which emulate the behaviour of physically based process models and a hierarchical optimisation scheme is applied. The water management system is driven by different scenarios of the water resources availability which were generated by using time series analyses and modelling of local groundwater replenishment rates. An application is performed for the south Batinah coastal region in the Sultanate of Oman which is affected by saltwater intrusion into a coastal aquifer system due to excessive groundwater withdrawal for irrigated agriculture. Several scenarios of water resources availability are used to compare long-term and adaptive management strategies and to demonstrate and to evaluate the impact of climate variability regarding agricultural profit and sustainable aquifer management.