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The use of surrogates for an optimal management of coupled groundwater-agriculture hydrosystems

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For ensuring an optimal sustainable water resources management in arid coastal environments, we develop a new simulation based integrated water management system. It aims at achieving best possible solutions for groundwater withdrawals for agricultural and municipal water use including saline water management together with a substantial increase of the water use efficiency in irrigated agriculture. To achieve a robust and fast operation of the management system regarding water quality and water quantity we develop appropriate surrogate models by combining physically based process modelling with methods of artificial intelligence. Thereby we use an artificial neural network for modelling the aquifer response, inclusive the seawater interface, which was trained on a scenario database generated by a numerical density depended groundwater flow model. For simulating the behaviour of high productive agricultural farms crop water production functions are generated by means of soil-vegetation-atmosphere-transport (SVAT)-models, adapted to the regional climate conditions, and a novel evolutionary optimisation algorithm for optimal irrigation scheduling and control. We apply both surrogates exemplarily within a simulation based optimisation environment using the characteristics of the south Batinah region in the Sultanate of Oman which is affected by saltwater intrusion into the coastal aquifer due to excessive groundwater withdrawal for irrigated agriculture. We demonstrate the effectiveness of our methodology for the evaluation and optimisation of different irrigation practices, cropping pattern and resulting abstraction scenarios. Due to contradicting objectives like profit-oriented agriculture vs. aquifer sustainability a multi-criterial optimisation is performed.