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Optimal groundwater management using surrogate models: a case study for an arid coastal region

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Optimal water management is an indispensible need for the arid coastal regions. Due to the high water demand in various consumption sectors, excess water is often driven out from the aquifer resulting into water table drawdown and seawater intrusion. While applied in irrigation, the excess salinity level in the pumped water jeopardizes the agricultural production. Robust management strategies are required to combat this problem taking into consideration the profit from agriculture as well as the sustainability of the aquifer. For optimal groundwater resources management, a two-dimensional transient density dependent groundwater flow and salt transport model was developed with the help of the simulation package OpenGeoSys (OGS) and then it was replaced by trained approximate surrogates i.e. Artificial Neural Network (ANN) and Gaussian Process Model (GPM). The relatively new GPM showed satisfactory performance with a little compromise in the computational time. With the surrogate groundwater model mono-criteria and multi/criteria optimization runs over a period of more than 60 years are conducted using the evolutionary algorithm CMA-ES. The proposed methodology has significant applicability in the decision making for groundwater and agriculture related issues in the arid coastal aquifers since it offers high effectiveness and efficiency.