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OPTIMAL GEOGRAPHICAL WELL POSITIONING IN AGRICULTURAL POLLUTED AREAS

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Summary. The extended use of organic and inorganic chemical fertilizers, animal waste and domestic effluents are the main sources of nitrate pollution in cultivated lands. In this paper, a new optimization formulation for the optimal geographical positioning of a number of pumping wells is proposed to achieve containment of the nitrate plume by reducing the geographical extent of the polluted areas. The problem formulation includes the following characteristics: a cost function equal to the area of the plume, a set of integer design variables corresponding to the mesh node numbers used as candidate positions for the remediation wells, a modified Differential Evolution (DE) algorithm able to address a mixture of real and discrete values of design variables, and the PTC algorithm used to evaluate each candidate solution. The objective function is defined as minimization of the original polluted area while the solution of the optimization problem provides the optimal locations of the 10 remediation wells with fixed pumping rate over the 166 candidate locations. The proposed formulation requires evaluation of extreme large number of candidate well locations in order to achieve shrinkage of the contaminant plume. To overcome the computational burden, a DE algorithm is properly used showing convergence flexibility. The DE optimizer managed to converge to a (sub-) optimal solution, corresponding to a containment of the plume inside a specific area and, additionally, providing a 5% reduction in the plume area. This reduction is by no means a trivial result, as far as the nitrate sources continue to pollute the soil for all 15 years of the remediation period. A very high computational cost, associated with the simulation of the contaminant mass field for the 15 years of pumping activity, was required for each candidate solution, resulting in a time consuming optimization procedure which took almost 4 weeks to complete 200 generations. Consequently, a speed up of the optimization process is needed to render the methodology suitable for practical applications.