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A GIS-linked unit response function approach to stochastic groundwater nonpoint source pollution modelling

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Abstract A 3-D groundwater flow and transport modelling algorithm specifically designed for nonpoint source transport modelling is applied to a large groundwater sub-basin of the Central Valley, California, USA, to simulate and predict spatio-temporally distributed nitrate contamination over a century-long period. A simplistic domain decomposition method is proposed to simulate the velocity field (flow) at the decameter scale across a 2000 km^2 domain. A streamline transport model is used to simulate the fate of contaminants and to link a large number ($>10^3$) of discrete discharge surfaces (production wells) with an even larger number ($\sim10^4$) of individual contaminant sources via unit response functions. Based on the historic and projected, spatio-temporally variable nitrate recharge history, nitrate output at wells is predicted via convolution of loading functions with unit response functions and integration across individual discharge surfaces. The results show that 45% of wells in this agricultural groundwater basin exceed the drinking limit in 2011, with an increase to 58% in 2050, despite an assumed reduction of nitrate recharge rates after 2011.

Key words nonpoint source modelling; streamline transport model; domain decomposition method; unit response functions; nitrate contamination; Central Valley, California