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Catchment scale land use optimisation using genetic algorithm to mitigate acute diffuse pollution

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Diffuse pollution resulting from rainfall runoff processes is known to adversely affect surface water quality, including in areas where surface water is used for drinking water supply. Designing and implementing targeted mitigation measures to reduce peak concentrations of specific contaminants such as pesticides is challenging due to the spatial and temporal variability of rainfall-runoff processes. Receiving water pollutant concentrations are a function of rainfall processes, catchment characteristics, receiving water conditions and the locations of pollution sources (i.e. spatial distribution of 'high risk' land use types). Past work has developed a validated, travel time based, physically distributed model used to predict metaldehyde levels after a rainfall event accounting for variations in rainfall and distribution of land use. However, targeted field scale mitigation measures require an understanding of how different land use distributions affect pollutant concentrations in river water over a representative number of rainfall events.

In this study, an inverse modelling approach is adopted in which the metaldehyde model is used in conjunction with spatial and temporal distributions of rainfall data spanning over a number of years. Genetic algorithm(GA) technique is used to carry out land use optimisation. This technique can be used to determine distributions of land use that minimises the total number of predicted hours that metaldehyde levels exceed the EU and UK threshold of $0.1 \mu\text{g L}^{-1}$ for pesticides in drinking water. The approach can also be used to show how the removal of specific high risk fields will affect metaldehyde concentrations as well as rank and prioritise specific catchment areas. This can be used to inform catchment management groups of the most effective locations for the implementation of mitigation measures.