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Examining the relevance of macrodispersion coefficients for a semi-analytical solution for nonlinear biodegradation in a dispersive regime.

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Nonlinear biodegradation is modelled using a system of coupled nonlinear partial differential equations and it has proven almost impossible to find analytical solutions. Therefore there is a constant effort to find semi-analytical solutions which simplify the problem considerably. In this work we examine a recent semi-analytical solution found by Ham and co-workers which involves three components: electron acceptor, contaminant and microbial mass. This semi-analytical solution assumes no retardation of the contaminant and a spatiotemporal constant velocity and dispersion coefficients. To use this semi-analytical solution for heterogeneous aquifers, macro coefficients are needed to account for the effects caused by the heterogeneities. In this work we concentrate on different expressions for the macrodispersion and compare them to each other and a full numerical model by means of the first en second central moments of the concentration distribution. We apply Gelhar's macrodispersion tensor, normally used for non-reactive transport, and Miralles-Wilhelm's macrodispersion tensor for reactive transport. Results show that Gelhar's macrodispersion significantly underestimates the effect of transverse dispersion on the ensemble averages. Calculations using Miralles-Wilhelm's macrodispersion are still ongoing at the moment of writing. The results imply that we can't use Gelhar's macrodispersion in semi-analytical solutions for nonlinear biodegradation to predict the transverse spread as is usually done, but the possibility of using specialised macrodispersion coefficients is still open at the moment of writing. It is also shown that a semi-analytical solution isn't suited for individual realisations, because of the reasonable deviation of the individual realisations compared to the ensemble average.