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THE USE OF MODELS TO DETERMINE THE IMPACT OF PUMPING ON PESTICIDE CONTAMINATION OF GROUNDWATER

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Pesticides are the most important reason for closure of water supply wells in Denmark, with pesticides being detected in 37% of monitoring wells sampled, and with 12 % exceeding drinking water guidelines. Observations show that pesticide concentrations vary greatly over time and space in monitoring and pumping wells. This study aims to use models to determine how pumping affects pesticide concentrations in groundwater wells used for water supply. Conceptual models are constructed to show how pump rate, recharge, geology, pesticide properties and pesticide application (point source vs. diffuse source) affect pesticide concentrations in water supplies. Two approaches are used: a comparison of groundwater age and pesticide application history and direct groundwater pesticide transport simulation.

Numerical models of groundwater age and contaminant transport in a pumping well capture zone are constructed using COMSOL Multiphysics. A suite of simulations are then conducted to show how various factors affect well concentrations. The factors include: Pump rate; recharge rate; seven different geologies; 3 pesticides representing the range of pesticide properties (MCPP, Bentazone, Glyphosate); point (e.g. farm yards where agricultural pesticides were prepared and machinery washed) and diffuse (broad-acre) pesticide sources; and different application histories (continuous vs. time varying input following crop rotation). For comparison, each factor is varied individually and compared with two base case scenarios, one for point and diffuse sources respectively.

Results show that pesticide breakthrough patterns vary greatly depending on all of the factors considered. For example, diffuse source application of pesticides results in earlier breakthrough of pesticides, but with lower concentrations than typically result from point sources. Pumping history has a great impact on observed pesticide concentrations. For example, larger pumping rates draw both younger contaminated water from shallow aquifers and cleaner deep groundwater into the well, and resultant pesticide concentrations depend on the balance between the different groundwater sources, the geology, application history etc.

This study shows that well head management of pumping strategies is as important as catchment management for controlling pesticide concentrations in water supply wells. Model results also show why monitoring programs often report highly variable (time and space) pesticide concentrations. The groundwater age and conceptual models of pesticide transport developed in this study provide comparative information on the impact of the factors affecting contaminant breakthrough at wells, and can be used by authorities to guide pesticide management decisions.

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