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Meta-analysis of pesticide sorption in subsoils

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It has been known for several decades that sorption koc values tend to be larger in soils that are low in organic carbon (i.e. subsoils). Nevertheless, in a regulatory context, the models used to assess leaching of pesticides to groundwater still rely on a constant koc value, which is usually measured on topsoil samples. This is mainly because the general applicability of any improved model approach that is also simple enough to use for regulatory purposes has not been demonstrated. The objective of this study was therefore first to summarize and generalize available literature data in order to assess the magnitude of any systematic increase of koc values in subsoil and to test an alternative model of subsoil sorption that could be useful in pesticide risk assessment and management. To this end, a database containing the results of batch sorption experiments for pesticides was compiled from published studies in the literature, which placed at least as much emphasis on measurements in subsoil horizons as in topsoil. The database includes 967 data entries from 46 studies and for 34 different active substances (15 non-ionic compounds, 13 weak acids, 6 weak bases). In order to minimize pH effects on sorption, data for weak acids and bases were only included if the soil pH was more than two units larger than the compound pKa.

A simple empirical model, whereby the sorption constant is given as a power law function of the soil organic carbon content, gave good fits to most data sets. Overall, the apparent koc value, koc(app), for non-ionic compounds and weak bases roughly doubled as the soil organic carbon content decreased by a factor of ten. The typical increase in koc(app) was even larger for weak acids: on average koc(app) increased by a factor of six as soil organic carbon content decreased by a factor of ten. These results suggest the koc concept currently used in leaching models should be replaced by an alternative approach that gives a more realistic representation of pesticide sorption in subsoil. The model tested in this study appears to be widely applicable and simple enough to parameterize for risk assessment purposes. However, more data on subsoil sorption should first be included in the analysis to enable reliable estimation of worst-case percentile values of the power law exponent in the model.