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Are physical site characteristics allowing pesticide products to leach to groundwater in Ireland?

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Land application of agricultural pesticide products may have the ability to travel to groundwater and it has been suggested that physical properties at the site of application controls their movement ...(Worrall et al, 2002). As of yet no one has tried to correlate pesticide occurrence in groundwater with physical attributes of the Zones of Contribution (ZOC) which have been specifically identified as contributing to the sampling point. The aim of this study was to explore association between ZOC physical characteristics and pesticide presence or absence at 158 sites in Ireland sampled for pesticides in 2008 as part of the Environmental Protection Agency's (EPA) national groundwater quality monitoring programme for the European Union (EU) Water Framework Directive (2000/60/EC).

Pesticide detections greater than or equal to the EU drinking water standard (0.1μg/L), greater than the analysis detection limit (0.02μg/L) and those monitoring points with no detections were identified from the 2008 groundwater quality dataset (n=158), generating a new dataset of the 3 classes (19 sites $\geq$0.1μg/L, 64 sites $>$0.02μg/L & $<$0.1μg/L & 75 sites with no detection). Physical attributes in each ZOC for each monitoring/sample point were obtained from national GIS datasets. ZOCs were defined using an ArcGIS tool developed for the EPA and the most prevalent characteristic within each ZOC recorded. Associations between ZOC characteristic and pesticide occurrence were explored using Fisher's Exact Test (SAS, 2004) and significant associations were further analysed by logistic regression.

Sample point i.e. borehole or spring ($p<0.008$), aquifer type ($p<0.001$) and subsoil type i.e. Quaternary deposits ($p<0.02$) were significantly associated with pesticide detections. The physical characteristics which do not have an association are land use (CORINE 2000), soil association (General soil map 1980), IFS soil type (Teagasc EPA), subsoil permeability 2011 (Geological Survey of Ireland (GSI)) and bedrock geology (GSI). Further analysis of those physical characteristics with associations using logistic regression suggests that springs are more likely to have a pesticide detection than boreholes ($p<0.0076$). There was evidence that regionally important aquifers were more likely to have a detection than poor aquifers which in turn were more likely to have a detection than locally important aquifers ($p<0.0007$) when aquifers were classified according to the GSI's system of hydrogeological characteristics. Classifying the aquifers based on the Irish system of flow regime used for the Water Framework Directive has revealed that karstic aquifers have a greater probability of a pesticide detection followed by intergranular, productive fractured bedrock and finally poorly productive bedrock aquifers (p 0.0002). Main flow lines through karstic aquifers to springs can allow pesticides to travel quickly through the subsurface without much interaction or attenuation in the soil (Iker et al, 2010), which normally suppresses pesticide mobility via sorption within the soil matrix (Bakouri et al, 2008). The subsoil /quaternary deposit type which had the greatest likelihood of a pesticide detection was basic subsoil types ($p<0.0101$). Springs, regionally important aquifers, karstic aquifers and basic subsoil types are the physical attributes most likely to be associated with a pesticide detection in Irish groundwater.

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