Catchment scale modelling to refine FOCUS scenario based risk estimates of selected veterinary medicines in drinking water

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Introduction

Human exposure to residues of veterinary medicines may occur through the consumption of drinking water abstracted from surface or ground water sources in agricultural catchments. A recent Drinking Water Inspectorate (DWI) project (70/2/235) used FOCUS scenario approaches to demonstrate safe levels of intake for most veterinary medicines, but identified ten compounds where intake may be close to or above the acceptable daily intake. This project (DWI 70/2/286) assessed the potential risk posed by these compounds ((altrenogest, apramycin, cefapirin, dicyclanil, florfenicol, lincomycin, luprostiol, sulfadiazine, acetylsalicylic acid and monensin[1]) by generating more realistic estimates of exposure through: (i) surveying veterinary practices to refine the estimates of usage (ii) taking account of manure storage, handling and spreading practices, (iii) improved active substance property information and (iv) the use of a catchment-based simulation modelling approach to improve on the FOCUS scenario approach to take into account catchment dilution.

Methodology

Catchment Selection

Four groundwater and four surface water catchments representative of each animal type (cattle, poultry, pigs, sheep), yielding a total of 16 catchments, were selected ensuring they were both vulnerable to leaching or runoff while having high animal manure and veterinary medicine pressures.

Catchment Model Parameterisation and Setup

There was variable success in improving the compound properties for the ten compounds collated for the simulation modelling. For each animal type, a number of veterinary practices were consulted regarding their usage of the ten compounds. Good coverage of the catchment (cattle – 100%) and national herds/flocks (Pigs – 25%; All poultry – 55%; Broilers – 69%) was achieved. For dicyclanil usage in sheep, data on the sale of ectoparasiticides of large agricultural supply chains that covered the selected catchments was analysed. Single integrated usage regimes were calculated from the survey returns for each compound, livestock group and mode of administration. The catchment specific loads of each veterinary medicine were calculated through integrating the usage survey results with the manure production, handling and spreading modelled using the ADAS Manures-GIS system. The calculated annual applications were small, typically <1 g/ha.

Environmental Modelling and Risk Assessment

For both the surface water and ground water catchments the maximum daily/annual predicted environmental concentrations for each of the representative catchments and compounds were modelled using a catchment modelling framework underpinned by regulatory models (MACRO; PRZM) parameterised using regulatory guidance (See Figure 1). These were compared with the lowest acceptable daily intake concentrations (ADI; 0.03 µg/L) for the three toxicological age classes for conventional and advanced water treatment options.

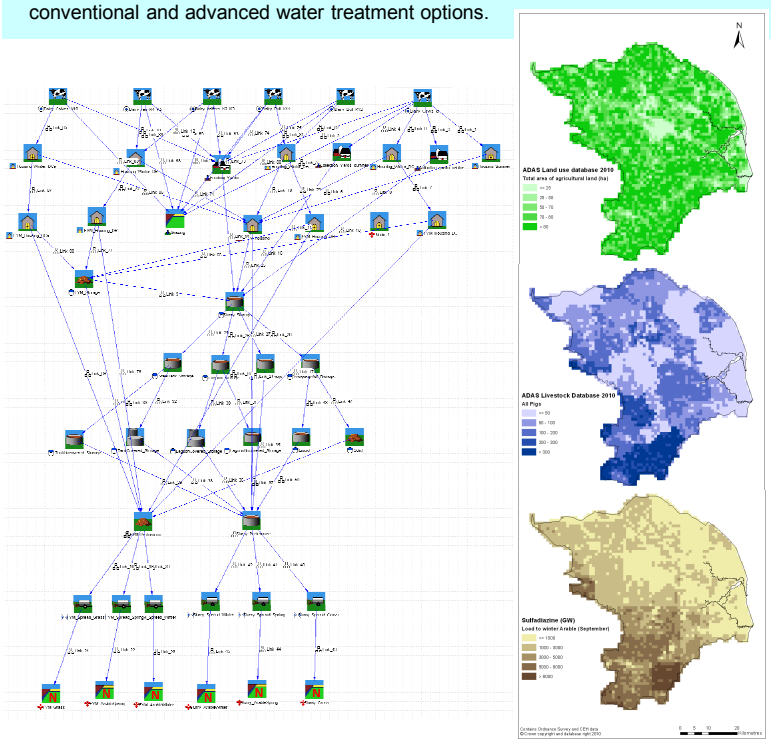

Figure 1: Schematic of the cattle Manures-GIS model for a single catchment alongside 1 km resolution data layers (i) agricultural land, (ii) livestock density for modelling (iii) sulfadiazine loadings in the pig/poultry groundwater catchment

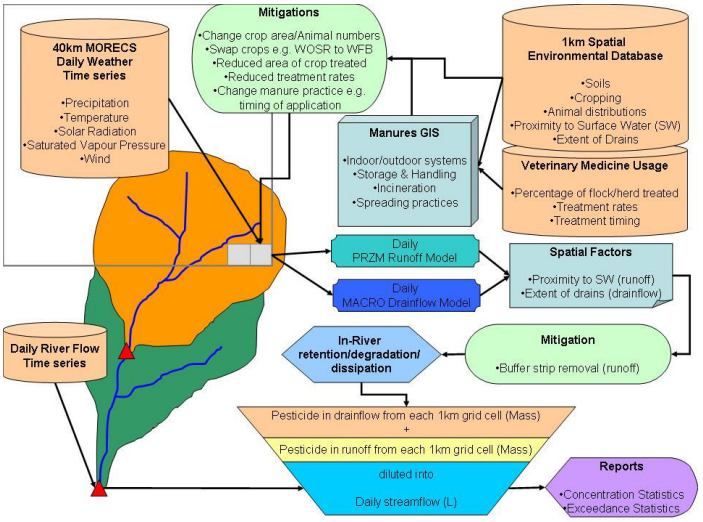

Figure 2: Schematic of the ADAS Catchment Pesticide Environmental Risk Assessment Modelling Framework outlining the inputs, models and outputs for surface water simulations.

Results

For both surface and groundwater catchments the maximum daily/annual PECs for each of the representative catchments and compounds **did not** exceed the lowest ADI concentrations for either the conventional or advanced water treatment options. The low maximum modelled concentrations are unsurprising given the low application rates of veterinary medicines spread into the environment. In order to ensure that the maximum annual predicted environmental concentration for groundwater did not exceed the toxicological threshold for an individual crop/soil combination within the catchments, these were extracted for a high usage compound (sulfadiazine) and high toxicity compounds (luprostiol and altrenogest). Similarly, these concentrations for specific soil and crop combinations do not exceed the most sensitive toxicological end points.

The modelled concentrations were typically a factor of several hundred to several tens of thousands below the most sensitive toxicological threshold, and there are also additional factors which provide further margins of safety, e.g.: (i) the ADI thresholds are based on 10% of the ADI concentration; (ii) no account was taken of metabolism of the compounds in the animal; (iii) the modelling considers that veterinary medicines spread into the environment are immediately available for transport in water; (iv) the groundwater PECs are for the base of the soil profile and there would likely be additional attenuation of the compounds while moving through the unsaturated vadose zone *en route* to groundwater.

Conclusions

Based on the results of this study it is concluded that the ten compounds investigated are not expected to impact on drinking water quality under realistic worst case conditions in real world catchments.

Footnotes
1 – As a poultry feed additive. Has subsequently been approved for use in cattle in 2013 which is not covered by this risk assessment.

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