Geophysical Research Abstracts,
Vol. 11, EGU2009-2135, 2009
EGU General Assembly 2009

FOOT-CRS – a GIS-based tool for pesticide risk assessment and management at the catchment scale

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In the EU-project FOOTPRINT three pesticide risk assessment and management tools were developed, for use by three distinct end-user communities at three different spatial scales: policy makers and registration authorities at the national/EU scale, water managers and local authorities at the catchment scale, and farmers and extension advisors at the farm scale. The three FOOTPRINT tools share the same underlying science (e.g. a database of agro-environmental scenarios occurring in the EU) and provide an integrated solution to pesticide risk assessment and management in the EU. The tools allow users to: i) identify the dominant pathways and sources of pesticide contamination in the landscape, ii) estimate levels of pesticide concentrations in ground- and surface water, and iii) make assessments of how the implementation of mitigation strategies would reduce pesticide contamination. Furthermore, the exposure estimates provided by the tools can be easily compared with ecotoxicological endpoints or legal thresholds such as the drinking water limit.

In the tool FOOT-CRS (Catchment and Regional Scale), which has been programmed as an add-on in ArcGIS, the emphasis is on i) identifying the areas most contributing to the contamination of water resources by pesticides, and ii) defining and/or optimising action plans at the scale of the catchment. In contrast to the national-scale tool FOOT-NES, where pesticide concentrations in hypothetical edge-of-field surface water bodies are calculated, FOOT-CRS uses the actual surface water network. For the calculation of pesticide inputs into surface waters via surface runoff and erosion, a routing to the surface water network is performed on a grid basis, and the pesticide load reduction during transport in overland flow by reinfiltration or redeposition is explicitly calculated. Subsequently, the fractions of pesticide surface runoff loss and pesticide erosion loss from a cell that finally reach the surface water network are computed for each cell. This information is crucial for determining the sites where the establishment of additional mitigation measures will be most effective. Drift input calculation is also done on a grid basis, considering mitigating landscape elements like hedges and riparian vegetation. FOOT-CRS produces several types of output:

1. maps and spatial cumulative distributon functions (CDFs) of pesticide leaching concentrations (PECgw)
2. maps and spatial CDFs of pesticide losses from fields and pesticide inputs into the surface water network
3. temporal CDFs of Predicted Environmental Concentrations in surface water (PECsw) at the catchment outlet (i.e. for one point in space), for different pesticide input pathways. These CDFs can e.g. be used to determine the return period of a given peak exposure concentration.

Further key features of the FOOTPRINT tools are:

The FOOTPRINT agro-environmental scenario database

Our objective was not to develop a small number of realistic worst case scenarios, but to develop a large number of realistic scenarios covering the diversity in European conditions supporting agricultural activities. The FOOTPRINT agro-environmental scenarios are the results of an integration of information on climate, soils and crops. The scenarios and their supporting information are used to identify dominant contamination pathways for pesticides across Europe, to underpin model parameterization and to enable the spatial processing of the pesticide losses simulated by MACRO and PRZM.

The FOOTPRINT modelling database(s)

The fate of ca. 100 theoretical compounds (i.e. Koc/DT50 combinations) for all soil/climate/crop combinations relevant for Europe and 12 different application months has been simulated using the pesticide fate models MACRO (predictions of pesticide loss via leaching, drainage and lateral subsurface flow) and PRZM (predictions of pesticide loss via surface runoff and erosion). The simulation period was twenty years for both MACRO and PRZM simulations. Summary statistics of every simulation time series were stored in a large number of MS Access databases "FOOTPRINT modelling databases", which are included in the FOOTPRINT tools. For surface water, the model output variables stored in the modelling database are: daily pesticide losses (drainage, lateral subsurface flow, surface runoff, erosion), associated water volumes or eroded sediment yield, resp., and the associated month. While in the FOOT-CRS databases maximum daily losses for each simulation month are stored (n = 240), the databases used by FOOT-NES and FOOT-FS contain 11 percentiles of the whole time series (corresponding to return periods between 10 days and 10 years). For groundwater, the modelling databases contain average leaching concentrations at the bottom of the soil profile (2 m or shallower) over the 20-year simulation period (flux concentrations for most soils, resident concentrations for soils with shallow groundwater, no output for soils with impermeable substrate) and mean annual percolation.

3. The SUGAR index

Risk assessment for groundwater in FOOT-CRS will make use of the recently developed SUGAR index, which tells whether a particular area contributes more to groundwater recharge or to surface water discharge. SUGAR combines two approaches for hydrological assessments: the IDPR index (which is computed using only observed data: a DEM and the observed surface water network) and the SPR (Standard Percentage Runoff), which is used in catchment hydrology and available for each FOOTPRINT soil type.

The oral presentation will include a demonstration of the FOOT-CRS tool and preliminary evaluation results.

Acknowledgement - The funding of the FOOTPRINT project (EC ref. no. SSPI-CT-2005-022704) by the European Commission through its Sixth Framework Programme is gratefully acknowledged.