

# PESTICIDE RISK MAPPING AND INTERVENTIONS

## Executive Summary

### **Background**

Pesticides applied to agricultural land, such as metaldehyde and other “actives” that are difficult to remove by existing potable water treatment processes, can cause water companies to fail current EU water quality standards. Catchment intervention measures are considered an important and sustainable means of mitigating this risk to drinking raw water quality, however, a harmonised approach of selecting and targeting interventions that was consistent across the water industry, and endorsed by regulators, was lacking.

### **Objectives**

The overall project objective was therefore to arrive at an agreed risk mapping methodology, transparent to all stakeholders, and produce UK-wide risk maps of both ‘difficult to treat’ actives and those that might be treatable (but at a significant cost). The maps were to identify areas of high risk with respect to raw water quality and supporting evidence. Catchment interventions were to be assessed and accommodated within the methodology, to help decision-makers arrive at appropriate interventions based on their impact, barriers to adoption and costs.

### **Results**

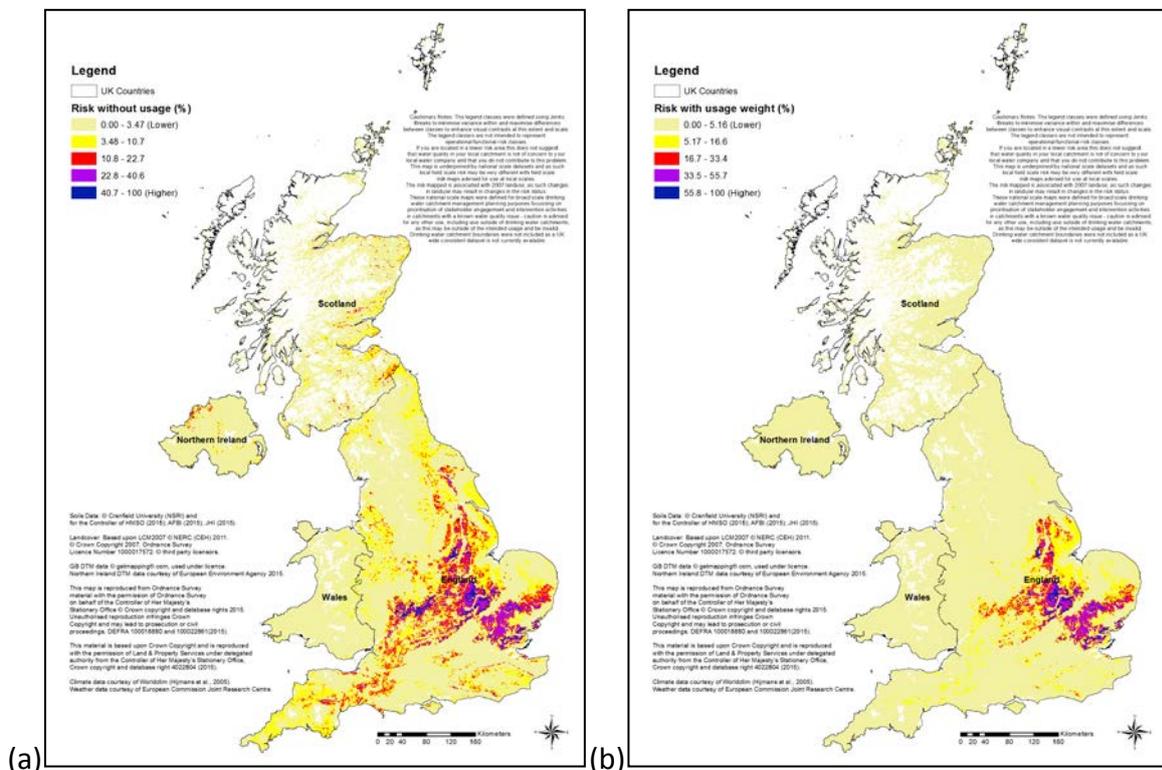
#### **Risk Mapping**

Following a review, the risk-mapping methodology developed incorporated the most promising elements of many the approaches reviewed into a single, new approach. The methodology encompasses a single source (agricultural diffuse pollution), three transport pathways (surface runoff, drainflow and leaching) and two water body types (surface and ground water bodies) at two varying scales (1km gridded and field). The risk factors being taken into account for each of the transport pathways vary but include: climate, soil, drain status, slope, landcover, connectivity to water bodies and pesticide properties/usage. These risk factors may be defined for a site (at varying scales from individual field to 1 km grid square) using a range of spatial datasets or site inspection. Having defined these, the normalised average annual percentage of applied pesticide simulated to be lost to surface water *via* surface runoff and drainflow or leached to groundwater is “looked up” for the combination of risk factors specific to that site. These lookup values were determined using regulatory pesticide fate models, PRZM for runoff and MACRO for drainflow and leaching using a 30 year simulation period. These values may then be weighted according to landscape (proportion of soil present or extent of drains) or field scale weights (e.g. degree of connectivity) or intervention effectiveness scores (e.g. % reduction of surface runoff losses on implementation of a vegetated buffer strip) to derive the final risk indices.

UK-scale risk maps at 1km gridded resolution were produced for (i) mobile herbicides used on arable and grassland moving to surface water and ground water and (i) metaldehyde used on arable land moving to surface and ground water. These 1km scale risk maps are available as digital PDF files. An example is shown in Figure E1.

**Figure E1 National surface water risk map expressed at 1 km grid resolution for metaldehyde applied to arable land (a) without and (b) with the pesticide usage weight applied.**

Cautionary Notes: The legend classes were defined using Jenks Breaks to minimise variance within and maximise differences between classes to enhance visual contrasts at this extent and scale. The legend classes are not intended to represent operational/functional risk classes. If you are located in a lower risk area this does not suggest that water quality in your local catchment is not of concern to your local water company and that you do not contribute to this problem. This map is underpinned by national scale datasets and as such local field scale risk may be very different with field scale risk maps advised for use at local scales. The risk mapped is associated with 2007 landuse, as such changes in landuse may result in changes in the risk status. These national scale maps were defined for broad scale drinking water catchment management planning purposes focussing on prioritisation of stakeholder engagement and intervention activities in catchments with a known water quality issue - caution is advised for any other use, including use outside of drinking water catchments, as this may be outside of the intended usage and be invalid. Drinking water catchment boundaries were not included as a UK wide consistent dataset is not currently available.



Field-scale risk maps were also developed for a range of example catchments, (Avon, Leam, Mimmshall Brook, Pincey Brook, Cherwell, Tamar, Exe, Sussex Ouse, Pitsford, Chelmer, Waveney, Wayoh, Wensum and Wiske), which helped inform the potential to roll out this finer scale of mapping to all drinking water catchments in the UK. Due to some data licensing constraints, the field-scale risk maps for these catchments are only currently available to those with the relevant licences.

The evaluation of the risk-maps produced took several forms, including: (i) comparing modelled pesticide values to literature, (ii) comparison with areas of known drinking water quality problems, (iii) comparing outputs with other mapping approaches and (iv) catchment officer feedback. In general the evaluation was positive and the risk maps

validated. However potential issues regarding risk communication to stakeholders were highlighted (eg the fact they are intrinsic risk maps; the assumption of land use underpinning the risk index may be different to current land use and/or future land use.)

Guidance for risk communication, communication of limitations for specific usage situations (e.g. rushy pasture or peaty soils) and the inclusion of risk interventions within the risk mapping framework are provided in the report to facilitate use of the risk mapping in a wide range of geographical and usage situations.

## Interventions

Having identified and characterised the risk associated with a site it is important to outline intervention options that might be used to mitigate these risk(s) and provide supporting evidence on their potential impacts, costs and barriers to uptake such that the most appropriate intervention(s) might be selected. A list of farm practices (interventions) was compiled based on current approaches identified from submissions from UKWIR members, Catchment Sensitive Farming and other emerging options from the scientific literature. Farm practices were grouped under the following headings – storage and handling (for completeness only), application technology, field operation and management and modified movement. The focus was on farm practice at the field level as this links closely with the risk mapping, i.e. having identified and characterised the risk associated with a field, the most practical/cost-effective intervention to address this might be selected. Each of the farm practices identified were assessed on a range of high level criteria using evidence from scientific literature, reports, surveys and expert opinion. The assessment criteria used were: (i) type of measure e.g. statutory or best practice, (ii) current level of adoption, (iii) barriers to adoption – range of criteria in overall assessment e.g. cost, evidence of efficacy and skill levels required to implement and (iv) potential efficacy.

A long list of 26 interventions were assessed according to the criteria laid out. The following were taken forward for more detailed costings: (i) vegetated buffers, (ii) reduced dose rate through a range of mechanisms (e.g. Low concentration products, changing crop rotation, changing crop, changing equipment, changing application timing), (iii) product substitution (e.g. Changing from metaldehyde to ferric phosphate, using glyphosate in weedwipers) and (iv) vegetated ditches and constructed wetlands. For each of the interventions a 1-page characterisation summary for use in stakeholder engagement discussions is provided (although limitations are also noted e.g. possible changes in commodity prices).

In order to evaluate the efficacy of the interventions, data was gathered from a number of sources including water companies and other stakeholders, ADAS-held study data and a literature review. Using this data the effectiveness for a wide range of interventions was established and those sufficiently well characterised that they might be included in the risk mapping tool identified as follows: (i) interventions associated with drainflow – application rate and timing and drain efficiency, (ii) interventions associated with surface run-off - application rate and timing, vegetated buffer strips and constructed wetlands and (iii) interventions associated with groundwater – application rate and timing.

Having identified both the field risk and the intervention that might be most acceptable to a land manager or most cost-effective to implement it is important that the catchment

implications of the field level changes in practice be assessed. This was undertaken by considering if, as a “proof of concept”, the change in the catchment total of modelled changes in field level risk scores, owing to interventions, might be used to inform the likely change in the raw water quality at the catchment abstraction point. It focussed on a small number of catchments (Avon, Leam, Pitsford and Sussex Ouse) where more detailed intervention effectiveness modelling had been conducted for changes in inputs. While each of these studies used slightly different approaches to modelling the fate and behaviour of metaldehyde, they generated daily predicted water concentrations of metaldehyde in raw water abstractions for a baseline situation and a series of interventions. The interventions selected for consideration in this proof of concept were those that sought to reduce the extent of arable land treated with metaldehyde. Analysis of the percent reductions in total catchment risk versus the simulated percent reductions in daily PCV exceedance for the same reduced extent of arable land treated with metaldehyde suggest that there is good degree of correlation ( $R^2$  approaching 0.75). While this assessment is currently limited to just one of the compound types and one intervention approach it does suggest that the total catchment risk score and changes therein through the implementation of interventions may yield an indication of possible changes in raw water quality as measured by number of exceedances of the PCV.

## **Conclusions**

A pesticide risk mapping approach, which draws on and builds on previous risk mapping approaches employed by water companies and other industries, has been outlined and implemented at both a coarse resolution and field level scale. Pesticide risk maps for mobile herbicides (applied to arable and grassland) and metaldehyde (applied to arable land only), covering the UK have been developed at a 1 km grid resolution using a reasonably consistent set of input datasets and approaches. Accompanying assessments of interventions that might be employed to tackle losses of pesticide from high risk sites have been outlined along with their likely effectiveness, associated barriers to uptake and typical costs of implementation. Sharing and communicating the approach and progress with relevant stakeholders during the project has proved beneficial to all parties.

## **Recommendations**

Preliminary evaluation of the risk mapping approach against real world observations has been undertaken, albeit the approach would benefit from further evaluation and use by catchment managers. In this regard, a series of tools for expanding the field scale risk mapping to the UK scale and to promote its use both in an operational sense, and within the planning of catchment management programmes, have been outlined. Possible work packages to further develop the intervention effectiveness and costings have also been outlined. The above, along with other stakeholder feedback, should help inform development of Phase 2 of the project.

The outputs of this project were designed to meet the needs of the water industry and their regulators in addressing drinking raw water quality pressures from mobile pesticides. Uses beyond this scope should be carefully assessed, as they may not be valid.

## **Benefits**

The outputs from this project will benefit UKWIR stakeholders by identifying high risk areas where catchment intervention stands a good prospect of addressing potential risk and making significant improvements in raw water quality. This will aid targeting of limited resources and aid in catchment stakeholder engagement programmes by expanding the evidence base required to change behaviour.

**For further information please contact UK Water Industry Research Limited,  
8<sup>th</sup> Floor, 50 Broadway, London, SW1H 0RG quoting the report reference number**