Agricultural Discharge Scenario

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Aims

The workshop aims are to develop a framework/decision-tree that simplifies the complexities of mixture assessments into methods that can be easily adopted by decision-makers, including science-based policy development. End-users are in regulatory-, industry- and academics sectors. The aim is for a framework that:

1. is cross-cutting i.e. it can be applied to any scenario
2. considers tools that can be used for forecasting mixture risks based on potential exposure scenarios as well as retrospective mixture diagnostic approaches, based on field observations
3. is practical to apply
4. represents state-of-the art with respect to the science of mixture interactions

The product of the agricultural discharge workgroup is a proposed framework including one or more decision trees relating to specific scenarios. The agricultural scenario looks at the potential for effects related to emissions of chemicals into aquatic environments which may result from both crop cultivation and livestock rearing. Practices within these two broad activities can occur within the same catchment, resulting in the potential co-occurrence in both lentic and lotic waterbodies.

Introduction

For Plant Protection Products, the assumption for this scenario would be that entry of chemicals follows use of plant protection products, as foliar, soil or seed treatment applications applied as single products or possibly tank mixes. Entry into aquatic environments could be direct through drift at application or through subsequent run-off and drainage. The use of PPPs is a highly regulated activity in both registration and application. However, the registration procedure is generally based on single active ingredients or products (mixtures potentially containing multiple active ingredients and other chemical adjuvants). The aquatic assessments are generally edge of field scenarios and the question remains as to how protective they are in the wider environment where other chemical stressors may be present.

Animal husbandry can be associated with the use of veterinary medicines including hormones, disinfectants and biocides. There are multiple routes of entry into aquatic environments including run-off from animal feed-lots or manure storage areas, pasture and grazing areas, agricultural fields or grasslands where manure has been applied as a fertilizer or for disposal, or water from feedlot lagoons that has been use for irrigation.

Approach

Development of scenarios can take either a retrospective or prospective approach. In the retrospective approach, we will seek to understand real world configurations of factors (anthropogenic and environmental) that can be used to identify existing hot-spots/vulnerable areas. In a prospective manner, we can generate stylized scenarios to configure to different situations in order to answer “what if” questions. Some example questions to help evaluate these approaches.

1. If I have an area with a certain mix of arable and livestock production and environmental variables (weather, terrain, etc), what is the likelihood that I might see mixture effects?
2. If I have an aquatic habitat that is/appears impacted, what are the potential [chemical] agricultural-related

stressors that may have originated within the watershed that may be contributing?

   a. How can I improve the ecological quality of this site (i.e., what mitigation measures might be applicable)?

3. If I have a certain set of measured chemical concentrations in surface water or sediment, what are the potential effects on various taxa, what are the driving chemicals for the effects, and what are the likely sources?

4. If I look at a large region (e.g., EU-wide, individual Member State, broad ecoregion), where might I find the combinations of agricultural chemicals in surface water/sediment that may have adverse impacts on aquatic environemts?

Charge questions

The questions outlined below are a beginning set of those which can help identify the types of contaminants that could enter aquatic surface water or sediment and developing scenarios which may be used to perhaps identify potential effects in vulnerable areas in either a prospective or retrospective manner.

Details of receiving water body and contributing aspects

- Define type - stream, river, watershed, pond, lake
- Define a spatial scale
- How many scenarios are needed?
- What are the expected relative contributions/emission routes to surface waters, e.g. from PPP, veterinary medicines/other products, manure, silage?

Details of PPP application regime

- Which PPP are used, e.g. Insecticides, fungicides, herbicides?
- What is the application regime – times of year, number and frequency of applications, how applied – applied together as mixture formulation, tank mix – temporal co-occurrence?
- Area applied - % of watershed use of different ais
- Are uncultivated riparian buffer zones present between the land and drainage channels/other water bodies?
- Slope – run-off potential, identify vulnerable areas
- What do we have to model potential combinations of pesticides for catchment wide inputs?
- How do we model various combinations ?
- Could we use monitoring data to focus on specific chemistry classes ?
- Synthetic fertiliser applications – do we include these in exposure decision tree ?

Details of livestock rearing

- Are animals grazing on land and/or intensively reared – feed lots- hard surfaces v free range?
- Large scale chicken production – litter holding and disposal/distribution ?
- Aquaculture considerations
- Which veterinary medicines, disinfectants, biocides are used?
- Is manure/slurry applied to land adjacent to the water body, how far is it transported for application?
- Is silage produced on site and can leachate reach surface waters?
- Are land drains installed that discharge to receiving waters?
- Are there other local land uses that could lead to contaminant exposure?
- What are the local flow/dilution factors and upstream loading?

Monitoring data for specific contaminants

- Validate modelling approaches, what mixtures likely?
- Availability of information, where do we get info from? (e.g., NORMAN at http://www.norman-network.com, IPCHEM from JRC)
- Are data from routine monitoring or targeted sampling?
    - Drift and runoff events are highly-episodic, therefore timing of sampling relative to pre-sample environment is crucial for interpretation (e.g., when did it last rain, how much, what was river flow, etc).
- Are the farming practices working to minimize impacts on water quality (i.e., meeting DO, BOD, NH3)?
- Measured concentrations in the form of total, suspended solids, organic matter, bioavailability issues
- Is there an adequate understanding of the relationship of in-stream habitat that can potentially support aquatic communities that are classified with good ecological status?
    - The goal here is to avoid conducting site-based monitoring at sites where habitat quality is limiting.

Modeled contaminants

- Based on knowledge of application regime and influencing factors, estimate local and downstream receiving water concentrations. There are several regulatory/non-regulatory models available for predicting surface water PECs for PPPs, e.g. EU FOCUS scenarios (in conjunction with a spray drift calculator and the MACRO, PRZM and TOXSWA models) and Vet meds, e.g. Uniform approach, VetPEC, Etox, VetCalc, SWAT.
    - How to connect edge of field models to watershed? perhaps easier for water soluble rather than lipophilic compounds
    - Consider use of meta-models (e.g., Meta-PEARL) for efficiency and consistency?

Effects and Risk

- Do measured contaminants lead to identification of potential risks associated with mixtures? If so,
    - is it due to the cumulative effects of all contaminants or just a few?
    - is acceptable recovery expected based on knowledge of similar application regimes? Account for factors reducing exposure e.g. dissipation rates, adsorption and type of impact (taxa impacted, potential for recruitment/re-colonization).
- Several monitoring campaigns on mixture effects are going on under the European water framework directive (e.g., Mischet et al, 2014, Botta et al, 2014)
- How do we identify ecological risk, EQS/PNEC approaches for mixtures?
- Can we mix community level endpoints?
    - If so, is it due to the cumulative of all contaminants, or the dominance of just few chemicals?
- MoA – risk based rankings – how to do additive assessment?
- PNEC/Ecosystem approach, specific endpoints additive approach, direct/indirect effects.
- Ecological modelling – extrapolation from individual to population to community/ecosystem?
- What is the relationship of prospectively identified risks with measured biological data per site?