Geospatial approaches to increasing the ecological relevance of Environmental Risk Assessment

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Introduction
The prospective risk assessment of chemicals across all regulatory jurisdictions follows a generic approach, comparing estimated exposures to toxic thresholds designed to be protective of all species. This approach does not recognise geographic patterns of species distributions or acknowledge that particularly sensitive species may not occupy potentially exposed habitats. Therefore, risk assessments could be overly conservative and restrictive for some uses of chemicals.

Geo-referenced ecological data are becoming increasingly available at spatial resolutions applicable to chemical risk assessment, potentially facilitating enhanced environmental relevance of such risk assessments.

Greater realism in assessing additional stress due to chemical exposure could be achieved if the range of managed and unmanaged environmental typologies and their constituent biological communities were mapped and described.

In 2017 ECETOC initiated a Task Force to investigate current capabilities in making spatially explicit chemical risk assessments (from both an exposure and effects perspective). After comprehensive research for applicable and available data, we investigated techniques and methods for combining disparate data sets using case studies, and identified some of the challenges of using different levels of taxonomic, spatial and temporal resolution in spatially explicit risk assessments.

Conceptual Framework
Objective: Demonstrate capability to obtain and map spatially explicit chemical exposure information and integrate with geo-referenced ecological receptor data to determine priority locations suitable for refined risk assessment. Two “proof of principle” studies were investigated.

Case studies
A Pan-European exposure of freshwaters to a surfactant used in domestic cleaning products.

- The aggregate risk of three Plant Protection Products (PPPs) (herbicide, insecticide and fungicide) used on three crops in Rhineland-Palatinate, Hessen and Saxony, Germany.

Conclusions
- Generation of geo-referenced data describing environmental characteristics and ecological receptors is increasing although access and utilisation can be problematic.
- Starting with the goal of developing Europe-wide datasets to use in case studies proved challenging, we needed to focus on smaller geographic areas to obtain biological data to which we could compare our estimated chemical stressors.
- We demonstrated capability for making retrospective analyses of the relationships between ecological status and chemical stressors across a wide range of spatial scales.

In the PPP case study highlighted here:
- these relationships do not indicate a clear cause for concern from acute or chronic exposure at the catchment scale.
- estimated risks at field level are much greater than at catchment scale, indicating a low occurrence of potential impacts requiring further investigation/refinement.
- the identification of small numbers of “field specific” relatively high risks might not be expected to be seen in current RA paradigms.
- even at field level, there is no clear relationship between ecological status and PPP risk, suggesting that the 3 PPPs investigated are not driving the ecological status.
- Accounting for variation in time/space of exposure and receptors could improve current regulatory risk assessment methods.
- An ECETOC Technical Report will be prepared and made available to the public when completed (http://www.ectoc.org/publications/technical-reports/).

Analysis Flow
Data needs: Geo-spatial information research and acquisition

1. Chemical emissions
2. Receiving environment
3. Geo-referenced Predicted Ecological Concentrations (PECs)
4. Geographical distribution
5. Landscape-specific protection goals
6. Results: If needed, determine locations of concern for focused Ecological Risk Assessment

Geo-referenced mapping of exposure facilitates assessment of specific protection goals.

Spatially relating exposure and receptors
Spatially linking data of different scales can be challenging. In one approach we identified the proportion of sites ranked as good ecological status (ecological class 1 or 2) within each catchment, and compared to SYNOPS catchment risk. We also related each biological sampling site to the closest agricultural field (very high resolution) within 300m. We attempted to identify via statistical analysis of matched data if we could find correlations between relative exposure/risk and ecological receptors/indicators. This work is ongoing.

PPP exposure
Information on environmental exposures were modelled using SYNOPS from the Julius Kühn Institutes1. Application of 3 PPPs to 3 crops (winter wheat, winter barley and winter oilseed rape) were modelled using surveyed usage data randomly applied to individual fields. Concentrations in surface water were estimated for each field based on many factors, including soils and rainfall using standard PPP exposure models.

PPP risk
Daily field-level exposures in surface water were converted to Exposure : Toxicity Ratios (ETRs) for each PPP, and summed to an acute and chronic risk index for four taxa. The annual 90th percentile sum of risk (all 3 PPPs) for all fields within a catchment was used as an indicator of potential exposure to aquatic organisms.

Evaluating specific protection goals based on key sampling locations:

1. Determine chemical exposure scenario via spatial distribution of concentrations
2. Determining exposure scenarios with existing datasets e.g., GeoCAT, ECOAT, UKH, Hessen, Saxony
3. Uniting potential GIS quantitative (MARS) mapping of exposure/impact
4. Linking exposure information and integrate with geo-referenced ecological receptor data
5. Comparing with relevant recent data and existing ecological assessments
6. Developing or integrating protection goals based on key sampling locations

PPP risk1 and fish ecological status2

At the catchment scale, there is no strong evidence that increased PPP risk1 is linked to reduced proportion of sites with good ecological quality2.

References
1. Julius Kühn Institute (JKI), Krefeld, Germany. Strassemeyer J. https://www.julius-kuehn.de/

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