EXPLORING COMMUNITY BASED ENVIRONMENTAL RISK ASSESSMENTS OF MIXTURES USING MODE-OF-ACTION APPROACHES

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BACKGROUND FOR THE TASK FORCE

There is an increasing awareness of the need to complement single substance assessments with the assessment of mixtures. MODE OF ACTION considerations have been proposed to derive environmental thresholds for substances with the same mode of action. This implies that for MIXTURES OF SUBSTANCES which act according to the same mode of action, there is one threshold, i.e. a concentrations below which no impact on the environment is expected. Finally, there is an acknowledged need to increase ecological realism of environmental assessments by considering COMMUNITIES rather than single species to represent that whole communities.

MODE OF ACTION: AN OVERVIEW

While our understanding of MoA is increasing, chemical classification remains a challenge. The conventional schemes proposed by Verhaar and Russom provide a low MoA resolution that is not sufficient to account for mixture effects in specifically acting chemicals. The mode of action database from Barone et al. (figure below) illustrates our increasing understanding of MoA. This information, however, is not routinely used for mixture effect analysis.

TERMS OF REFERENCE FOR THE TASK FORCE

The objective of the task force is to draft a provisional ecological risk assessment approach based on a review of the current state of science in the areas of mode of action, mixtures and community assessment.

TASK 1: Review literature on extrapolation of effects from single chemicals to mixtures

TASK 2: Review literature on MoA-approaches for approximating mixture effects with focus on aquatic communities

TASK 3: Address effects both direct and indirect, on communities

TASK 4: Identify knowledge gaps and research needs to close the gaps

MAPPING AVAILABLE DATA: LITERATURE REVIEW

We performed a literature review, identifying key studies that deal with chemical effects of mixtures in a community context.

THOUGHTS ON FATE: CHEMICAL SPACE ANALYSIS

Anthropogenic chemicals are designed to perform a specific function. The physico-chemical parameters that enable this functionality will cause chemicals to partition in environmental compartments in particular ways. Here we illustrate the predicted chemical fate of some selected chemicals identified from the literature review.

GETTING TO THE COMMUNITY LEVEL: A TOOLBOX

The combination of mode-of-action based mixture effect modelling at single species levels with knowledge about species ecology and ecological interactions in a community builds the basis for the extrapolation from single compound toxicity to community-level effects.

TOWARDS A RISK ASSESSMENT FRAMEWORK: RESULTS SO FAR

Any ecological risk assessment for chemicals needs a defined protection goal and a required level of detail. The toolbox allows these choices to be defined explicitly. Upon problem definition, a suggestion for a provisional ecological risk assessment approach is to:

1. Collect toxicity and MoA data for relevant chemicals and group into different MoA classes
2. Calculate expected mixture effects for single species by:
   1. Application of concentration addition for effects from one MoA
   2. Application of independent action concept for mixtures of multiple MoA’s (mixed model)
3. Extrapolate to the intended level of ecological realism by application of a corresponding model

MORE WORK IS REQUIRED: FUTURE RESEARCH NEEDS

Although the broader scheme appears clear, there are many details which need further research:

• Ecological knowledge is necessary to parameterise taxonomy- or function-driven ecological models at higher levels of details. Although, the knowledge in traits databases (e.g. freshwaterecology.eu) appears as a good basis, it is still unclear which community models can be parameterised by such databases and for which approaches more quantitative information needs to be collected first.

• Existing modelling approaches can be used to predict community effects for combinations of chemicals from different MoA classes, and to predict extreme scenarios (e.g. synergism or antagonism of effects at community levels). Existing assessment tools lack data for this.

• Increasing ecological realism of community effects is mostly for compounds from one (broad) MoA, so new experiments could be done, which are guided by model predictions and used to test and validate the models.

REFERENCES

European Centre for Ecotoxicology and Toxicology of Chemicals