

Effect-based methods for ecological risk assessment of chemical mixtures

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Ecosystem health and chemical mixture risk assessment and management

Ecological Risk Assessment

Ecotoxicology faces the challenge of assessing and predicting the effects of an increasing number of chemical stressors on species and ecosystems

With increasing ecological relevance the reproducibility, specificity and thus suitability for standardization of methods tends to diminish

The promising concept of "adverse outcome pathways (AOP)" links mechanistic responses on the cellular level with whole organism, population, community and potentially ecosystem effects and services

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Madden et al., 2014 Phil. Trans. R. Soc

Chemical mixtures

Simultaneous exposures to multiple chemicals can exert additive, synergistic, or antagonistic effects; equal to, greater than, or less than the sum of the independent effects of each contaminant, respectively

- Effect-based tools can be useful in the development of rational and cost-effective monitoring programs, to improve the environmental relevance of the assessment,
- and to link ecological and chemical information.



Connon et al., 2012 Sensors

Natural vs engineered nanomaterials





Measuring the occurrence is not predictible of real exposure scenarios Low relevance for ecological risk assessment

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Corsi et al. , 2020 Frontiers in Marine Sciences

Nanoplastics





	PE (%)	PP (%)	PS (%)	PVC (%)	PET (%)
mesoplastic (5 mm -20 cm)	59	17	12	6 ^{<i>a</i>}	nd
large microplastic (1 mm -5 mm)	90	10	nd	nd	nd
small microplastic (20 μm–999 μm)	73	13	2	8	1
nanoplastic (1–999 nm)	4	nd	9 ^b	70 ^b	17 ^b

Ter Halle et al., 2018 Env Sci Technol

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- Z-Average: 883.9 ± 3.2 nm
- PDI: 0.533 ± 0.05
- Count-Rate: **17.4 ± 0.4 kcps**

Polystyrene nanoparticles

Up to mg/L in the real exposure scenarios due to fragmentation and weathering of macro and micro



PS PEC 1.5 μg/L



Impact on phytoplankton

single cell level



Dunaliella terctiolecta

Surface adhesion Aggregation No toxicity







Bergami et al., 2017 Aquat Toxicol



Bellingeri et al. 2020 Env Pollut



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Bergami et al., 2017 Aquat Toxicol



Impact on carbon flux in Southern Ocean_Antarctica

Bergami et al., 2020 Environ Int

British Antarctic Survey

New paradigm

Effect-based tools for emerging pollutants in chemical mixtures



Listen up men. You are about to embark on a toxicity test to determine an LC50. Look left, look right – half of you won't be coming back.

Single-species assay Single-substance basis Limited number of species Classical end-points The measurement endpoint is a measure obtained from a standard laboratory toxicity test using a model organism, whereas the **assessment endpoint is often** *ecosystem function and biodiversity*



Purple = +/-, uncertain Red = con

Integrated approaches of linking mechanistic responses on the cellular level with whole organism, population, community and ecosystem effects and services would be desiderable for a comprehensive assessment of ecotoxicological risks



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