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Characterisation of cumulative risk of contaminants to organisms exposed to stormwater in Oslo, Norway

Background

Oslo, the capital of Norway, is situated by the Inner Oslofjord. In addition to municipal discharges, the Inner Oslofjord ecosystem is affected by industry, leisure boats and commercial ships. Furthermore, various environmental contaminants enter the fjord by rivers and streams, and through surface water/stormwater. The conditions of the Inner Oslofjord have been monitored by several different monitoring programs, and data for concentrations of a wide range of contaminants have been reported in biota, water and sediment samples [1,2].

The objective of the present study was to use data gathered through the "Urban fjord" monitoring programme (administered by the Norwegian Environment Agency and carried out by NIVA) to perform a retrospective cumulative environmental risk assessment (CRA), identify species groups of highest risk for toxic effects and identify the main contributing stressors (risk drivers) (Figure 1).

Approach

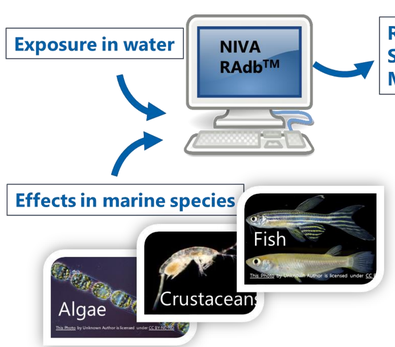

Figure 1. Cumulative Risk Assessment (CRA) of >150 organic and inorganic pollutants in stormwater enetering inner Oslofjord.

Monitoring data for concentrations of contaminants in stormwater from 2016 (more than 150 individual compounds), and effect data for those pollutants where such data were available, were imported to the NIVA Risk Assessment database (NIVA RAdb, www.niva.no/radb). Acute and chronic cumulative risk quotients (CRQs) were calculated (Fig. 1). Toxicity studies with defined mixtures of risk drivers were conducted with the marine copepod *Tisbe battagliai*. *In situ* fractionation and chemical analysis was performed to evaluate CRA predictions and identify the most risk-contributing fractions (to copepods).

Results

Highest CRQ for acute toxicity was observed in fish, while highest CRQ for chronic toxicity was observed in molluscs (Fig. 2). Metals were in most cases the main contributors to the CRQ in fish, algae and crustaceans (Fig. 3). The exposure studies with a site-relevant mixture of 12 pollutants showed that the predictions were typically 0.6-2 times lower than observed (Fig. 4).

Figure 2. Cumulative risk quotients (weighted average and and 95% CI) for a contaminant mixture in stormwater entering the Oslofjord. The figures display predicted acute (left) and chronic (right) toxicity to different organism groups.

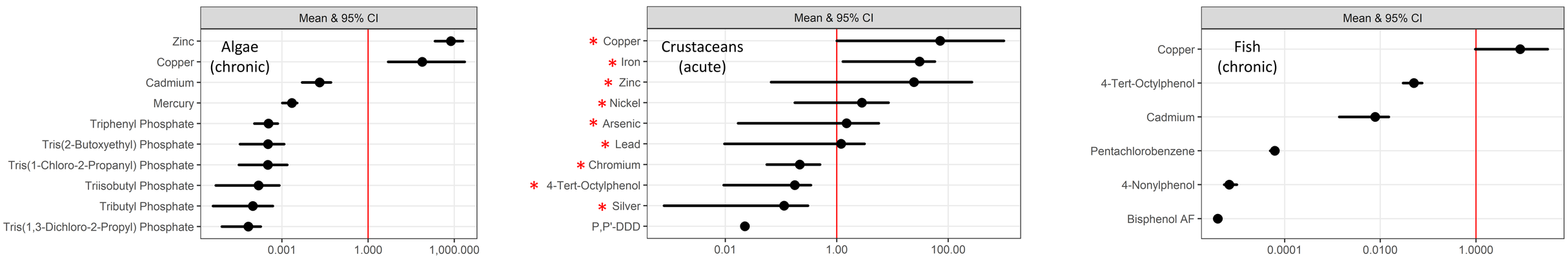

Figure 3. Compound-specific risk quotients (weighted average and 95% CI) for a contaminant mixture in stormwater entering the Oslofjord. The figures display the predicted risk to algae (left, chronic toxicity), crustaceans (middle, acute toxicity) and fish (right, chronic toxicity). Data display the most risk-contributing pollutants (n≤10).

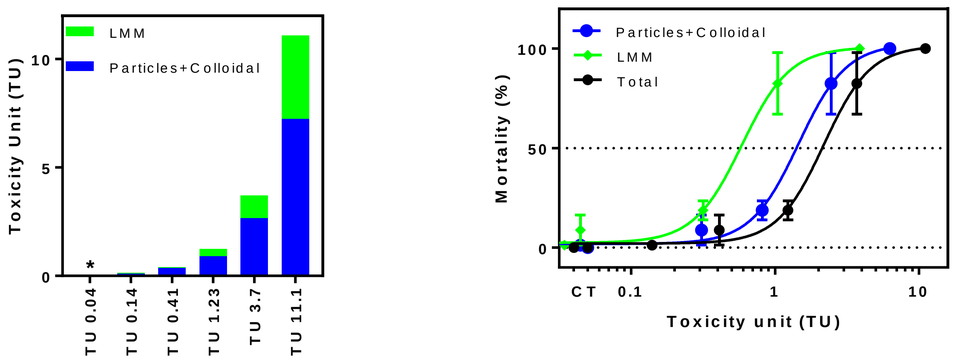

Figure 4. Speciation-specific risk (left) and speciation-associated acute mortality to T. battagliai (right) for a 12 component mixture (, fig. 3, plus Sb, TCPP). Asterics: <LOD.*

Conclusions

There is a predicted risk for biological effects in organisms exposed to stormwater entering the Inner Oslofjord, where metals as well as a few organic chemicals were typical risk drivers. Experimental studies with defined pollutant mixtures identified that risk (of acute mortality) to the marine copepod *T. battagliai was* fairly accurately predicted by the CRA model.

References

[1]Green, NW. et al., 2016. Contaminants in coastal waters of Norway 2015. NIVA-report 7087-2016.
[2]Ruus, A. et al., 2017. Environmental Contaminants in an Urban Fjord, 2016. Norwegian Environment Agency report M812-2017.

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NIVA Ecotoxicology and Risk Assessment

NIVA's Computational Toxicology Program

Acknowledgement. This work was funded by The Research Council of Norway, project 268294: Cumulative hazard and risk assessment of complex mixtures and multiple stressors (MixRisk) and NIVAs Computational Toxicology Program (NCTP).

With funding from The Research Council of Norway