EFFECT MONITORING: MEASURING TOXIC POTENCY OF WATER

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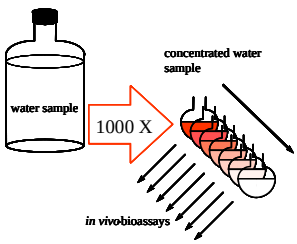
Introduction

The European Water Framework Directive demands monitoring of chemical and biological water quality. Until now the official monitoring guidances provide only for measuring concentrations of individual chemicals and assessing the biological community in the water.
To measure the toxic effect of concentrated water samples, we use a battery of laboratory bioassays to incorporate the joint effect of complex unknown mixtures of organic pollutants.
This method, as a first step in assessing the water quality, screens for potential chemical problem areas. This may help water managers to identify the main reason for not reaching good ecological status (eg chemical, hydromorphological or eutrophication) and prioritize their means.

Method [1]

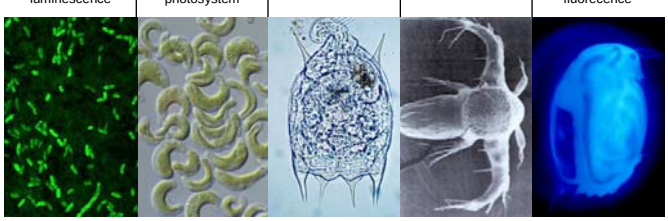
- 48h extraction of organic pollutants with XAD 4/8 resins.
- Acetone elution and distillation: selective 1000-fold concentration of water sample.
- Eliminates other factors that can affect bioassays (humic acids, pH, nutrients, metals).



Bioassays

- Different types of species in morphology and trophic level.
- Test the effects of different dilutions of the 1000-fold concentrate.
- Endpoints expressed as EC^f_{50} or LC^f_{50}: the concentration factor (C^f) of the water where 50% of the organisms is affected (Fig. 1).

Microtox®	Algae (PAM)	Rotoxkit F™	Thamnotoxkit F™	Daphnia (IQ)
Vibrio fischeri	*Pseudokirchneriella subcapitata*	*Brachionus calyciflorus*	*Thamnocephalus platyurus*	*Daphnia magna*
5 and 15 min	4,5 h	24 h	24 h	1 h 15 min
Inhibition of luminescence	Fluorescence photosystem	Mortality	Mortality	Inhibition of fluorecence



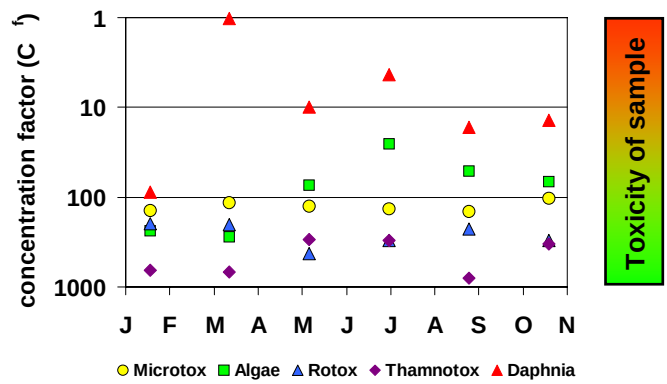


Figure 1. Concentration factor of the water where 50% of the organisms is affected in each bioassay. Results from location Eijsden 2005. E.g. at C^f = 10 the original water sample needs to be concentrated 10 times to find acute effects.

Risk assessment (Fig 2)

- Cumulative Species Sensitivity Distribution from EC/LC^f_{50} from 5 bioassays (analogue to SSD's at given toxicant concentration).
- Extrapolate SSD curve to chronic No Effect by assuming average ratio of 10.
- Toxic Potency: PAF at C^f = 1 represents % of species that may be affected.

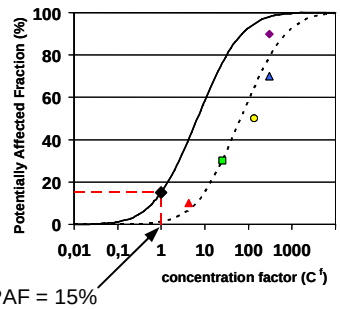


Figure 2. Extrapolation from acute bioassay-endpoints (coloured symbols), to acute SSD (dashed curve), to chronic SSD (solid curve), to toxic potency: potentially affected fraction (PAF, black diamond) at C^f = 1. Example from location Eijsden July 2005.

Results & discussion

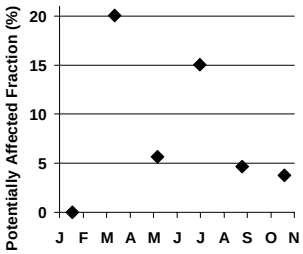


Figure 3. PAF (as % of potentially affected species) at location Eijsden in 2005.

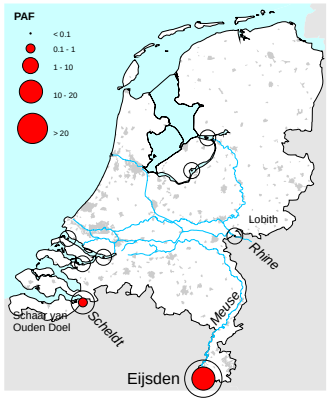
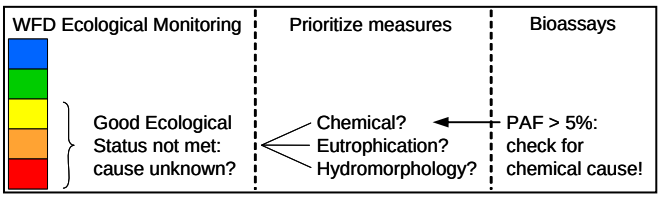


Figure 4. PAF at different locations in The Netherlands in July 2005

Monitoring data of > 10 years available. E.g. water in Meuse at Eijsden was potentially toxic at least 2 times in 2005.
Although this method cannot replace ecological monitoring, it can be used to assess toxic potency imposed by chemicals concentrated from the surface water, complementary to chemical analyses.
It serves as first screening for effects of complex unknown mixtures (a.o. of priority substances) and helps decision makers to identify cause and focus on right measures to improve water quality:



New developments

- Joint monitoring at official WFD sites.
- Research on applicability of specific tests for endocrine disruption.
- Develop specific tests for pharmaceuticals,
- e.g. antibiotics: with cyanobacteria
  with different bacterial groups[2]

References

[1] De Zwart, D. & A. Sterkenburg. Toxicity-based assessment of water quality. In: L. Posthuma, G.W. Suter II and Th.P. Traas (eds), Species sensitivity distributions in Ecotoxicology, pp 383-402. Boca Taton: Lewis Publishers, 2002.
[2] Rotteveel, S.GP., G. Stroomberg, J. Tiesnitsch & H. van Egmond. Development of fast screening methods to identify active antibiotics in wastewater and surface water samples. SETAC poster 2006.

Acknowledgements

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