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Towards the review of the European Union Water Framework Directive: Recommendations for more efficient assessment and management of chemical contamination in European surface water resources

Werner Brack[a,b,*], Valeria Dulio[c], Marlene Ågerstrand[d], Ian Allan[e], Rolf Altenburger[a,b], Markus Brinkmann[b], Dirk Bunke[f], Robert M. Burgess[g], Ian Cousins[d], Beate I. Escher[a,h], Félix J. Hernández[i], L. Mark Hewitt[j], Klára Hilscherová[k], Juliane Hollender[l], Henner Hollert[b], Robert Kase[m], Bernd Klauer[a], Claudia Lindim[d], David López Herráez[a], Cécil Miège[n], John Munthe[o], Simon O'Toole[p], Leo Posthuma[q,r], Heinz Rüdel[s], Ralf B. Schäfer[t], Manfred Sengl[u], Foppe Smedes[k], Dik van de Meent[v], Paul J. van den Brink[w,x], Jos van Gils[y], Annemarie P. van Wezel[z,aa], A. Dick Vethaak[y,ab], Etienne Vermeirssen[l], Peter C. von der Ohe[ac], Branislav Vrana[k]

[a] Helmholtz Centre for Environmental Research UFZ, Leipzig, Germany
[b] RWTH Aachen University, Aachen, Germany
[c] Institut National de l'Environnement Industriel et des Risques INERIS, Verneuil-en-Halatte, France
[d] ACES - Department of Environmental Science and Analytical Chemistry, Stockholm University, Stockholm, Sweden
[e] Norwegian Institute for Water Research (NIVA), Oslo, Norway
[f] Oeko-Institut e.V. - Institute for Applied Ecology, Freiburg, Germany
[g] U.S. Environmental Protection Agency, ORD, NHEERL, Atlantic Ecology Division, Narrangansett, RI, USA
[h] Eberhard Karls University of Tübingen, Tübingen, Germany
[i] Jaume I University, Castellón, Spain
[j] Aquatic Ecosystem Protection Research Division, Environment Canada, Burlington, Ontario, Canada
[k] Masaryk University, Research Centre for Toxic Compounds in the Environment (RECETOX), Brno, Czech Republic
[l] EAWAG, Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland
[m] Swiss Centre for Applied Ecotoxicology, Eawag-EPFL, Dübendorf, Switzerland
[n] IRSTEA – UR MALY, Villeurbanne Cedex, France
[o] IVL Swedish Environmental Research Institute, Gothenburg, Sweden
[p] Environmental Protection Agency, Dublin, Ireland
[q] National Institute for Public Health and the Environment RIVM, Bilthoven, The Netherlands
[r] Department of Environmental Science, Institute for Water and Wetland Research, Radboud University Nijmegen, The Netherlands
[s] Fraunhofer Inst Mol Biol & Appl Ecol IME, Aberg 1, D-57392 Schmallenberg, Germany
[t] University Koblenz-Landau, Landau, Germany
[u] Bavarian Environmental Agency, D-86179 Augsburg, Germany
[v] MERMAYDE, Groet, The Netherlands
[w] Alterra, Wageningen University and Research Centre, P.O. Box 47, 6700 AA Wageningen, The Netherlands
[x] Department of Aquatic Ecology and Water Quality Management, Wageningen University and Research Centre, P.O. Box 47, 6700 AA Wageningen, The Netherlands
[y] Deltares, Delft, The Netherlands
[z] KWR Watercycle Research Institute, Nieuwegein, The Netherlands
[aa] Copernicus Institute, Utrecht University, Utrecht, The Netherlands
[ab] VU University Amsterdam, Institute for Environmental Studies, Amsterdam, The Netherlands
[ac] Amalex Environmental Solutions, Leipzig, Germany

* Corresponding author at: Helmholtz Centre for Environmental Research UFZ, Leipzig, Germany.
E-mail address: werner.brack@ufz.de (W. Brack).

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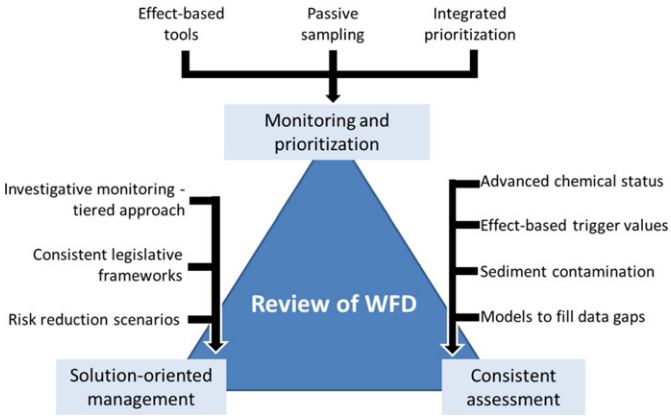
HIGHLIGHTS

- Improve monitoring and strengthen comprehensive prioritization of toxic pollutants
- Foster consistent assessment of water pollution
- Support solution-oriented management of chemicals in the water cycle

GRAPHICAL ABSTRACT



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ABSTRACT

Water is a vital resource for natural ecosystems and human life, and assuring a high quality of water and protecting it from chemical contamination is a major societal goal in the European Union. The Water Framework Directive (WFD) and its daughter directives are the major body of legislation for the protection and sustainable use of European freshwater resources. The practical implementation of the WFD with regard to chemical pollution has faced some challenges. In support of the upcoming WFD review in 2019 the research project SOLUTIONS and the European monitoring network NORMAN has analyzed these challenges, evaluated the state-of-the-art of the science and suggested possible solutions. We give 10 recommendations to improve monitoring and to strengthen comprehensive prioritization, to foster consistent assessment and to support solution-oriented management of surface waters. The integration of effect-based tools, the application of passive sampling for bioaccumulative chemicals and an integrated strategy for prioritization of contaminants, accounting for knowledge gaps, are seen as important approaches to advance monitoring. Including all relevant chemical contaminants in more holistic "chemical status" assessment, using effect-based trigger values to address priority mixtures of chemicals, to better consider historical burdens accumulated in sediments and to use models to fill data gaps are recommended for a consistent assessment of contamination. Solution-oriented management should apply a tiered approach in investigative monitoring to identify toxicity drivers, strengthen consistent legislative frameworks and apply solutions-oriented approaches that explore risk reduction scenarios before and along with risk assessment.

1. Introduction

Water is a vital resource for natural ecosystems and human life, and therefore, as stated by the European Union (EU) Water Framework Directive, a "heritage which must be protected, defended and treated as such" (European Union, 2000). Especially freshwater is limited in quantity and in quality, and currently under a variety of increasing pressures; for example, climate change, overexploitation and contamination from point and diffuse sources, including agriculture, industry and households. Ensuring a high quality of water and a high level of protection from chemical contamination is fully in line with the major societal goals presented by the 7th Environmental Action Plan of the EU "Living well within the limits of our planet" (European Union, 2013a). Consistent with this, the earth's capacity to assimilate chemical pollution has been proposed as one of the nine planetary or regional boundaries in relation to which anthropogenic impact needs to be reduced if unacceptable global or regional change is to be avoided (Rockström et al., 2009a; Rockström et al., 2009b; Steffen et al., 2015).

Threats to clean water (and other environmental compartments) have resulted in a number of regulations around the globe aiming to reduce the production and use of the most hazardous chemicals. Nevertheless, despite significant achievements, toxic pollution still poses a substantial risk to almost half of the water bodies recently monitored in Europe (Malaj et al., 2014). Such risk assessment results are corroborated by diagnostic eco-epidemiological impact studies, in which changes in biodiversity associate with mixture exposures (Posthuma et al., 2016; Posthuma et al., 2016), but, due to lack of knowledge, current regulation of environmental quality is mostly based on a limited number of single chemicals. Consequently, and in agreement with the concepts of ecological, energy, carbon, and water footprints (Fang et al., 2014), the concept of a chemical footprint has been advanced to enable exploration of mixture threats for water systems. The chemical footprint has been defined as "a quantitative measure describing the environmental space needed to dilute net chemical pollution – commonly by a mixture – due to human activities to a level below a specified boundary condition" (Zijp et al., 2014). It is, however, very challenging to identify and quantify boundaries for chemical pollution either at local or global scales (Diamond et al., 2015) given the very large number of chemicals present in the environment, the wide-ranging sensitivity of natural species, and the vulnerability of ecosystems (Posthuma et al., 2014).

At present, man-made products containing >100,000 chemicals are registered in the EU, where 30,000 to 70,000 are in daily use (Loos et