Prioritisation of water pollutants: the EU Project SOLUTIONS proposes a methodological framework for the integration of mixture risk assessments into prioritisation procedures under the European Water Framework Directive

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POLICY BRIEF

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Prioritisation of water pollutants: the EU Project SOLUTIONS proposes a methodological framework for the integration of mixture risk assessments into prioritisation procedures under the European Water Framework Directive

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Abstract

Current prioritisation procedures under the EU Water Framework Directive (WFD) do not account for risks from chemical mixtures. SOLUTIONS proposes a multiple-lines-of-evidence approach to tackle the problem effectively. The approach merges all available evidence from co-exposure modelling, chemical monitoring, effect-based monitoring, and ecological monitoring. Full implementation of the proposed methodology requires changes in the legal text in adaptation to scientific progress.

Keywords: Water pollutants, Priority substances, Combined exposure, Mixture toxicity, Cumulative risks, European chemicals legislation, WFD revision

Challenge

As a strategy against chemical pollution, Article 16 of the EU Water Framework Directive (WFD) [1] requires the identification of EU-wide priority substances (PS) selected amongst those pollutants or groups of pollutants presenting significant risks to or via the aquatic environment. In addition, EU Member States are required to identify river-basin specific pollutants (RBSP) (WFD Article 4 and Annex V). Furthermore, beyond the fulfilment of EU-wide WFD requirements, national or regional rules and provisions may require local water managers to identify site-specific pollutants or groups of pollutants causing significant local risks. EU-wide priority substances, RBSPs, and site-specific pollutants are subject to risk reduction efforts. The aim is to reduce pollution to safe concentration levels, currently formatted as so-called environmental quality standards (EQS) for separate chemicals.

Current regulatory procedures for prioritisation [2–4] and EQS setting [5] are focused on single substances. Individual pollutants are assessed as if they would occur in isolation. The fact that they are part of complex multi-constituent mixtures is largely ignored. However, a mixture of pollutants usually poses a higher risk than each individual constituent alone, as detailed in a separate policy brief on mixture risks [6]. As a consequence, compliance with EQS values for single pollutants (PS and RBSP) may not be sufficiently protective against toxic effects from combined exposure to multiple chemicals. This is not just a theoretical assumption but has also been demonstrated empirically in a study led by the European Commission's Joint Research Centre [7].

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The problem is well recognized but approaches for tackling it effectively were missing. The EU project SOLUTIONS, therefore, took up the challenging task to develop a proposal for an advanced methodological framework which integrates mixture risk assessments into prioritisation procedures under the WFD. The prioritisation is important to make river basin management planning most efficient.

Recommendation

SOLUTIONS proposes a multiple lines-of-evidence (LOE) approach for the identification of priority mixtures presenting significant risks and drivers of mixture toxicity dominating the overall risks (Fig. 1). The suggested methodology is applicable at all scales (EU, river basin, and site-specific level).

The approach merges evidence from

i. chemical monitoring, in combination with so-called component-based approaches for mixture risk assessment and driver identification,
ii. integrated modelling of co-exposure and resulting mixture risks,
iii. effect-based monitoring, in combination with so-called effect-directed analyses or related methods for the identification of causative (groups of) pollutants,
iv. ecological monitoring, (field observations on so-called biological quality elements), in combination with possible indications on causative (groups of) pollutants.

The multiple LOE approach is detailed in a public SOLUTIONS deliverable [8]. Explanations of individual techniques are given in dedicated policy briefs on chemical screening [9] and associated component-based methods [10], modelling of co-exposures [11] and resulting mixture risks [6], effect-based methods [12], and ecological tools [13].

For developing the approach, SOLUTIONS thoroughly examined all available concepts and methods for both (i) the regulatory assessment of risks from chemical mixtures and (ii) the integration of such mixture risk assessment methods into prioritization procedures. No single method was found to provide a comprehensive solution for the complex problem of assessing risks from pollutant mixtures in the aquatic environment. Every option has some advantages but also suffers from specific limitations. As the best possible way forward, SOLUTIONS, therefore, proposes a framework which integrates all available LOEs on significant risks.

The advanced framework does not replace existing procedures for single substance prioritisation but integrates them with novel methodological elements into the suggested multiple LOE approach. Where one or more lines of evidence identify groups of pollutants presenting a significant risk, these should be included in ranking procedures for risk reduction measures. Criteria for mixture risk ranking may be essentially the same as those which have been established for single substance prioritization, including the frequency and the extent of threshold exceedances [14]. Where appropriate, large groups of dozens or hundreds of

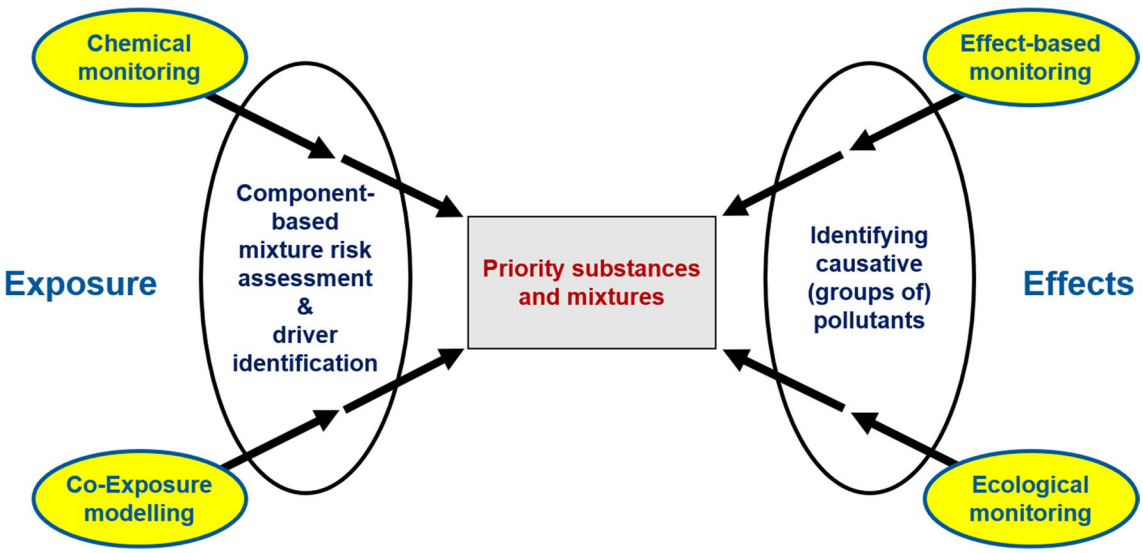

Fig. 1 Graphical presentation of the proposed multiple lines-of-evidence approach for the identification of priority substances and priority mixtures under the EU Water Framework Directive

co-occurring pollutants may be reduced to few mixture components or even one single component which can be demonstrated to explain most of the overall risk, so-called drivers of mixture risks.

Wherever conclusive evidence on significant risks and resulting needs for risk reduction cannot be provided because all LOEs suffer from significant knowledge-gaps, mixture components of potential concern are not left unaccounted for but are prioritised for further research and testing. This principle is adopted from the NORMAN approach for the prioritisation of individual substances of emerging concern [15].

Implementation

Implementation of the proposed framework for effectively dealing with mixture risks under the WFD requires changes in the legal text. The following is needed:

- A broader approach to the prioritisation of pollutants for risk reduction measures, including all substances that make a significant contribution to an unacceptable overall risk, irrespective of whether they exceed individually acceptable levels or not.
- Comprehensive assessments of the chemical status, including all pollutants at a given site. Currently, EU wide priority substances and RBSPs are assessed in isolation. EU wide priority substances define the "chemical status", while RBSPs are considered to affect the "ecological status". In a real water sample, however, both types of pollutants occur together and they may be accompanied by site-specific pollutants. EU wide priority pollutants, RBSPs, and site-specific pollutants jointly contribute to the overall mixture risk. Therefore, they need to be assessed together.
- Uniform legal principles and harmonised technical rules for the assessment and prioritisation of pollutants and pollutant mixtures on different scales such as EU wide priority substances, RBSPs, and site-specific pollutants. For example, EQSs or PNECs or other reference values used by different Member States for RBSP identification currently differ, sometimes by orders of magnitude [16]. Such inconsistencies in single substance assessments render transparent, consistent, and meaningful mixture risk assessments impossible.
- A clear legal mandate for the establishment of an effect-based monitoring system, which may be performed in parallel to chemical monitoring or which may serve as a trigger for targeted chemical monitoring, as detailed in a European technical report [17] and specifically addressed in a separate Policy Brief [12].

These special needs for amendments are part of a broader array of recommendations for revising the WFD with the aim to improve the achievement of its protection and risk reduction goals, as detailed in Brack et al. [18].

Chemical risk assessment and risk-based prioritisation are data-hungry exercises. The generation of necessary input data, however, is not part of the WFD but governed by other pieces of EU chemicals legislation. In addition to amending the WFD, complementary measures must, therefore, be taken to ensure data availability. Currently, the limited availability of (eco)toxicity data that are considered reliable for EQS derivation already poses a serious problem for the assessment of many individual water pollutants. For conclusive mixture risk assessments, the lack of such single substance toxicity data is an even more severe bottleneck [6]. In addition, co-exposure modelling suffers from the limited availability of chemical use and emission data [11]. The WFD does not include mechanisms to close any of these data gaps. Strengthening risk assessments of both individual aquatic pollutants and pollutant mixtures, therefore, requires cross-cutting initiatives, including all pieces of EU chemicals legislation [19] and clearly assigning responsibilities for providing reliable (eco)toxicity data.

Abbreviations

EQS: environmental quality standards; LOE: lines-of-evidence; PS: priority substances (in the sense of the WFD); RBSP: river-basin specific pollutants; WFD: Water Framework Directive.

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Disclaimer

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Authors' contributions

All authors contributed to a series of SOLUTIONS prioritisation workshops from which this Policy Brief emerged. MF drafted the manuscript. All co-authors helped to refine it and agreed on the final version. All authors read and approved the final manuscript.

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