

POLICY BRIEF

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The RiBaTox web tool: selecting methods to assess and manage the diverse problem of chemical pollution in surface waters

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Abstract

Chemical pollution of water bodies is a complex problem around the globe. When described by the extremes of the range of problem definitions, water bodies can be chemically polluted by a single compound that is emitted from a point source or an incidental spill, or by chronic diffuse emissions from local and upstream land uses. The resulting mixture exposures can vary in space and time, e.g. due to the use of pesticides in the crop growing season. The environmental management objectives are commonly to protect and restore surface waters against human influences. Currently, chemical pollution is globally judged for a selected set of compounds, by judging each of these individually in comparison with protective environmental quality standards. Research has provided a novel assessment paradigm (solution-focused risk assessment) and novel data, measurement methods and models to improve on current practices. Their adoption and application require establishing novel linkages between the diverse problem definitions and the novel approaches. That would assist water quality professionals to select the most effective option or options to protect and restore water quality. The present paper introduces the RiBaTox (River Basin Specific Toxicants assessment and management) web tool. It consists of short descriptions of the novel approaches (made available as Additional file 1) and a decision tree for end-users to select those. The overview of novel approaches collated in RiBaTox is relevant for end-users ranging from local water quality experts up till strategic policy developers. Although RiBaTox was developed in the context of European water quality problems, the methods provided by RiBaTox are relevant for users from (inter)national to local scales. This paper is part of a series of Policy Briefs from the EU-FP7 project SOLUTIONS (<http://www.solutions-project.eu>), which provide backgrounds on chemical pollution of surface waters and policy practices and proposed improvements.

Challenge

Chemical pollution in European water resources is of growing societal concern due to the potential risks to ecosystems and human health [1, 2]. The pollution problem can vary from simple and local, to complex and basin-wide. In 2010, the EU funded a substantial body of research activities to improve on the approaches for diagnosing and managing chemical pollution for surface waters in Europe [3]. In response, the SOLUTIONS-project (<http://www.solutions-project.eu>) undertook

fundamental research in water pollution. Results were evaluated in the context of, and aligned with, the current regulatory framework (the EU-Water Framework Directive [4]). This resulted in (a) a proposal to improve the utility of chemical risk assessments, a (b) suite of improved or novel technical tools and services to diagnose water quality problems with chemicals, and (c) a proposal of a strategy and a solutions database to translate diagnostic results in a programme of measures [5].

The results may lead to changes to current practices. As yet, the methods to assess chemical pollution problems are commonly applied in a straightforward way. That is, monitoring efforts yield data on measured concentrations of chemicals, and the observed values are compared on a per-chemical basis to a protective environmental

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quality standard. Amongst others, this involves an analysis of pressures and impacts [6] and the classification of the chemical and ecological status on the basis of chemical and ecological monitoring data and the quality standards [7, 8]. The current approach does not sufficiently cover the chemical pollution problem, as both societal concerns and scientific research asks consideration of far more chemicals and their mixtures [9, 10]. The results of the research encompass a suite of tools to characterize the pollution problem, as described in associated Policy Briefs of the SOLUTIONS-project. Due to the diversity of the new opportunities and the need to change the current practice, their practical implementation might be challenging for experts involved in chemical pollution assessment and management. These challenges might be faced by experts who are involved in the day-to-day practices of monitoring, assessment and management at the level of a water board up till decision makers working on the long-term strategic planning to prevent and reduce chemical pollution via, e.g. improved regulations or the provision of applicable guidance documents. Building forth on the current practices, the new opportunities for diagnosis confronts them with the choice to address the chemical pollution problem diagnosis, e.g. with improved component-based methods [11], or effect-based methods [12], or ecological methods [13], or any combination thereof.

Given the project results, the practical challenge boils down to the question of how to support the process of matching the novel assessment approaches to the diverse chemical pollution problems for the diverse end-users.

To address this problem, the SOLUTIONS-project designed the RiBaTox (River Basin Toxicants assessment and management) web tool. Despite the tools' name suggest a limitation to river basin-specific pollutants (a group of chemicals specifically considered within a river basin) in the EU-WFD context, the web tool provides information for any spatial level and for all surface waters globally. The WFD itself has no scale limitation, as any chemical may locally threaten the ecological status; if so, that chemical is identified as 'specific chemical' against which measures much be taken to reduce those impacts (see also [6]).

The RiBaTox web tool was designed to provide a decision tree and fact sheets that describe the novel assessment methods. Despite the EU-context of the SOLUTIONS research, the applicability of the methods is not limited to the EU only. The contents of RiBaTox are applicable to any water management situation, whether local, regional or (inter)national. The decision tree and the methods were derived in the context of the solution-focused risk assessment paradigm [5, 14]. This paradigm is used to improve the utility of the risk assessments and

has been the basis for a strategy and a database that provides end-users with solutions options for water quality management planning. The fact sheets can be updated in response to novel practical needs or results of research. RiBaTox is available via <https://solutions.marvin.vito.be/>.

Recommendations

To assist water quality protection, monitoring, assessment and management in practice, water quality managers and policy makers are recommended to:

- Use the SOLUTIONS conceptual framework for protecting, assessing and managing surface water pollution with complex mixtures, and consider RiBaTox as operational tool to use this conceptual framework in practice;
- Use RiBaTox to navigate from the specifications of a (likely) water pollution problem towards the diagnostic tools and services with which that problem can potentially be assessed and managed, and to identify the best (combination of) tool(s) that serves the purposes best;
- Apply RiBaTox for making decisions on the design of monitoring campaigns, on prioritizing chemicals, sites and abatement options, on the use of models to bridge data gaps and to prioritize them for the need of experimental efforts to fill them;
- Use RiBaTox as a basis for the development of a long-standing and regularly updated information platform that reflects the newest knowledge and further develop the structure of solutions-oriented decision trees with informative fact sheets as end points.

Requirements

Any tool or service needs to be useful, known, accessible by stakeholders and actual. The requirement of potential usefulness is that the web tool allows stakeholders to find science-based proposals to address the wide array of chemical pollution problems, beyond the methods currently known and frequently used. The set of tools and services can be used by experts at any level of organization—be it those that are responsible for local water quality management or those working as strategic policy designers at the level of countries or the EU.

The other requirement of 'being known' is reflected in the web tool (and the present paper). Scholars and practical end-users can find and use the available knowledge on approaches to investigate surface water chemical pollution.

The requirement of accessibility of the web tool has been arranged until at least 2020 via the SOLUTIONS Web site (<https://www.solutions-project.eu/>).

Longer-term maintenance and regular updates are achieved with the European science-policy network on emerging pollutants NORMAN (<https://www.norman-network.net/>), which acts as RiBaTox host.

The requirement of actual information is organized via the potential to update to information in RiBaTox. Active management of RiBaTox is recommended to continue that assessors can identify contemporary tools and services for their chemical pollution problem specification. Such management could be based on testing and implementing continuous improvements as needed. Systematic management would advance the system and its utility for water quality assessment and management beyond the duration of the SOLUTIONS-project, aligned with the longer-term requirements of the WFD and/or of other (inter)national water management schemes.

Achievements

RiBaTox as versatile and actual web tool

The goal that novel and diverse science-based approaches for chemical pollution assessment and management can be found by end-users has been achieved by creating the RiBaTox web tool.

The web tool concerns a specific policy area, which is chemical pollution of surface waters. The web tool assists end-users in understanding solution-focused risk assessment (with early focus on the 'solution space' when a pollution problem is encountered), in identifying potential diagnostic tools and services to diagnose the relevance of mixtures and individual chemicals in affecting water quality, and in the combination of both in selecting measures to prevent or reduce chemical pollution. The latter are required for the programmes of measures, which are the key management step in the assessment/management cycle for improving water quality.

The web tool supports the recommended changes of chemical pollution protection, assessment and management that have been proposed in associated Policy Briefs (e.g. on using holistic approaches considering chemical pollution from a water-system level point of view [5], for vastly more chemicals and their mixtures [10–12], via both monitored and modelled environmental concentrations of chemicals [15], with early consideration of the 'solution space' [16, 17], and with associated improvements on, e.g. monitoring data management [18]).

The web tool consists of a decision tree (to identify and select available tools and services for diagnosis) and of a set of fact sheets (available also as Additional file 1 to this paper). RiBaTox supports end-users in applying the novel science-based tools and services, fully in line with the obligations of the regulations to protect and restore surface water quality. For example, if an end-user is confronted with evidence for chemical pollution—e.g. from

an analysis of the drivers of chemical emissions in an area—and is specifically interested in impacts, the web tool shows potential approaches to be component-based methods, effect-based methods or ecological tools. All three can be used from a scientific perspective, as all three are a line of evidence on the presence of impacts. All three can also be used from the regulatory perspective of water quality management, as most regulations specifically suggest collecting data on multiple lines of evidence for this (e.g. WFD, Annex II). The assessor can select either individual methods or combinations of methods for the specific conditions of the pollution case. The web tool and the fact sheets can be updated to novel scientific insights or societal/regulatory needs if needed.

Alignment between the solution-focused approach and RiBaTox

The research achieved to use the solution-focused risk assessment paradigm as basis for the design of RiBaTox decision tree and the fact sheets on the diagnostic tools and services. According to the conceptual framework for solution-focused risk assessments [16], the problem of- and solutions for chemical pollution can be explored from different angles (chemicals, environment, abatement and society, see also [5]). The RiBaTox web tool reflects the different angles of the conceptual framework in the decision tree and the presence of fact sheets related to all the framework angles. It provides information on, e.g. monitoring strategies, modelling strategies, prioritization strategies, abatement strategies and policy strategies. Those strategies not only enable to find approaches or models for the various purposes, but also the data sets that have been compiled to serve as a harmonized volume of information for the different uses, available to all.

The compilation of current diagnostic tools and services in RiBaTox

More than 80 potentially relevant tools and services were identified in the research. This expands vastly on the current practices, in which classification of chemical and ecological status on the basis of monitoring data is common [2], but where the consideration of multiple lines of evidence and comprehensive diagnosis of causes of impacts as suggested, e.g. in WFD Annex II is relatively rare [5]. To support end-users in applying the novel approaches, RiBaTox provides a decision tree and fact sheets on methods that end-users can apply. The idea for stepwise guidance to most-profitable approaches helps in the selection of methods from the available options. For example, for a local or regional diagnosis of the role of chemical pollution in affecting water quality in the European context (WFD Annex II) or for the design of

monitoring approaches (WFD Annex V). The latter is illustrated in Table 1.

The full set of current fact sheets is shown in Additional file 1. Fact sheets contain contact information, so that end-users can contact scholars for more information on use and implementation or on novel developments of the methods, if needed.

End-user evaluation

The RiBaTox web tool is one of the three major achievements of the recent research activities, next to the conceptual framework for solution-focused risk assessment and the provision of a strategy and a database to support management planning. RiBaTox collates the final results of the research in a user-oriented format, but as yet no extensive practice validation of its utility

in case studies was feasible. It is clear, however, that the gaps between diverse chemical pollution cases, diverse diagnostic methods and diverse stakeholders need to be bridged. However, positive evaluations on the concept and approaches of RiBaTox have been received in both the planning phase (from the EU as commissioning body) and on the final product (the web tool). The latter was apparent from a dedicated stakeholder meeting in Paris, 2018, and from a memorandum of members of the stakeholder board [19]. This result can be understood in the context of 11 RiBaTox-dedicated stakeholder interactions, three dedicated RiBaTox surveys on draft web tools and the workshop with water managers, co-hosted together with stakeholder board member Veolia, June 2018.

Table 1 Illustration representing some elements of the RiBaTox decision tree and fact sheets, in relation to the conceptual framework for solution-focused risk assessment and end-user needs

Decision tree-level 1	Level 2	Level 3
Monitoring strategies	Sampling strategies	Grab sampling Passive sampling for organic contaminants Passive sampling for trace metals LVSPE Event sampling
	Analytical strategies	Target analysis SOPs compounds SOPs compound classes Preparation of standards Suspect screening Non-target screening
	Strategies for effect-based monitoring	In vivo tools In vitro tools Benchmarks and trigger values Biological early warning systems
	Strategies for toxicant identification	Ecotoxicological mass balances Virtual EDA Higher tier EDA
	Strategies for ecological assessment	Macrofauna community based PICT Fish biomarkers Weight of evidence approaches

The table shows a part of the decision tree that users are offered regarding monitoring strategies (column 1, WFD, Annex V). Column 2 shows the systematic subgrouping of main actions that can be applied. Column 3 identifies specific techniques and provides detailed fact sheets

Supplementary information

Supplementary information accompanies this paper at <https://doi.org/10.1186/s12302-019-0244-7>.

Additional file 1. RiBaTox fact.

Abbreviations

NORMAN: Network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substances; RiBaTox: Web tool on River Basin Specific Toxicants; WFD: Water Framework Directive.

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KJMK, FS and LP conceptualized and drafted the manuscript. The other authors helped to further elaborate the manuscript and contributed specific aspects. All authors read and approved the final manuscript.

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