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The SOLUTIONS project: Challenges and responses for present and future emerging pollutants in land and water resources management

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ABSTRACT

SOLUTIONS (2013 to 2018) is a European Union Seventh Framework Programme Project (EU-FP7). The project aims to deliver a conceptual framework to support the evidence-based development of environmental policies with regard to water quality. SOLUTIONS will develop the tools for the identification, prioritisation and assessment of those water contaminants that may pose a risk to ecosystems and human health. To this end, a new generation of chemical and effect-based monitoring tools is developed and integrated with a full set of exposure, effect and risk assessment models. SOLUTIONS attempts to address legacy, present and future contamination by integrating monitoring and modelling based approaches with scenarios on future developments in society, economy and technology and thus in contamination. The project follows a solutions-oriented approach by addressing major problems of water and chemicals management and by assessing abatement options. SOLUTIONS takes advantage of the access to the infrastructure necessary to investigate the large basins of the Danube and Rhine as well as relevant Mediterranean basins as case studies, and puts major efforts on stakeholder dialogue and support. Particularly, the EU Water Framework Directive (WFD) Common Implementation Strategy (CIS) working groups, International River Commissions, and water works associations are directly supported with consistent guidance for the early detection, identification, prioritisation, and abatement of chemicals in the water cycle. SOLUTIONS will give a specific emphasis on concepts and tools for the impact and risk assessment of complex mixtures of emerging pollutants, their metabolites and transformation products. Analytical and effect-based screening tools will be applied together with ecological assessment tools for the identification of toxicants and their impacts. The SOLUTIONS approach is expected to provide transparent and evidence-based candidates or River Basin Specific Pollutants in the case study basins and to assist future review of priority pollutants under the WFD as well as potential abatement options.

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1. Introduction

“Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such.” The claim by the EU Water Framework Directive (WFD) that water is a key resource for ecosystems and human life is still in contrast with an often poor ecological status in many European rivers and lakes. The Blueprint to Safeguard Europe's Water Resources (European Commission, 2012a) and the Commission assessment of the Member States River Basin Management Plans (RBMPs) (European Commission, 2012f) states that a good ecological status is currently achieved in only 43% of the reported freshwater bodies and even the additional measures included in the plans are not expected to increase this to over 53% by 2015. Previous projects have shown that chemical contamination may have significant effects on aquatic ecosystems (Hein et al., 2010). However, the assessment of chemical status indicates that a large proportion (about 40%) of the EU water bodies have an unknown status due to insufficient monitoring in many Member States. Still, the monitoring programmes initiated under the WFD have accumulated vast amounts of data on contamination and on the ecological status of surface waters in the EU (European Environment Agency, 2012). At the same time, a wealth of chemical property and environmental data from registration of chemicals (e.g. REACH (European Chemical Agency, 2014), biocides (European Commission, 1998), plant protection products (European Commission, 2009) and pharmaceuticals (European Commission, 2010)) is gradually becoming available. Although toxic effects on aquatic life are regularly observed, it remains a great challenge to link occurrence of chemicals with the ecological status of waters, to identify major chemical stressors that would call for management, and to find efficient solutions for the abatement of pollution-related risks. Typically, complex mixtures of priority pollutants, emerging substances, by- and transformation products, and natural compounds co-occur in aquatic systems, thus rendering a comprehensive assessment challenging. Emerging substances include a multitude of polar and even ionic compounds for which many of the models developed for classical non-polar persistent organic pollutants (POPs) do not apply. Exposure resulting from direct emissions by point sources and by diffuse sources such as remobilisation from contaminated sediments, groundwater input, soil run-off, or atmospheric deposition is variable in time and space. Pollution may affect a multitude of targets in organisms, populations, and communities. The sheer number of potentially harmful chemicals challenges chemical monitoring and consequently there is a good chance that adverse impacts from

unknown or unexpected chemicals and mixtures on aquatic communities and human health remain unrecognised. The problem is aggravated by analytical detection limits that may be too high for detecting chemicals below their predicted no-effect-concentrations (PNEC). There is also a lack of understanding regarding sources, transport pathways, transfer times, fate, and mixture effects, together with insufficiently developed modelling capacity. Finally, a better understanding is required of how to link early biological responses to chemical exposure detectable in bioassays and biomarkers to ecological responses at the population and community level (Ankley et al., 2010; Segner, 2011).

The EU-FP7 project SOLUTIONS is addressing these challenges by developing approaches to alleviate and prevent chemical pressures on Europe's water bodies and to strive for the goals of the WFD. These approaches are designed as interactive processes between hazard identification efforts and problem solving options (National Research Council, 2009) and by continuously involving stakeholders as well as a think tank. SOLUTIONS will help to develop a harmonised and transparent procedure for setting up lists of candidate River Basin Specific Pollutants (RBSPs) in support of the ecological status assessment, and will further support the review and update of the list of WFD priority substances that applies in chemical status assessment (European Commission, 2013). This goal requires improved procedures for the identification and prioritisation of emerging pollutants, and the development of new criteria and predictive tools for new and unrecognised pollutants, together with scientifically sound assessments of mixtures and options for their management. To this end, SOLUTIONS combines, integrates and validates monitoring- and modelling-based approaches and evaluates potential opportunities for improved coherence between water quality regulation (WFD and Drinking Water Directive) and regulations for market authorisation such as REACH.

Biological responses and chemicals will be identified with tools that are not based on pre-conceptions of effects or compounds present. Currently, the focus is often on pre-selected biological endpoints and targeted compounds with the aim of defining the specific toxic burden of aquatic ecosystems and for human health. SOLUTIONS has the vision of understanding the overall and cumulative ecological and human health impact of all chemical substances relevant for European water resources, which will also address also the objectives of the Blueprint to Safeguard Europe's Water Resources (European Commission, 2012a) whose time horizon is closely related to the EU's 2020 Strategy, the European Innovation Partnership on Water (European Commission,

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