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Brief Communication

The EU Green Deal's ambition for a toxic-free environment: Filling the gap for science-based policymaking

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Abstract

Around the world, many ambitious environmental conventions and regulations have been implemented over recent decades. Despite this, the environment is still deteriorating. An increase in the volume and diversity of chemicals is one of the main drivers of this deterioration, of which biodiversity loss is a telling indicator. In response to this situation, in October 2020, a chemicals strategy for sustainability (CSS) was published in the EU. The CSS is the first regional framework aiming to address chemical pollution in a holistic manner. The CSS covers the complete lifecycle of a chemical, including the design of better substances and remediation options, to remove chemicals from the environment. The strategy contains terms, such as a "toxic-free environment," for which no clear definition exists, potentially hampering the implementation of the CSS. In this paper, a definition for a "toxic-free environment" is proposed on the basis of a survey and a discussion held at the 2020 SETAC Europe Annual Meeting. In addition, key issues that are absent from the CSS but are considered to be key for the realization of a toxic-free environment are identified. To achieve the policy goals, it is recommended to align the definition of risk across the different chemical legislations, to establish a platform for open data and data sharing, and to increase the utility and use of novel scientific findings in policymaking, through the development of a strong science to regulation feedback mechanism and vice versa. The paper concludes that environmental scientists have the tools to address the key challenges presented in the CSS. However, an extra step is needed by both policymakers and scientists to develop methods, processes and tools, to increase the robustness and transparency of deliberation processes, and the utility of science. *Integr Environ Assess Manag* 2021;17:1105–1113. © 2021 The Authors. *Integrated Environmental Assessment and Management* published by Wiley Periodicals LLC on behalf of Society of Environmental Toxicology & Chemistry (SETAC).

KEYWORDS: Environmental pollution, Green Deal, Regulatory risk assessments, Science–policy interface, Toxic-free environment

INTRODUCTION

Chemical substances provide vital services for our health, food security, and daily life. The use of chemicals is intimately linked to our society's modern lifestyle and has steeply increased over recent decades (Bernhardt et al., 2017). Wang et al. (2020) provided a global overview of chemicals on the market, which showed that over 350 000 chemicals and mixtures of chemicals have been registered for production and use. Despite their increased use, relatively little is known about the possible adverse effects of the vast majority of chemicals on the environment and human health (European Environment Agency, 2019). Global chemical sales, excluding pharmaceuticals, are expected to double from 3.47 trillion euros in 2017 to 6.6 trillion euros by 2030 (United Nations Environment Programme, 2019).

The World Health Organization (2018) estimated the burden of disease that can be prevented by sound management of chemicals as approximately 1.6 million lives and approximately 45 million disability-adjusted life years (DALYs) in 2016, corresponding to 2.7% and 1.7% of total

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global deaths and global DALYs, respectively. Landrigan et al. (2018) identified air pollution as the worldwide number one cause of premature deaths. Chemical pollution is identified as one of the main drivers behind biodiversity decline (IPBES, 2019). There is increasing evidence of adverse chemical effects on wildlife and ecosystems (Johnson et al., 2020). Examples include the effects of neonicotinoids on bee health (Woodcock et al., 2017), and the effects of sunscreen UV filters on coral reefs (Wijgerde et al., 2020).

In numerous countries around the world, chemicals legislation has been established to manage the adverse effects of chemicals. In the United States, the first pesticides law was established in 1972 and the Toxic Substances Control Act has been in place since 1976. Global agreements have been made to regulate chemicals, including the Basel Convention, the Rotterdam Convention, the Minamata Convention, and the Stockholm Convention (UNEP, 2019, 2020a, 2020b, 2020c). During the 2002 World Summit on Sustainable Development, it was agreed that the safe management of chemicals, throughout their lifecycle, should be achieved by the year 2020. In addition, all UN Member States adopted the 2030 Agenda for Sustainable Development, including the 17 Sustainable Development Goals (SDGs). Several of these SDGs are linked to chemicals, including SDG2 (Safe food and sustainable agriculture), SDG3 (Good health), SDG6 (Clean water), SDG8 (Safe working environments), SDG11 (Sustainable cities), SDG12 (Sustainable consumption and production patterns), SDG14 (Protection of ecosystems), and SDG15 (Protecting biodiversity).

In Europe, the chemicals policy has evolved since the 1960s and has generated over 40 pieces of legislation. As stated in the consolidated version of the Treaty on European Union (Article 191, EU 201 6/C 202/01), all European policies on the environment should be based on the precautionary principle, on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at the source, and that the polluter should pay (European Union, 2016). The precautionary principle means that decision makers should adopt precautionary measures when a scientific evaluation does not allow the risk to be determined with sufficient certainty (EC, 2000). Risk assessments of chemicals allow safe exposure levels to be determined, according to the context of the authorized use under REACH, pesticide, biocide, and pharmaceutical legislations. Although there are synergies between the risk assessments, analyses also show that cooperation, harmonization, and information exchange between different legislations need to be further improved, and opportunities for this have been identified (Munthe et al., 2019; van Dijk et al., 2020).

The European Commission (EC) recently adopted eight political priorities in the EU Green Deal (EUGD), of which some are particularly relevant to the challenge of chemical sustainability (EC, 2019). This includes the zero-pollution ambition for a "toxic-free environment" but also relates to the ambition around biodiversity (EC, 2020c) and that of a "fair, healthy and environmentally-friendly food system" as expressed in the Farm-to-Fork Strategy (EC, 2020a). This builds upon the 7th European Action Programme, which aimed to achieve a non-toxic environment. The EUGD does not focus only on the state of the European environment, it also has a global dimension, by supporting the EU's commitment to the UN SDGs and the World Summit on Sustainable Development. The EUGD defines the actions related to a toxic-free environment: Pollution prevention as well as measures to clean and remedy it, restoration of natural functions of ground and surface water, addressing pollution from industrial installations and creating a chemicals strategy for sustainability (CSS). The CSS aims to protect human health and the environment and encourages innovation in the chemical sector by outlining multiple goals and actions. The strategy is an opportunity to rethink the EU's approach to chemicals management and would stop the most hazardous substances from entering the European market. Figure 1 shows the main topics and actions that are addressed in this paper and in the CSS, to achieve a toxic-free environment.

Independent scientific advice has an eminent role in European policymaking and can contribute directly to improving the quality of legislations (EC, 2016a). There is, however, a need for a strong science–policy interface to effectively manage chemicals, in which scientists are involved in the decision making processes, while policymakers have direct access to experts in the scientific community (Wang et al., 2019, 2021). Setting aside political and business considerations, and focusing strictly on the scientific foundation, this paper builds on a Discussion Forum held in a multi-partite setting at the 2020 Society of Environmental Toxicology and Chemistry (SETAC) Europe Annual Meeting, which was a virtual event. The Discussion Forum was informed by a survey of the SETAC scientific community (Supporting Information files S1 and S2). Building on these outcomes, this paper has three aims. First, the meaning and implications of the term "toxic-free" used in the EUGD are explored. Second, knowledge and communication gaps raised in the survey and Discussion Forum are discussed. The final aim is to identify actions that are required to address the described gaps. An outlook is also presented and recommendations are given on how to provide a strong scientific basis for the measures required to execute on the EUGD.

GAPS TO ACHIEVE A TOXIC-FREE ENVIRONMENT

Establishing common ground—Definition of "toxic-free"

First of all, it is essential to determine what concepts such as "toxic-free" mean, to understand what is required to achieve this target and to involve stakeholders. The importance of this has been demonstrated by the "circular economy" concept, which has over 100 different interpretations. It is argued that these different interpretations hamper the implementation of the circular economy and could eventually result in the collapse of the concept

(Kirchherr et al., 2017). The EUGD's toxic-free environment and zero pollution ambition are to build upon previous EU ambitions for a nontoxic environment (EC, 2017). The new term "toxic-free environment" is considered, by some, to be political, while for others, the phrase might appear non-scientific as, in the end, everything can be toxic depending on the dose or concentration. However, this ambition appears to reflect the opinion of society, as many Europeans are concerned about the environmental impact of chemicals present in everyday products (EC, 2016b). In the CSS, a toxic-free environment is described as an environment "… where chemicals are produced and used in a way that maximizes their contribution to society including achieving the green and digital transition while avoiding harm to the planet and to current and future generations." However, to determine how the risk of chemicals should be assessed and what risk management decisions need to be taken on a regulatory level, we argue that a more specific definition is needed for the successful implementation of the concept.

In the survey of the SETAC scientific community (Supporting Information SI1), four definitions of the term "toxic-free" were presented (Figure 2). Twenty-five percent of respondents (25.2%) interpreted a toxic-free environment as "an environment in which only low-risk compound can be emitted." Thirty-two percent (32.2%) of the respondents considered this term to mean zero chemical emissions, of which 16.1% observed this as zero emission of synthetic chemicals to the environment and 16.1% as zero emission of any chemicals as a result of human activity. However, most respondents (42.6%) interpreted the term toxic-free environment as "an environment in which all chemicals can be emitted as a result of human activities, but in low concentrations, so that no adverse effects to organisms occur." For the remainder of this paper, the latter interpretation of the term "toxic-free" will be used. However, this definition of "toxic-free" raises other important points, including what is meant by "no adverse effects." Hence, as a next step, it will be crucial to define what organisms, functions, and environmental effects are to be protected, to achieve the toxic-free ambition (Supporting Information SI3). This step has also been identified as one of the priority research questions in the field of environmental sciences (van den Brink et al., 2018).

Addressing environmental concerns through an improved risk assessment framework

On a global scale, the EUGD is the first regional policy instrument that aims to address all chemical pollution and focuses on the whole chemical lifecycle. The EUGD starts with the design of better chemicals, moving through to the support of research and the development of decontamination methods. In the EU, it is acknowledged that chemical pollution can have long-term and large-scale environmental impacts, and the multiple aims and corresponding actions in the CSS cover a wide range of topics that need to be addressed, according to the EC (Figure 1). Mainly, the EC places emphasis on reducing the risks of endocrine-disrupting chemicals, chemicals that are mobile in the environment, PFAS and other persistent chemicals, and mixtures. However, by only focusing on these chemicals, a toxic-free environment will not be achieved, as there exist many more issues concerning chemical pollution of the environment.

The SETAC Global Horizon Scanning Project identified the specific research requirements to deliver the SDGs and move toward sustainable environmental quality (Fairbrother et al., 2019; Gaw et al., 2019; Leung et al., 2020; van den Brink et al., 2018). These research requirements mainly focus on developing a better understanding of the adverse impacts of stressors on environmental sustainability, but some are also directly related to policy and regulation. With regard to the ambition of a toxic-free environment, it will be key to update regulatory risk assessments with new knowledge about exposure and effects.

Currently, risk assessments used within the regulatory context do not reflect realistic conditions and, consequently, might underestimate the true risks of chemicals (Johnson et al., 2020; Schäfer et al., 2019; Topping et al., 2020). In the CSS, it is acknowledged that current regulatory and policy frameworks fail to take into account the long-term and large-scale environmental impacts of chemicals (and their mixtures) and their interaction with other (environmental) stressors. However, many of these interactions are not fully understood. At the SETAC Discussion Forum, it was highlighted that current risk assessments do not sufficiently consider where substances end up in the environment, nor do they accurately predict which non-target species will be affected.

The zero pollution ambition for a toxic-free environment implies a continuous improvement of the environmental status, but currently risk assessments do not predict the impact of a chemical, especially a persistent one, in years from now by continued emission. The future risk of chemicals is not explicitly covered in the CSS. However, this is essential as the fate and behavior might change and hence the risk of chemicals in the environment might be exacerbated, due to their accumulation and due to climate change (Bunke et al., 2019; Cousins, Ng, et al., 2019). Hence, to achieve policy goals and identify appropriate risk management actions, the variation of pollution and effects over space and time need to be considered in risk assessments. Identification of appropriate ex-ante management actions to protect the environment and human health is key, as it can be very challenging to ex-post remove chemicals once they are present in the environment (Cousins et al., 2016; Kümmerer et al., 2018).

Simplifying the legal framework: One substance–one assessment

In the EU, chemical risks are assessed per sector (e.g., pesticide, pharmaceutical, and industrial chemical) and assessment schemes of these sectors differ. The result is inconsistent outcomes, such as a chemical being banned under one but approved under another framework (van Dijk et al., 2020). Inconsistent risk assessments can create public mistrust, as with glyphosate and bisphenol-A (van Straalen & Legler, 2018; Vandenberg et al., 2009), for example. As a solution, the risk assessment process should be harmonized. The EU tries to achieve this by enabling a "one substance–one assessment" approach. With such an approach, one assessment can be used to define the environmental hazard potential of a chemical. It would be even better if the long-term and combined exposures were considered so that a more holistic risk assessment would be achieved. There are plans at the EC level to combine efforts that are currently performed separately, including regulatory instruments, databases, regulatory timelines, expertise involved, and IT tools (ECHA, 2020). However, experts agreed that there is currently not enough information available on chemical uses, emissions, and environmental fate to perform risk assessments that are inclusive for all uses and enable a "one substance–one assessment" approach. It will also be essential to have an understanding of the different types of uncertainties for each substance, as uncertainties have a role in framing what is considered as a risk (Supporting Information SI3).

The definition of risk is driven by regulations, and hence protection goals vary depending on the type of application. During the Discussion Forum, concerns were raised about taking these different protection goals into account and it was questioned whether it is desirable for one risk assessment to be protective for all chemical uses. This is especially relevant for human health impacts, where, for example, genotoxic substances are by default banned for use as a pesticide, but pharmaceuticals with this property can still be marketed as treatment of diseases or symptoms when benefits outweigh the associated risks. For the environment, however, it is desirable to align and define specific protection goals, to protect the environment as a whole (Brown et al., 2017).

A comprehensive knowledge base on chemicals: Communication and open information

Information requirements. In the CSS, it is acknowledged that a comprehensive information base of all the substances placed on the European market is missing, which prevents proper management of chemicals (EC, 2020b). Currently, databases such as IUCLID and the IPCHEM could provide a good starting point for such an information base. Risk management decisions will, however, be based on risk assessment outcomes, for which open and transparent information on all chemical use and emission is essential to allow for accurate exposure estimations. As emphasized in the Discussion Forum, there is a lack of information on different chemical uses, emission volumes, and their spatial differences (van Gils et al., 2019), and this aspect is not yet picked up in the CSS. This implies that key uncertainties considering the environmental concentrations of chemicals will remain in place when framing what risk management actions are needed to reach a toxic-free environment. Therefore, the knowledge base should include information on the use and emission of chemicals. It is proposed to create a European Safety Data platform that spans all regulatory frameworks and that will connect with the EU Chemicals Legislation Finder and monitoring databases (Brack et al., 2019; ECHA, n.d.).

Information on a manufacturing process and substance use can currently be claimed under REACH to be confidential, for example, due to commercial interest or potential harm caused by publication. However, in 1998, it was agreed in the Aarhus convention—adopted by the EU in 2001—that chemical emission data are essential to protect the environment and should be openly available (Aarhus Convention, 1998). Moreover, the EC wants to adopt the concept of "essential use," as reported by Cousins, Goldenman, et al. (2019), to promote safe and sustainable chemicals, and to protect human health and the environment. For the essential use concept to be fully embedded in chemical risk management decisions, there is a need for information on chemical use to be openly available.

Science–policy interface. Almost half of the survey respondents from academia (44.2%) thought that a toxic-free environment is achievable, whereas a similar number of respondents from the industry sector (44.9%) did not think that a toxic-free environment can be achieved (Figure 3 and Supporting Information SI1). The EC aims to establish tools and practices to ensure that relevant academic data are easily and readily accessible for safety assessments, and are usable for regulatory purposes. Thus, strengthening the science–policy interface is important, and the CSS provides several actions for policymakers to achieve this. There is a need for scientists to be aware of how their science is received, to effectively inform policymaking (Spruijt et al., 2014) (Supporting Information SI3). When developing advice around chemical safety issues, there is a need for scientists to provide clarity and transparency (EU, 2019). It was shown that transparency improves science communication; for example, clearly communicating about the uncertainties and trade-offs is critical (Supporting Information SI1). Scientists can also play a key role by removing the hype around certain chemicals and highlighting the consequences of chemical use and non-use to the general public (Supporting Information SI3).

Capturing uncertainties and clearly communicating about them will improve stakeholder trust in scientists and their research (EC, 2019; van der Bles et al., 2020). Although there is an assumption that a consensus will be reached during discussions related to chemical safety, disagreements between experts can remain, as was the case for acrylamide and glyphosate (Rudén, 2004; van Straalen & Legler, 2018). To ensure that regulatory outcomes are robust, actionable, and democratic, it is of critical importance to provide procedural transparency (Beatty & Moore, 2010; McIlroy-Young et al., 2021; van der Sluijs et al., 2012). Finally, scientists need to engage in interdisciplinary interactions, when providing policy advice on issues that

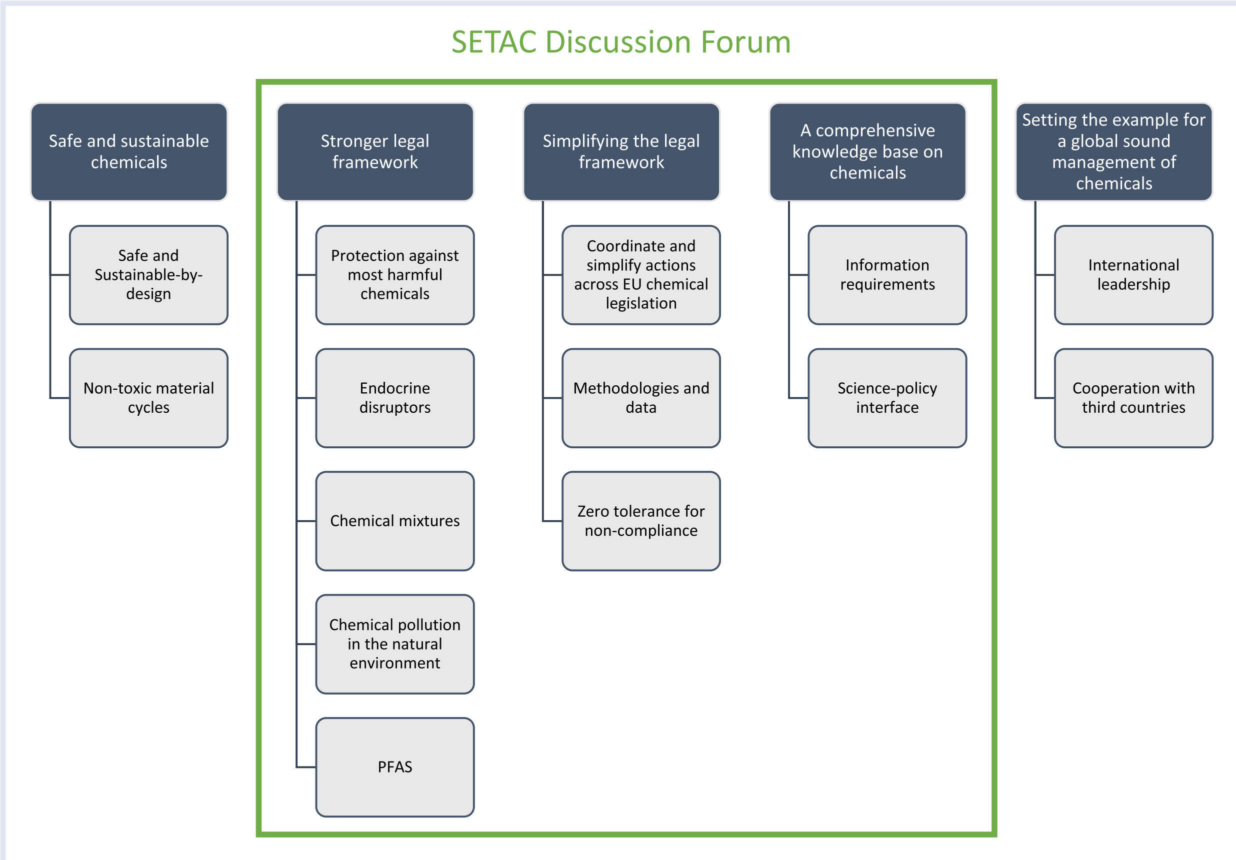

FIGURE 1 Topics covered in the new long-term vision for the EU chemicals policy, the Chemicals Strategy for Sustainability, to achieve a toxic-free environment (EC, 2020b). The green box highlights the topics discussed at the SETAC Discussion Forum and that are addressed in this paper. SETAC = Society of Environmental Toxicology and Chemistry

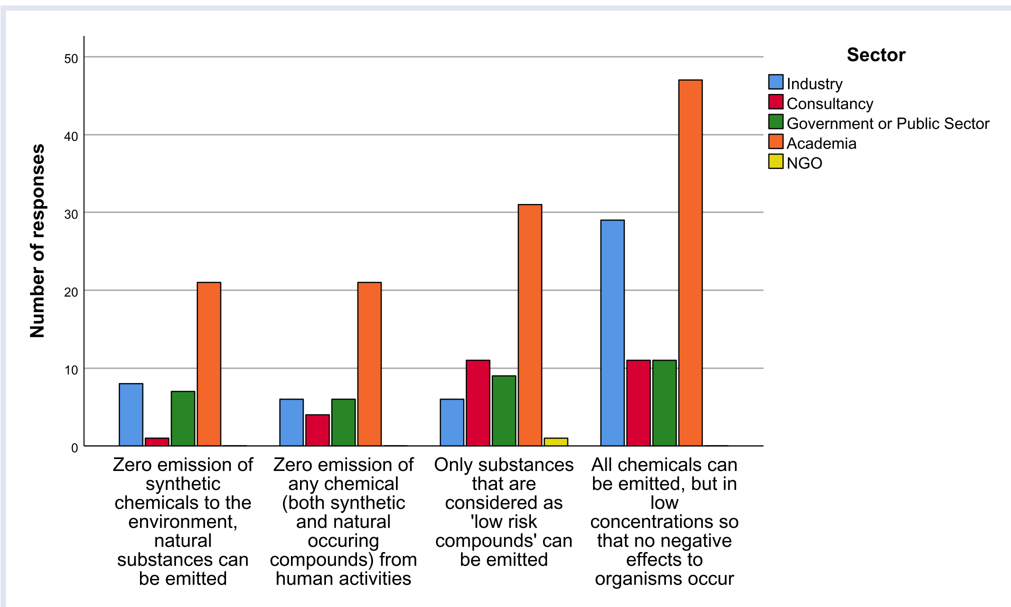

FIGURE 2 Interpretation of the term "toxic-free environment" by the survey respondents ($n = 230$) from the four different sectors represented within SETAC. SETAC = Society of Environmental Toxicology and Chemistry

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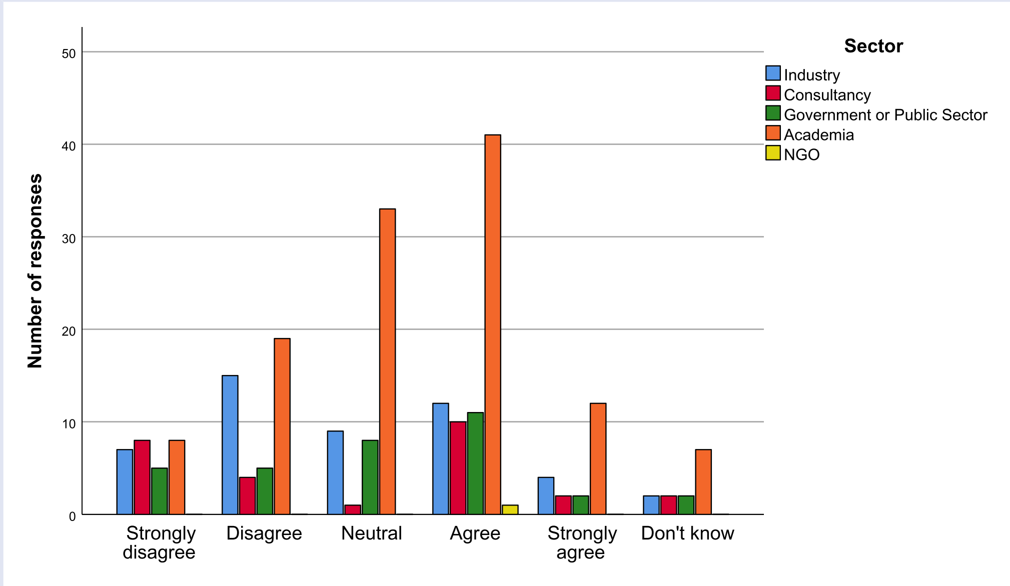

FIGURE 3 An indication of how achievable a toxic-free environment is according to the survey respondents ($n = 230$)

are embedded in a wider environmental, social, economic, legislative, and political context (Supporting Information SI3).

CONCLUSION AND OUTLOOK

For environmental scientists to contribute meaningfully to the CSS and the EUGD ambitions, the SETAC Discussion Forum (Supporting Information SI3) recognized the need for debate among environmental scientists and other disciplines, such as but not exclusive to civil engineers, environmental engineers, economists, and social scientists. By having regular exchanges and debates in (to be) established platforms, by participating in public consultations of the European strategies and action plans, and by contributing to impact assessment reports, policymakers can gather independent advice from a wide range of scientific sources. Where uncertainties exist, such an exchange provides the opportunity for additional consultation around complex areas. The Scientific Advice Mechanism, in cooperation with the Scientific Advice for Policy by European Academies, has recommended panel deliberation techniques, taking care that differing views are identified and recognized (EU, 2019). Unintended consequences of regulatory decisions will be minimized, as alternative approaches might have been foreseen during the deliberation, and thus making the final decision more robust (Beatty & Moore, 2010; McIlroy-Young et al., 2021).

During the SETAC Discussion Forum and the preparatory survey responses, the most recognized research requirements were: (1) The inclusion of spatial and temporal variation (mobility) in risk assessments, to predict future scenarios of global change. This need is also recognized by the GHSP in van den Brink et al. (2018). Closely connected is the need for improved emission data (van Gils et al., 2019) and to avoid using similar hazard data differently in different regulatory frameworks. (2) Given that ecosystems and humans are exposed to chemical mixtures and not to individual chemicals, there is a need to recognize which compounds drive the toxicity of these mixtures (van den Brink et al., 2018) and how these drivers vary in space and time (tying back to the first research requirement that was identified above). (3) It was identified by the SETAC Discussion Forum panel of experts that environmental researchers are inclined to describe a problem, whereas a future research need is to integrate solutions into the risk assessment and risk management process. An example of this approach is the EU-Project SOLUTIONS (Brack et al., 2019; Posthuma et al., 2019; van Wezel et al., 2017), which aimed at producing sustainable solutions for legacy, present and future chemicals that pose risks to environmental and human health in European watercourses.

The solutions aspect of this project includes a set of potential activities that are foreseen to protect or restore water quality, following hazardous impacts from chemicals. Abatement options are included, for example, improved wastewater treatment systems, as is the development of the concept of sustainable chemicals, as a forward-thinking solution.

There is an urgent need to strengthen the utility of science for policy and to improve the science–policy interface (Wang et al., 2021). Politicians require the simplification and standardization of risk assessments, but at the same time, it is essential that the use and utility of novel scientific findings are increased, through the development of a strong science to regulation feedback mechanism and vice versa. As scientists become more involved in the complex deliberations that are required to achieve policy targets, the need intensifies for methods, processes, and tools to increase the robustness and transparency of the deliberation process.

However, this can be addressed through interdisciplinary research efforts. Finally, an extra challenge will be to identify how concepts can be applied in a global setting, to address the impacts of chemical pollution in all regions of the world. The scientific community is already interconnected on a global level, so these communities have great potential to share experiences and, by doing so, accelerate the processes that lead to global environmental protection.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

This paper was partly based on a discussion forum that took place during the 2020 SETAC Europe Annual Meeting and a preparatory questionnaire on the EU Green Deal. Outcomes of the questionnaire and Discussion Forum can be found in the Supporting Information.

SUPPORTING INFORMATION

Survey Summary: A document describing the methods (including statistical analysis) and results of the analysis of the survey, which were used as preparatory information for the discussion forum.

Questionnaire Responses: All responses (anonymized) to the survey, which were used as preparatory information for the discussion forum.

Transcript from Green Deal Discussion Forum: Transcript of the main arguments given during the discussion forum.

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