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Original Article

Hazard/Risk Assessment

Priority setting for chemicals, waste, and pollution prevention: a risk-based strategy for environmental and human health protection

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Abstract

Chemicals provide numerous benefits that support and improve the health and welfare of humans and the environment in a wide range of applications. The environmental release of chemicals, however, can result in risks to humans and the environment. Minimizing and eliminating chemical pollution should thus represent an important goal for all stakeholders and rights holders. Recognizing the global concerns associated with chemical pollution, in 2022, the United Nations Environmental Assembly 5.2 approved the adoption of resolution 5/8, declaring that a science-policy panel should be established to contribute further to the sound management of chemicals and waste and to prevent pollution. Three years later, the Intergovernmental Science-Policy Panel for Chemicals, Waste and Pollution (ISPCWP) was established on June 20, 2025 at an Intergovernmental Meeting in Punta de Este, Uruguay. A globally harmonized approach and collective international effort can maximize the value of existing national efforts, overcome regional disadvantages related to socioeconomic and geopolitical factors, and fast-track international responses to emerging and legacy chemicals and waste issues. The mission of the ISPCWP will only be achieved with multi-stakeholder and rights owner engagement, a robust scientific foundation, and the sound implementation of policies. A conceptual framework is presented that supports a risk-based prioritization of issues and actions for environmental and human health protection. It is proposed that the conceptual framework provides a tool that can be adopted to support science-based prioritization, and which can facilitate transparency with respect to the decision-making process of the ISPCWP's work program.

Keywords: chemicals regulation, chemicals, waste and pollution, conceptual framework, risk assessment

Introduction

Chemical pollution, climate change, and biodiversity loss are interconnected and influenced by anthropogenic activity, and there are substantial concerns about their impact on human and ecological health (Groh et al., 2022). Chemical pollution occurs at various points throughout a chemical's life cycle—from sourcing and processing of raw materials, through manufacture and consumer use, to end-of-life and disposal. For example, chemical pollution can occur during the extraction and manufacture of petroleum products, including the consumption of fossil fuels, the use of chemicals in agricultural activities, accidental spills of hazardous materials, and the production and application of a wide variety of industrial and consumer products, including those that support medical and scientific advancements. There is often an emphasis toward assessing the release and subsequent exposure of chemicals at the end of their usable life, through urban and industrial waste, wastewater, and atmospheric combustion emissions. However, recent advancements have highlighted the need to consider the release of chemicals throughout their lifetime, for example, the leaching of chemicals from plastic and electronic consumer goods (Fantke et al., 2016; Li & Wania, 2016; Li et al., 2023; Sijm et al., 2007).

Waste sustainability involves managing waste in an environmentally responsible way, through a waste hierarchy (D'Inverno et al., 2024). Many manufactured products contain hazardous and persistent substances, for example, upholstered domestic furniture contains persistent organic pollutants that remain for extended periods of time, resisting degradation. This poses significant challenges to achieving a circular economy by impeding the reuse, recycling, and remanufacturing of products and materials (Drage et al., 2018). Therefore, considering safe and sustainable-

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by-design, prioritizing product life cycle safety and sustainability is key (Caldeira et al., 2022; Posthuma et al., 2024).

The United Nations Environment Programme (UNEP) facilitates a range of initiatives targeting key global challenges, including, but not limited to, climate change (through the Intergovernmental Panel on Climate Change), biodiversity loss (through the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), and plastic pollution (through the Intergovernmental Negotiating Committee on Plastic Pollution). At a fundamental level, there is an interconnectedness between the global impact of chemical pollution, climate change, and biodiversity loss, which can be addressed through international collaboration, cooperation, and coordination (Baste & Watson, 2022). In 2022, the United Nations Environmental Assembly 5.2 approved the adoption of resolution 5/8 declaring that a science-policy panel should be established to contribute further to the sound management of chemicals and waste and to prevent pollution (UNEP, 2022a). To initiate the process, an ad-hoc Open-Ended Working Group (OEWG) was formed, which included a UNEP Secretariat, 193 Member States, regional organizations, and representatives from civil society through UNEP's 9 accredited Major Group categories (Children and Youth, Farmers, Indigenous peoples and their communities, Local authorities, Non-governmental organizations, Scientific and Technological Community, Women, Workers, and Trade unions) or a status with a Multilateral Environmental Agreement, including, but not limited to, the Basel, Rotterdam, and Stockholm Convention.

Following five OEWG meetings, the Intergovernmental Science-Policy Panel for Chemicals, Waste and Pollution (ISPCWP) was established at an Intergovernmental Meeting on June 20, 2025, in Punta de Este, Uruguay (Bloor, 2025; UNEP, 2025). The ISPCWP is an important step forward for the sound management of chemicals, waste, and pollution. It will highlight the global challenge of chemicals and waste and eradicate the existing siloed approach for dealing with and responding to these global and complex wicked problems. The establishment of a harmonized approach to tackle chemicals, waste, and pollution is paramount to addressing human health and environmental protection goals (Brack et al., 2022). This approach directly supports several UN Sustainable Development Goals (SDGs; UN Department of Economic and Social Affairs [DESA], 2024), including SDG 3 (Health), SDG 6 (Clean Water), SDG 12 (Sustainable Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). It also indirectly supports SDG 9 (Industry and Innovation), SDG 11 (Sustainable Cities), and SDG 17 (Partnerships) by encouraging sustainable practices and global collaboration.

It is anticipated that a globally harmonized approach to address chemical pollution will provide support to existing national efforts and will also be able to help address regional disadvantages related to socioeconomic and geopolitical factors (e.g., when Europe and the United Kingdom banned Chlorothalonil in 2020, large volumes of the pesticide were transported to developing countries, such as Costa Rica, which does not have a ban in place) and will fast-track international responses to emerging and legacy chemicals and waste issues (Naidu et al., 2021). However, this can only be achieved through stakeholder and rights owner engagement, a robust scientific foundation, and the UN DESA implementation of policies (Awewomom et al., 2024).

The Society of Environmental Toxicology and Chemistry (SETAC), founded in 1979, is a professional, multisectoral, membership-based scientific society comprised of ecotoxicologists, environmental risk assessors, risk managers, environmental scientists, and life cycle analysis practitioners. The SETAC mission is to advance environmental science and management, based on its principles of multidisciplinary approaches, sectoral balance, and science-based objectivity. Its global network of environmental experts makes SETAC especially suited to partner in any endeavor aiming to better understand and improve our environment. The SETAC is accredited to UNEP's Scientific and Technical Community Major Group and had observer status for the OEWG. To coordinate SETAC's contributions to the policy dialogue at UNEP and the OEWG, it established an advisory panel on chemicals management (SETAC CheM). The members of the SETAC CheM are appointed by the SETAC World Council, guided by the SETAC principles of sectoral balance, interdisciplinarity, and focus on science-based objectivity. The authors of this paper are members of the SETAC CheM.

Conceptual framework and its elements

The SETAC CheM created a conceptual framework intended to organize multifaceted elements that support a risk-based prioritization of issues and actions for environmental and human health protection (Figure 1). The intention of the framework is to help prioritize the work program for the ISPCWP, and it is intended for use by scientists, policy makers, stakeholders and rights holders, or any other audiences involved in addressing the chemical pollution and waste crisis. The conceptual framework is built upon key scientific principles, with consideration of socioeconomic and geopolitical factors and values. Priority setting is achieved through a multi-criteria assessment approach, where the fundamental basis builds on a transparent and well-defined formulation of the problem that is under consideration. In the context of problem formulation, many factors need to be considered, such as data availability and data reliability to support a fit-for-purpose assessment of the drivers and the receptor states, which may require risk management in instances where an unacceptable risk is identified. The conceptual framework draws upon the categories defined in the DPSIR causal framework for reporting on environmental issues—drivers, pressures, states, impacts, and responses [European Environment Agency (EEA), 1999]—to describe the interactions between society and the environment.

The conceptual framework is intentionally grounded in a risk-based approach, as it is recognized that both environment and human health protection require integrating the hazards of chemicals with factors influencing exposure. While hazard identification represents an essential component of chemical assessment, a risk-based conceptual framework better accommodates a holistic prioritization-based approach, which includes consideration of the likelihood, magnitude, and scale of potential impacts that are associated with evidence of exposure. Importantly, the conceptual framework has been designed with flexibility, allowing for adaptation to address a variety of applications depending on the problem context. Consequently, the framework can be adapted to address issues of varying complexity, which may include considerations of non-linear relationships.

Hazard-based applications, for instance, where data or policy contexts limit exposure assessment, or where precautionary measures are warranted for a particular context, typically follow a linear process, based on evaluating the hazard that a chemical represents against various screening-level criteria. Decisions are thus based on a binary result—either the chemical meets or does not meet the hazard criteria, a process that may not be sufficient at addressing the potential uncertainty related to the quality and reliability of available hazard-property data. Alternatively, the results from a hazard-based approach may represent important information toward identifying key data gaps, helping to guide the collection of

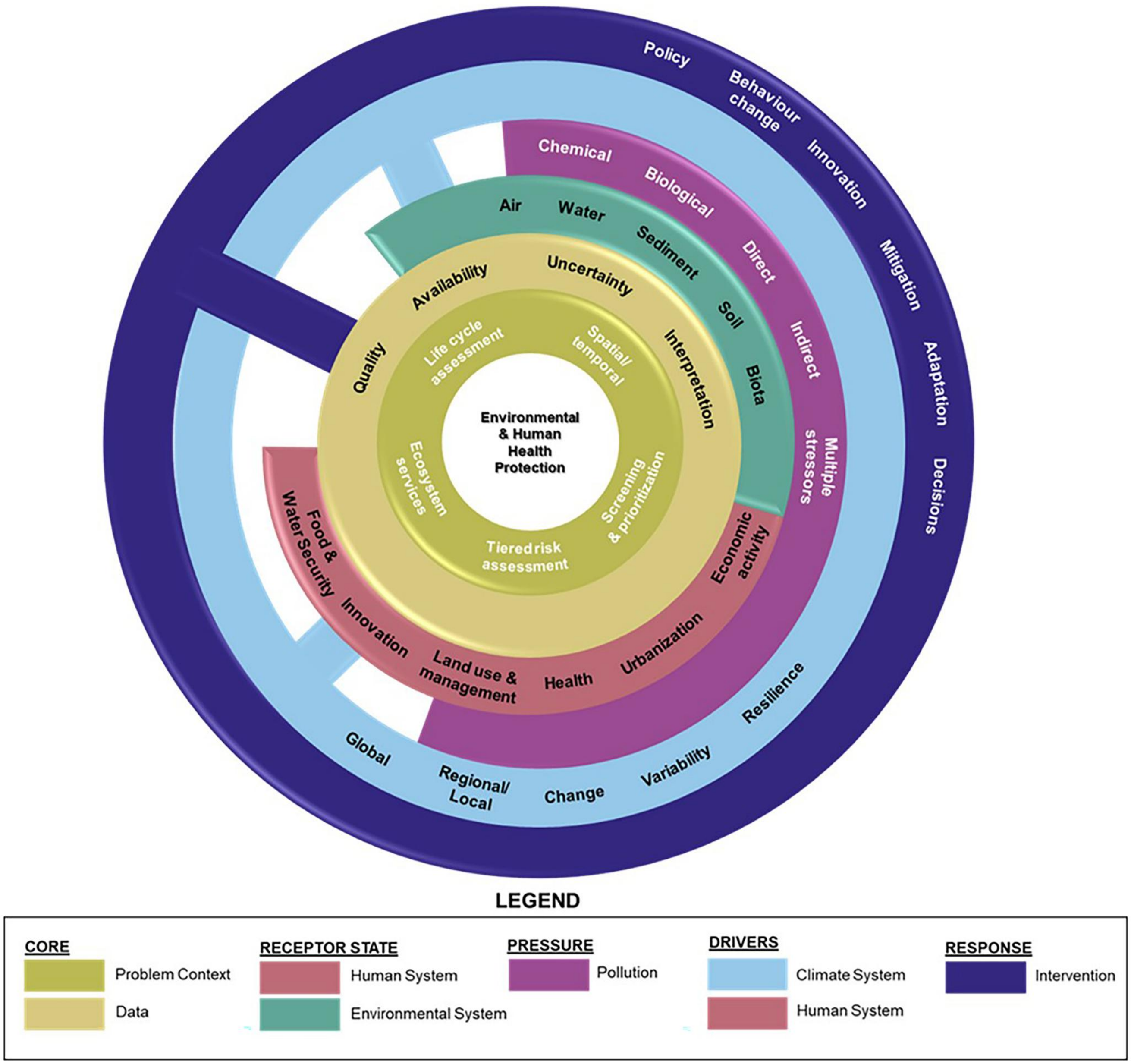

Figure 1. Conceptual framework to guide the setting of priorities in the space of chemicals, waste, and pollution prevention. Each shell represents an element, and the spokes illustrate connectivity between the elements. The adoption of concentric rings to illustrate the different elements and their connectivity aims to communicate the adaptability of the framework to address different issues, which may represent either linear or non-linear problems, ensuring that the framework is flexible and fit-for-purpose.

critical data and/or helping to inform mitigation strategies, the process of which may potentially be non-linear, requiring activities to be conducted in parallel, as opposed to being sequential. The overall flexibility illustrated in the conceptual framework thus enables a process that aims to inform both risk management and precautionary hazard-based interventions but which also supports science-based decision-making across diverse contexts, including regulatory and geographic and issue-specific needs. For these reasons, we have avoided being overly prescriptive with respect to the operationalization of the framework.

The conceptual framework's goal of environmental and human health protection is the central framing around which each of the elements is built. The core of the conceptual framework considers data, assessment methodologies, and problem context because of their importance to understanding drivers, receptors, pressures, and responses. Surrounding the core are human and environmental systems. The climate system and human system act as both a receptor and driver. Pressure in the form of chemicals, waste, and pollution is represented in the next layer, interfaced with the climate, human, and environmental systems that it affects. Finally, intervention is the outermost layer, representing a constructive international approach to the threat posed by pollution. A shell-based conceptual framework is used to reflect the connectivity between the different elements, but which also aims to communicate the flexibility to address either linear or non-linear issues that may arise. While the conceptual framework offers a tool to prioritize issues in the space of chemicals, waste, and pollution, we acknowledge that it is not exhaustive, whereby we encourage its future evolution to accommodate additional concepts as they are encountered.

Core

At the center of the conceptual model is the overall goal of environmental and human health protection. However, the use of this conceptual framework is dependent on the two other elements of the core, the problem context and data, which ensure assessment goals are focused and achievable.

Problem context

Problem context, or problem formulation, represents the initial step and primary element required to apply and use this conceptual framework. It provides the context around the core goal to frame the required considerations and actions and to identify the appropriate approaches and methodologies. For example, the problem formulation may focus on the need to screen and prioritize the most urgent environmental issues for strategic planning or resource allocation. Alternatively, there may be a need to identify priority areas for data collection or monitoring, or the concern may be related to addressing the development and application of risk reduction or mitigation strategies.

Different and complementary approaches can be implemented to address and evaluate chemical pollution, depending on the specific context and scope. These may include life cycle assessment, screening and prioritization tools, assessment of ecosystem services, the application of a tiered risk assessment approach, and specific considerations of spatial and temporal issues. Clarification of the problem within the context of these different approaches represents the primary step. This is critical, because an evaluation of the availability, reliability, and quality of data to support an improved characterization and quantification of the impact of chemical pollution on the environment and human health may vary depending on the approach defined. Consequently, problem formulation is needed to ensure that the data and methodologies adopted are fit-for-purpose. Although the conceptual model identifies specific elements that should be considered within the problem context, this is not an exhaustive list of all potential considerations.

- **Tiered risk assessments** are guided by simplified and conservative assumptions, with each step progressing from low to high tiers in a linear process. Low tiers, for example, can be supported by sensitivity and uncertainty analysis, the result from which is to screen and prioritize next steps toward guiding the decision-making process (Etterson, 2022). Risk in the context of the conceptual framework represents an approach that integrates both exposure and effects.
- **Spatial and temporal:** Trends in sources, pathways, bioavailability modifiers, receptors, and effects (including mixtures or multiple stressor interactions) affect current and projected risk and represent a variety of factors, directly and/or indirectly related, that should be considered. The exposure assessment should include source apportionment covering point, diffuse, and natural sources of chemicals, and their resulting concentrations, behaviors, and sinks. The effects assessment should incorporate the assessment of direct and indirect impacts on the environment, human health, and cultural and socioeconomic aspects.
- **Screening and prioritization:** Screening-level tools and approaches are critical for prioritization, particularly of new chemicals and chemicals of emerging concern. Screening tools may fit within a tiered-risk assessment framework and can include new assessment methodologies, such as in silico structure–activity relationships, or existing frameworks, such as outlined in Annex D of the Stockholm Convention, whereby a candidate chemical is assessed against persistence, long-range transport, and bioaccumulation criteria as a preliminary evaluation (Moore et al., 2023). The chemical grouping approach, which organizes chemicals into categories based on shared features, could also be used, as it allows for read-across and category-based evaluations for data-poor chemicals based on data from well-studied substances (European Chemicals Agency, 2017; Organisation for Economic Co-operation and Development [OECD], 2014).
- **Life cycle analyses and life cycle impact assessment:** These approaches use existing frameworks to evaluate environmental and human health impacts of chemicals throughout their entire life cycle—from raw material extraction and production to use and disposal. These assessments should not be narrowly focused and incorporate impact categories beyond climate change (i.e., carbon reductions and greenhouse gas emissions), including improved and accessible data sources and regional environmental effects. For example, the SETAC/UNEP Life Cycle Initiatives have developed approaches to evaluate the impact of chemicals, which include their impact on human health and the environment (Garman et al., 2021; Meskers et al., 2024).
- **Ecosystem services:** Ecosystem services approaches center around understanding and valuing the benefits that natural ecosystems provide to humans, with benefits generally characterized into four service categories: provisioning (e.g., food and water), regulating (e.g., floods, disease, and natural hazards), supporting (e.g., nutrient cycling), and cultural (e.g., recreation, spiritual, and cultural), (Millennium Ecosystem Assessment, 2005). These approaches are commonly used in sustainable resource management and conservation planning.

Data

Data and information are the other key aspect of the conceptual framework's core. These allow an understanding of the extent and impact of the problem, can inform the prioritization of mitigation actions, and can be used to quantify progress toward achieving protection goals. However, to ensure transparent and robust evaluations, data used to address the problem context need to be assessed for their reliability, quality, relevance, and interpretation. As well, a multiple line of evidence will help provide robust assessment. Critical data evaluation, characterization of uncertainty and variability, and transparency in interpretation are necessary for a multicriteria assessment of risk. Consideration for how to manage limitations in the state of knowledge and the absence of information is important to ensuring that the ISPCWP addresses emerging threats. In this context, it may be helpful to identify progress enablers, such as in the form of policies, Multilateral Environmental Agreements, chemical inventories, data tracking and reporting, data repositories and accessibility, state of knowledge reviews, and scientifically accepted frameworks. These may accelerate and greatly support the ISPCWP without duplication of effort. Within this context, it is important to acknowledge that regulations are not often globally harmonized, and that they may have different protection goals and ambitions, which could result in regional disadvantages for the implementation of recommendations. Identifying and evaluating the implications within the core problem formulation and data-gathering activities is thus critically important.

Clarity with respect to the problem formulation helps to identify an appropriate approach and should thus correspondingly support an efficient assessment of the data availability and/or help prioritize the need to acquire additional fit-for-purpose data. Defining the core elements of problem formulation and data will subsequently help to support the characterization of the drivers.

Drivers

The two main drivers with direct impact on the environment and human health are the climate and human systems. Within the climate system, factors, such as changes in global, regional, or local climate systems, variability, vulnerability, and resilience of the climate system, are identified as key factors that potentially influence the risks associated with chemical pollution. Changes in climate and weather patterns can also contribute to chemical and waste pollution due to the increased frequency, intensity, and duration of extreme events, including hurricanes, storms, and wildfires, among others. The human system influences chemical pollution by economic activities and social values related to human betterment and improvement. These include urbanization, health, land use and management, innovation, and food and water security, which are also interconnected with the aspirational objectives defined within the SDGs.

Receptor state

The receptor states characterize changes to the condition of environmental and human systems (e.g., physical, chemical, biological) that, in this case, may be impacted by chemical pollution. These include impacts to receptors, specifically to humans (health, societies, food and water securities, and economies) and the environment (biota, ecosystems, climate, biodiversity, and services) as well as their geopolitical and socioeconomic interdependencies. The economic and societal (including, but not limited to, rights holders, archeological values, etc.) cost of action and inaction can also be addressed within an assessment of risk or may be assessed in a comparative assessment of potential responses from the ISPCWP.

Pressure

The conceptual framework was developed assuming the main pressure on the system is chemical pollution. However, other pressures could also be considered, including physical, biological, indirect, or a combination of multiple concurrent stressors, as well as consideration of their persistency. This ensures that the framework resonates well with the premise of the exposomics research field: human health is to a large extent determined by the integrated chemical and non-chemical exposures to which individuals are exposed from conception to death (Wild, 2012). The conceptual framework, therefore, is flexible depending on the problem formulation and the availability and reliability of data to support a robust and effective assessment, which can be used to prioritize and identify effective risk mitigation options.

Response

The outer shell represents the response to the issue. These responses would require action in the form of policy development, alignment across decision makers, behavioral change, innovation, adaptation, and/or mitigation.

The conceptual framework ensures that responses are considerate of socioeconomic and geopolitical factors influencing the impact of chemicals throughout their life cycle, as well as different environmental compartments and exposure pathways. From this basis, the ISPCWP will be well positioned to fulfill its functions of recommending responses supported by scientific evidence without being policy prescriptive, raising awareness of issues, facilitating connections between scientists and policymakers, and enabling capacity building.

Consistent with UNEA 5.2, Resolution 5/7, an effective response should also encompass sustained financial support to strengthen national capacity, enable policy development, and implement agreements, and to support technical assistance and knowledge sharing. Financial support is particularly critical in developing countries and economies in transition (UNEP, 2022b). The ISPCWP will not provide funding opportunities, but the UNEP Global Framework on Chemicals, the successor to the Strategic Approach to the International Chemicals Management, which was established in September 2023 at the 5th Session of the International Conference on Chemicals Management, does fund a small number of collaborative projects between Member States and stakeholders. For example, a potential project proposal might involve the collaboration of a professional scientific society and a specific geographical region to provide training courses. So, UNEP funding opportunities for capacity building initiatives are possible under the umbrella of chemicals, waste, and pollution.

Conceptual framework operationalization and path forward

The proposed conceptual framework is intended to be flexible, scalable, and could be modified based on fit-for-purpose applications. The operationalization of this conceptual framework starts with a structured approach for organizing thinking, identifying issues and priorities, and guiding evidence-based actions. By anchoring problem formulation in transparent, fit-for-purpose criteria—including data quality, relevance, and stakeholder and rights holder values—the conceptual framework ensures a systematic evaluation of complex challenges. Furthermore, the use of the multi-criteria assessment allows the identification of key drivers and vulnerable receptor states, helping the ISPCWP or other conceptual framework users to anticipate, contextualize, and respond to threats before they escalate. The operational use of the conceptual framework would benefit from expert opinion input, and could include scenario analyses, early warning systems, or horizon scanning exercises, ensuring that emerging issues are addressed proactively and in alignment with the panel's mandate.

To enhance the utility and uptake of the conceptual framework, several next steps have been undertaken and are envisioned. Between 2023 and 2025, the SETAC CheM engaged the broader scientific community through dedicated sessions at SETAC Annual and Biannual Meetings in Africa, Asia-Pacific, Europe, Latin America, and North America, with the intent of sharing the framework and soliciting input. The conceptual framework was also shared at 2.0 OEWG (December 11–15, 2023, Nairobi) with UNEP Secretariat, Member States, stakeholders, and rights holders for reflection and feedback. Outcomes from these activities provided direction to the original framework, leading to improvements to its components. However, there continue to be opportunities for further refinement. Future efforts may include the development of case studies to demonstrate practical application across different contexts, including emerging issues and data-limited scenarios. In parallel, efforts will be made to collaborate with national and local regulatory agencies to assess alignment with existing risk-based approaches and explore opportunities for integration into policy and decision-making processes. These activities will support continued development, encourage stakeholder and rights holder buy-in, and ensure that the conceptual framework remains adaptive, inclusive, and aligned with evolving priorities.

The conceptual framework encourages the inclusion of all stakeholders and rights holders

Stakeholders are defined as a person, group, or organization that has a vested interest (stake) in the outcome of the decision-making process. A stakeholder group is likely to be comprised of academics, government officers, communities of the impact zone, non-government organizations, communities benefiting from the activity, industry associated with the activity, and investors in the activity, among others. Rights holders are individuals or groups that possess legal entitlements or claims; in the context of this study, the authors are referring to Indigenous rights. Each stakeholder and rights holder will bring their own perspectives, perceptions on priorities, and acceptable change, which may conflict with other stakeholder and rights holder opinions. The conceptual framework can help stakeholders and rights holders to find common ground and agreeable baselines.

The conceptual framework encourages the inclusion of all stakeholders and rights holders that support the purpose and function of the ISPCWP. While there may be instances where stakeholders have real or perceived conflicts of interest with the potential to obstruct the function of the ISPCWP, exclusion of stakeholders based purely on affiliation, as has been argued previously (Schäffer et al., 2023), is ill-advised. Instead, a robust conflict of interest policy, a prioritization framework founded in high-quality and defensible research, and a strong procedural framework should be implemented.

The authors believe that inclusion of all stakeholders and rights holders provides a diversity of perspectives not readily available if some stakeholders are excluded:

- Stakeholders from industry and innovation centers in academic and research institutions are knowledgeable about novel chemicals, emissions pathways, and waste inventories, and have data associated with these metrics. These data may not be otherwise publicly available unless provided by these stakeholders because different national regulatory frameworks may or may not require them to be reported. Emerging issues, such as those that may be identified in horizon scanning activities (Fairbrother et al., 2019; Furley et al., 2018; Gaw et al., 2019; Green et al., 2023; Leung et al., 2020; Van den Brink et al., 2018), may also be known by stakeholders and rights holders with knowledge of the adoption of new technologies, chemicals, or rapidly expanding use or emissions of waste or chemicals.
- Socioeconomic aspects of pollution, including the cost of pollution and interventions to prevent pollution, need to be understood by the ISPCWP. The polluter pays principle is a practice where the polluter bears the cost of pollution control and abatement. It is a widely adopted principle of environmental management in international and national environmental policy and agreements, including those of OECD and European Union nations. Stakeholders adhering to the polluter pays principle offer a perspective about the consequences of interventions (to supply chains, costs, and environmental impacts) that could help inform ISPCWP assessments (Ataria et al., 2023, 2025).
- Outcomes-based environmental policies, where proponents need to demonstrate how their activities will comply with a desired environmental outcome, result in industry, government, and non-government stakeholders funding environmental research. This type of applied research may be highly relevant to the ISPCWP's function and complements publicly funded research.
- Rights holders also have a deep knowledge and understanding of their socioeconomic, cultural, and environmental resources and have unique challenges related to chemical pollution, with perspectives often underrepresented.
- As noted by UNEP, local and regional stakeholders, regardless of sector, and rights holders can adapt science-policy panel recommendations to national or local realities and liaise between UNEP and the local communities.
- Stakeholders and rights holders can also provide scientific, policy, and law expertise necessary for the implementation of the recommendations emerging from the ISPCWP.

The ISPCWP must ensure the data, knowledge, and information from all stakeholders and rights holders used in assessments are robust, fit-for-purpose, and meet appropriate ethical and transparency standards. That is, studies should be judged by their merit regardless of source.

Conclusions

Chemical pollution and waste management are complex challenges. A globally harmonized approach and collective international effort can maximize the value of existing national efforts, overcome regional disadvantages related to socioeconomic and geopolitical factors, and fast-track international responses to emerging and legacy chemicals and waste issues. This will only be achieved with multi-stakeholder and rights owner engagement and a robust scientific foundation, and the sound implementation of policies. The experience of SETAC's diverse membership in advancing environmental science and management means it is well-positioned to support this process. The conceptual framework presented here captures key elements that are critical to a robust prioritization of issues and therefore to the success of the ISPCWP. However, global harmonization alone may not be sufficient. Meaningful change driven by the ISPCWP can only be achieved through binding global commitments and accountability mechanisms that ensure the consistent implementation of science-based measures and policies.

Data availability

No data were generated or applied in the creation of the paper.

Author contributions

Michelle C. Bloor (Conceptualization, Investigation, Methodology, Project administration, Visualization, Writing—original draft, Writing—review & editing), Stijn Baken (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft, Writing—review & editing), Adriana C. Bejarano (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft,

Writing—review & editing), Tarryn L. Botha (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft, Writing—review & editing), Michelle Embry (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft, Writing—review & editing), Todd Gouin (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft, Writing—review & editing), Darren Koppel (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft, Writing—review & editing), Lorraine Maltby (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft, Writing—review & editing), Amanda Reichelt-Brushett (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft, Writing—review & editing), and Helena Silva de Assis (Conceptualization, Investigation, Methodology, Visualization, Writing—original draft, Writing—review & editing)

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Conflicts of interest

All authors are members of the Society of Environmental Toxicology and Chemistry.

Disclaimer

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